7. und 8. Oktober 2021

7. a 8. října 2021

Magdeburger Gewässerschutzseminar 2021

Magdeburský seminář o ochraně vod 2021

Revitalisierung von Gewässern und der Wasserhaushalt im Einzugsgebiet der Elbe ~ Tagungsband

Revitalizace vod a vodní režim v povodí Labe ~ Sborník

Magdeburger Gewässerschutzseminar
MGS
2021
Magdeburský seminář o ochraně vod

Hauptorganisatoren – Hlavní organizátoři:

UFZ HELMHOLTZ
Zentrum für Umweltforschung

WILDE MULDE

IKSE · MKOL

Mitveranstalter – Spolupořadatelé:

Bundesministerium
für Umwelt, Naturschutz
und nukleare Sicherheit

Ministerstvo životního prostředí

MINISTERSTVO ZEMĚDĚLSTVÍ

SACHSEN-ANHALT
Ministerium für
Umwelt, Landwirtschaft
und Energie

Hamburg
Behörde für Umwelt,
Klima, Energie und
Agrarwirtschaft

FGG ELBE

WWF

bfg

LHW

Český
hydrometeorologický
ústav

DHG
Deutsche
Hydrologische
Gesellschaft

VÚV
TGM

Povodí Ohře

POVODÍ LABE

POVODÍ VLTAVY

Die Veranstalter bedanken sich beim Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit für die finanzielle Unterstützung zum Satz und Druck dieses Tagungsbandes zum Magdeburger Gewässerschutzseminar 2021.

Organizátoři děkují Spolkovému ministerstvu životního prostředí, ochrany přírody a jaderné bezpečnosti SRN za finanční podporu při sazbě a tisku tohoto sborníku Magdeburského semináře o ochraně vod 2021.

Magdeburger Gewässerschutzseminar 2021
Magdeburský seminář o ochraně vod 2021

Das Magdeburger Gewässerschutzseminar 2021 dient auch der Information der Öffentlichkeit im Rahmen der Umsetzung der Wasserrahmenrichtlinie (RL 2000/60/EG) und der Hochwasserrisikomanagementrichtlinie (RL 2007/60/EG) in der internationalen Flussgebietseinheit Elbe.

Magdeburský seminář o ochraně vod 2021 je i součástí informování veřejnosti v rámci implementace Rámcové směrnice o vodách (2000/60/ES) a Směrnice o vyhodnocování a zvládání povodňových rizik (2007/60/ES) v mezinárodní oblasti povodí Labe.

INHALT / OBSAH

IKSE ~ MKOL

Fachbeiträge

Odborné příspěvky

Magdeburger Gewässerschutzseminar 2021

Magdeburský seminář o ochraně vod 2021

31. Jahrestag der Gründung der Internationalen Kommission zum Schutz der Elbe (IKSE)

31. výročí založení Mezinárodní komise pro ochranu Labe (MKOL)

Magdeburger Gewässerschutzseminar
MGS
2021
Magdeburský seminář o ochraně vod

Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe
1990 – 2021

8. Oktober 1990 in Magdeburg
Die Vertragsparteien unterzeichnen die Vereinbarung über die Internationale Kommission zum Schutz der Elbe (IKSE).

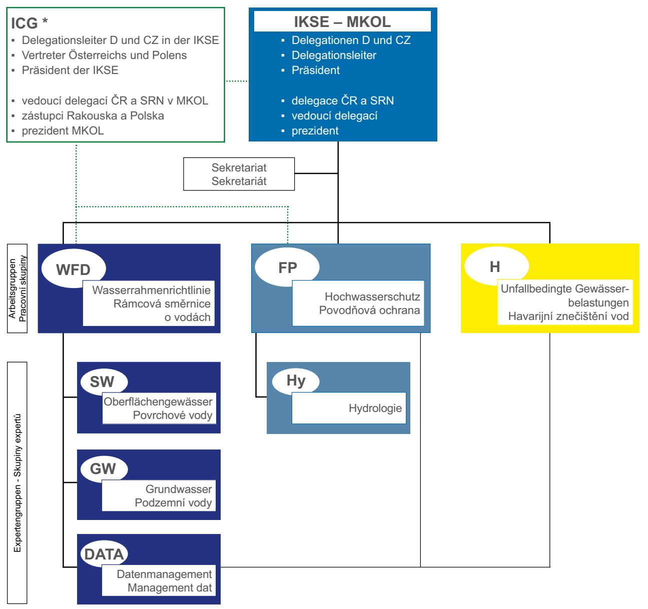
8. října 1990 v Magdeburku
Smluvní strany podepsaly „Dohodu o Mezinárodní komisi pro ochranu Labe“ (MKOL).

- ► Die **IKSE** erarbeitet Empfehlungen für die Vertragsparteien (Deutschland und Tschechien).
- ► In den Delegationen der IKSE, Arbeitsgruppen und Expertengruppen arbeiten ca. 120 Vertreter aus deutschen und tschechischen Ministerien, Behörden, Institutionen und wissenschaftlichen Instituten. Außerdem beteiligen sich an der Arbeit die Vertreter Polens, Österreichs und der NGOs.
- ► Arbeitssprachen der Kommission sind Deutsch und Tschechisch.
- ► Das Sekretariat der IKSE mit acht Mitarbeiterinnen und Mitarbeitern unterstützt die Arbeit der Kommission und ihrer Arbeitsgruppen fachlich, sprachlich und organisatorisch.
- ► Alle Veröffentlichungen werden zweisprachig abgefasst. Sie stehen auch auf den Internetseiten der IKSE zur Verfügung.

- ► **MKOL** vypracovává doporučení pro smluvní strany (Česká republika a Německo).
- ► V delegacích MKOL, v pracovních skupinách a ve skupinách expertů pracuje cca 120 zástupců českých a německých ministerstev, úřadů, institucí a vědeckých ústavů. Kromě toho se na práci podílejí zástupci Polska, Rakouska a nevládních organizací.
- ► Jednacími jazyky Komise jsou čeština a němčina.
- ► Osmičlenný sekretariát MKOL podporuje práci Komise a jejích pracovních skupin po odborné, jazykové a organizační stránce.
- ► Všechny publikace jsou vydávány dvojjazyčně. Jsou k dispozici také na internetových stránkách MKOL.

Nachdem die Elbe Ende der 1980er Jahre zu den am stärksten belasteten Flüssen Europas gehörte, war der gesellschaftliche Umbruch in Osteuropa für die Elbe Rettung in letzter Minute.

In den ersten Jahren zielten die Schwerpunkte der Arbeit der IKSE auf die Senkung der Gewässerbelastung durch kommunales und industrielles Abwasser, den Bau von kommunalen Kläranlagen, die Verbesserung der Gewässergüte und der ökologischen Verhältnisse, später kam auch der Hochwasserschutz dazu.



ICG *
- Delegationsleiter D und CZ in der IKSE
- Vertreter Österreichs und Polens
- Präsident der IKSE

- vedoucí delegací ČR a SRN v MKOL
- zástupci Rakouska a Polska
- prezident MKOL

IKSE – MKOL
- Delegationen D und CZ
- Delegationsleiter
- Präsident

- delegace ČR a SRN
- vedoucí delegací
- prezident

Sekretariat
Sekretariát

Arbeitsgruppen
Pracovní skupiny

WFD Wasserrahmenrichtlinie
Rámcová směrnice o vodách

FP Hochwasserschutz
Povodňová ochrana

H Unfallbedingte Gewässerbelastungen
Havarijní znečištění vod

Expertengruppen - Skupiny expertů

SW Oberflächengewässer
Povrchové vody

Hy Hydrologie

GW Grundwasser
Podzemní vody

DATA Datenmanagement
Management dat

* Die internationale Koordinierungsgruppe ICG behandelt Fragen der internationalen Koordinierung im Zusammenhang mit der Umsetzung der europäischen Wasserrahmenrichtlinie und der Hochwasserrisikomanagement-Richtlinie im Einzugsgebiet der Elbe.

* Mezinárodní koordinační skupina ICG řeší otázky mezinárodní koordinace v souvislosti s implementací evropské Rámcové směrnice o vodách a Povodňové směrnice v povodí Labe.

Labe patřilo koncem 80. let 20. století k nejvíce znečištěným řekám v Evropě, společenské změny ve východní Evropě proto pro Labe představovaly záchranu na poslední chvíli.

V prvních letech byla práce MKOL zaměřena hlavně na snižování znečištění způsobeného komunálními a průmyslovými odpadními vodami, na výstavbu komunálních čistíren odpadních vod, na zlepšení jakosti vody a ekologických poměrů, později přibyla i oblast ochrany před povodněmi.

Die europäischen Richtlinien (Wasserrahmenrichtlinie und Hochwasserrisikomanagement-Richtlinie) bilden die Grundlage der gegenwärtigen und zukünftigen Arbeit der IKSE.

Evropské směrnice (Rámcová směrnice o vodách a Povodňová směrnice) jsou základem současné i budoucí práce MKOL.

►Umsetzung der Wasserrahmenrichtlinie


INTERNATIONALE FLUSSGEBIETSEINHEIT ELBE

INTERNATIONALER BEWIRTSCHAFTUNGSPLAN
FÜR DIE FLUSSGEBIETSEINHEIT ELBE

nach Artikel 13 der Richtlinie 2000/60/EG
des Europäischen Parlaments und des Rates vom 23. Oktober 2000
zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft
im Bereich der Wasserpolitik

TEIL A

2009

Fachliche Bearbeitung und Redaktion:
Internationale Kommission zum Schutz der Elbe (IKSE)

Die Staaten im Einzugsgebiet der Elbe – Deutschland, Tschechien, Österreich und Polen – haben sich darauf geeinigt, einen gemeinsamen „Internationalen Bewirtschaftungsplan für die Flussgebietseinheit Elbe“ zu erarbeiten.

Das Ziel ist der
gute Zustand aller Gewässer.
Das bedeutet, dass alle relevanten Qualitätskomponenten bei der Bewertung die Kriterien des guten Zustands erreichen.

►Implementace Rámcové směrnice o vodách

Státy v povodí Labe – Česká republika, Německo, Rakousko a Polsko – se dohodly, že bude zpracován jeden společný „Mezinárodní plán oblasti povodí Labe“.


MEZINÁRODNÍ OBLAST POVODÍ LABE

MEZINÁRODNÍ PLÁN
OBLASTI POVODÍ LABE

podle článku 13 Směrnice Evropského parlamentu a Rady 2000/60/ES
ze dne 23. října 2000,
kterou se stanoví rámec pro činnost Společenství
v oblasti vodní politiky

ČÁST A

2009

Odborné zpracování a redakce:
Mezinárodní komise pro ochranu Labe (MKOL)

Cílem je
dobrý stav všech vod.
To znamená, že všechny relevantní složky kvality dosahují při hodnocení kritérií dobrého stavu.

►Sedimentmanagement

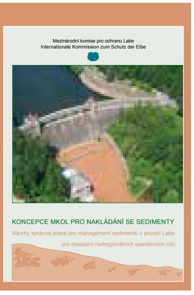

Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

SEDIMENTMANAGEMENTKONZEPT DER IKSE
Vorschläge für eine gute Sedimentmanagementpraxis im Elbegebiet
zur Erreichung überregionaler Handlungsziele

Sedimente erfüllen grundlegende Funktionen als Gewässerbett, aquatischer Lebensraum und in Stoffkreisläufen der Gewässer. Sie haben durch ihre Menge und Qualität eine Schlüsselfunktion für unverzichtbare Ökosystemleistungen und bedeutsame Gewässernutzungen.

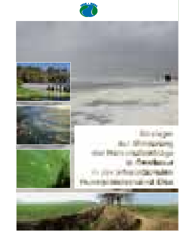
►Nakládání se sedimenty

Sedimenty plní základní funkce při utváření koryt vodních toků, jako akvatická stanoviště a v koloběhu látek vodních toků. Svým množstvím a svou jakostí hrají klíčovou roli pro nepostradatelné funkce ekosystémů a významné způsoby užívání vod.


Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

KONCEPCE MKOL PRO NAKLÁDÁNÍ SE SEDIMENTY
Návrhy správné praxe pro management sedimentů v povodí Labe
pro dosažení nadregionálních operativních cílů

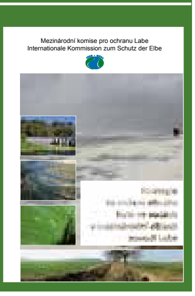
►Reduzierung der Nährstoffeinträge


Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

Nährstoffeinträge in die Oberflächengewässer und das Grundwasser bleiben auch weiterhin eine der wichtigen Wasserbewirtschaftungsfragen im Einzugsgebiet der Elbe.

►Snížení vnosu živin

Vnosy živin do
povrchových a podzemních vod
zůstávají i nadále jedním
z významných problémů nakládání
s vodami v povodí Labe.


Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

►Internationales Messnetz und Messprogramm


Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

Messstrategie der IKSE

Seit Beginn der 90er Jahre des 20. Jahrhunderts wird eine positive Entwicklung der Wasserbeschaffenheit der Elbe und ihrer Nebenflüsse beobachtet.

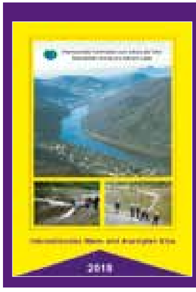
►Mezinárodní měřicí síť a program měření

Od začátku devadesátých let 20. století je v Labi a jeho přítocích sledován pozitivní vývoj jakosti vody.


Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

Strategie měření MKOL

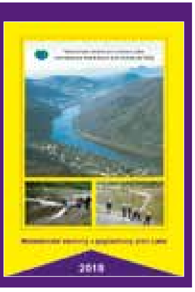
►Warn- und Alarmsystem an der Elbe



Dem Internationalen Warn- und Alarmplan Elbe (IWAPE) kommt eine außerordentliche Bedeutung insbesondere bei grenzüberschreitenden Unfällen zu.
Die Hauptstruktur bilden 5 Internationale Hauptwarnzentralen (IHWZ).

►Varovný a poplachový systém na Labi

Mezinárodní varovný a poplachový plán Labe (MVPPL) má mimořádný význam zejména v případě havárií přesahujících státní hranice. Hlavní strukturu tvoří 5 mezinárodních hlavních varovných centrál (MHVC).



►Hochwasserschutz

INTERNATIONALE FLUSSGEBIETSEINHEIT ELBE

INTERNATIONALER
HOCHWASSERRISIKOMANAGEMENTPLAN
FÜR DIE FLUSSGEBIETSEINHEIT ELBE

nach Artikel 7 der Richtlinie 2007/60/EG
des Europäischen Parlaments und des Rates vom 23. Oktober 2007
über die Bewertung und das Management von Hochwasserrisiken

TEIL A

2015

Fachliche Bearbeitung und Redaktion:
Internationale Kommission zum Schutz der Elbe (IKSE)

Die Staaten im Einzugsgebiet der Elbe – Deutschland, Tschechien, Österreich und Polen – haben sich geeinigt, einen „Internationalen Hochwasserrisikomanagementplan für die Flussgebietseinheit Elbe“ nach der „Richtlinie über die Bewertung und das Management von Hochwasserrisiken“ (RL 2007/60/EG) zu erarbeiten.

►Ochrana před povodněmi

Státy v povodí Labe – Česká republika, Německo, Rakousko a Polsko – se dohodly, že bude zpracován jeden „Mezinárodní plán pro zvládání povodňových rizik v oblasti povodí Labe“ dle „Směrnice o vyhodnocování a zvládání povodňových rizik“ (2007/60/ES).

MEZINÁRODNÍ OBLAST POVODÍ LABE

MEZINÁRODNÍ PLÁN
PRO ZVLÁDÁNÍ POVODŇOVÝCH RIZIK
V OBLASTI POVODÍ LABE

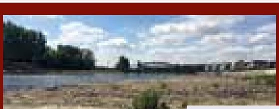
podle článku 7 Směrnice Evropského parlamentu a Rady 2007/60/ES
ze dne 23. října 2007
o vyhodnocování a zvládání povodňových rizik

ČÁST A

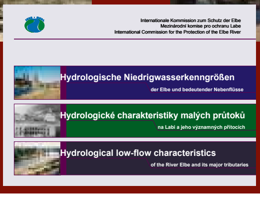
2015

Odborné zpracování a redakce:
Mezinárodní komise pro ochranu Labe (MKOL)

►Niedrigwasser



Die Elbe gehört in Mitteleuropa zu den großen Fließgewässern mit dem geringsten verfügbaren Wasserdargebot pro Einwohner des Einzugsgebiets.



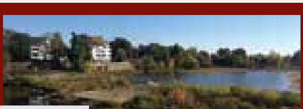
Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe
International Commission for the Protection of the Elbe River

Hydrologische Niedrigwasserkenngrößen
der Elbe und bedeutender Nebenflüsse

Hydrologické charakteristiky malých průtoků
na Labi a jeho významných přítocích

Hydrological low-flow characteristics
of the River Elbe and its major tributaries

►Sucho



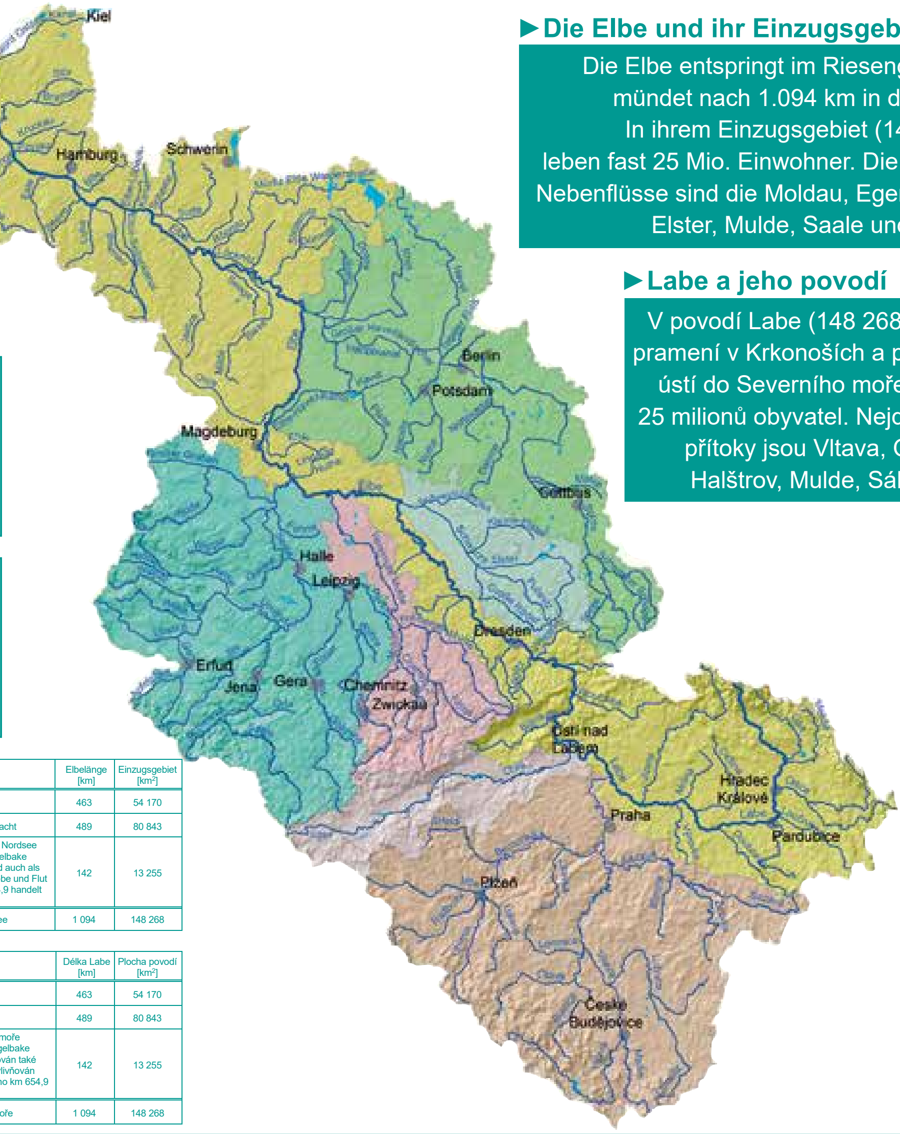
Ve srovnání s velkými toky ve střední Evropě patří povodí Labe k oblastem s nejmenšími dostupnými vodními zdroji na jednoho obyvatele.

►Die Elbe und ihr Einzugsgebiet

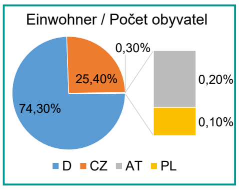
Die Elbe entspringt im Riesengebirge und mündet nach 1.094 km in die Nordsee. In ihrem Einzugsgebiet (148.268 km²) leben fast 25 Mio. Einwohner. Die wichtigsten Nebenflüsse sind die Moldau, Eger, Schwarze Elster, Mulde, Saale und die Havel.

►Labe a jeho povodí

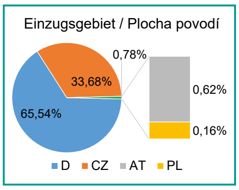
V povodí Labe (148 268 km²), které pramení v Krkonoších a po 1 094 km ústí do Severního moře, žije téměř 25 milionů obyvatel. Nejdůležitějšími přítoky jsou Vltava, Ohře, Černý Halštrov, Mulde, Sála a Havola.



Einwohner / Počet obyvatel



Einzugsgebiet / Plocha povodí



Einteilung der Elbe	Elbeabschnitte	Elbelänge [km]	Einzugsgebiet [km^2]
Obere Elbe	Elbequelle bis Schloss Hirschstein	463	54 170
Mittlere Elbe	Schloss Hirschstein bis Wehr Geesthacht	489	80 843
Untere Elbe	Wehr Geesthacht bis Mündung in die Nordsee an der Seegrenze bei Cuxhaven-Kugelbake (Elbe-km 727,7); dieser Abschnitt wird auch als Tideelbe bezeichnet, weil er durch Ebbe und Flut beeinflusst wird; ab dem Elbe-km 654,9 handelt es sich um ein Übergangsgewässer	142	13 255
Elbe gesamt	Elbequelle bis Mündung in die Nordsee	1 094	148 268

Rozdělení Labe	Úseky Labe	Délka Labe [km]	Plocha povodí [km^2]
Horní Labe	pramen Labe po zámek Hirschstein	463	54 170
Střední Labe	zámek Hirschstein po jez Geesthacht	489	80 843
Dolní Labe	jez Geesthacht po ústí do Severního moře na hranici s mořem u Cuxhavenu-Kugelbake (říční km 727,7); tento úsek je označován také jako slapový úsek Labe, protože je ovlivňován mořským přílivem a odlivem; od říčního km 654,9 se jedná o brakické vody.	142	13 255
Labe celkem	pramen Labe po ústí do Severního moře	1 094	148 268

Meilensteine, Aktivitäten, Ereignisse		Milníky, aktivity, události
Internationaler Warn- und Alarmplan Elbe (Meldesystem zur Weiterleitung von Informationen über unfallbedingte Gewässerbelastungen im Einzugsgebiet der Elbe)	1991	Mezinárodní varovný a poplachový plán Labe (systém hlášení případů havarijního znečištění vod v povodí Labe)
Erstes international abgestimmtes Messprogramm	1992	První program měření odsouhlasený na mezinárodní úrovni
Erstes Aktionsprogramm Elbe (Sofortprogramm)	1992 – 1995	První akční program Labe (Naléhavý program)
Ökologische Sofortmaßnahmen zum Schutz und zur Verbesserung der Biotopstrukturen der Elbe	1993	Naléhavá ekologická opatření k ochraně a zlepšení biotopních struktur Labe
Ökologische Studie zum Schutz und zur Gestaltung der Gewässerstrukturen und der Uferrandregionen der Elbe	1994	Ekologická studie k ochraně a utváření vodních struktur a břehových zón Labe
Die Elbe – Erhaltenswertes Kleinod in Europa	1995 / 1999	Labe – cenný přírodní klenot Evropy
Aktionsprogramm Elbe	1996 – 2010	Akční program Labe
Strategie zum Hochwasserschutz im Einzugsgebiet der Elbe	1998	Strategie povodňové ochrany v povodí Labe
Europäische Wasserrahmenrichtlinie	2000	Rámcová směrnice o vodách Evropského společenství
Bestandsaufnahme des vorhandenen Hochwasserschutzniveaus im Einzugsgebiet der Elbe	2001	Zmapování stávající úrovně povodňové ochrany v povodí Labe
Hochwasser im Einzugsgebiet der Elbe im August	2002	Povodeň v srpnu v povodí Labe
Aktionsplan Hochwasserschutz Elbe	2003 – 2011	Akční plán povodňové ochrany v povodí Labe
Alarmmodell Elbe (Vorhersagemodell für die Ausbreitung von Schadstoffwellen in der Elbe)	2004	Poplachový model Labe (model pro prognózu šíření vln znečišťujících látek v Labi)
Die Elbe und ihr Einzugsgebiet – Ein geographisch-hydrologischer und wasserwirtschaftlicher Überblick	2005	Labe a jeho povodí - geografický, hydrologický a vodohospodářský přehled
Europäische Hochwasserrisikomanagement-Richtlinie	2007	Povodňová směrnice Evropského společenství
1. Internationaler Bewirtschaftungsplan für die Flussgebietseinheit Elbe	2010 – 2015	1. Mezinárodní plán oblasti povodí Labe
Hochwasser im Einzugsgebiet der Elbe im Juni	2013	Povodeň v červnu v povodí Labe
Sedimentmanagementkonzept der IKSE	2014	Koncepce MKOL pro nakládání se sedimenty
2. Internationaler Bewirtschaftungsplan für die Flussgebietseinheit Elbe 1. Internationaler Hochwasserrisikomanagementplan für die Flussgebietseinheit Elbe	2016 – 2021	2. Mezinárodní plán oblasti povodí Labe 1. Mezinárodní plán pro zvládání povodňových rizik v oblasti povodí Labe
Erweiterung des Alarmmodells Elbe um die Nebenflüsse Moldau und Saale	2017	Rozšíření Poplachového modelu Labe o přítoky Vltavu a Sálu
Strategie zur Minderung der Nährstoffeinträge in Gewässer in der internationalen Flussgebietseinheit Elbe	2018	Strategie ke snížení obsahu živin ve vodách
Messstrategie der IKSE	2018	Strategie měření MKOL
3. Internationaler Bewirtschaftungsplan für die Flussgebietseinheit Elbe 2. Internationaler Hochwasserrisikomanagementplan für die Flussgebietseinheit Elbe	2022 – 2027	3. Mezinárodní plán oblasti povodí Labe 2. Mezinárodní plán pro zvládání povodňových rizik v oblasti povodí Labe

Internationale Kommission zum Schutz der Elbe **www.ikse-mkol.org** **Mezinárodní komise pro ochranu Labe**

31 years of the International Commission for the Protection of the River Elbe to the improvement of the Elbe Ecosystem

Pavel Punčochář

The International Commission for the Protection of the River Elbe (ICPER) was established in 1990, after the major political-economic changes in Europe in 1989. The creation of the commission was a great opportunity and challenge for water managers to start the effective measures for the improvement of badly damaged Elbe ecosystem. Water quality was very poor, with discharges of large volumes of untreated or insufficiently treated wastewaters from both cities and large industrial enterprises located along the watercourse.

The first president of the ICPER was Dr. h. c. Dietrich Ruchay, and this selection was absolutely invaluable not only because of his ability to manage international negotiations, but especially because of his experience in the work of the International Commission for the Protection of the Rhine, where he had been the president in the previous years.

An obvious priority of the first years of activity of the ICPER was the necessity to decrease the load of pollution discharged to watercourses in the Elbe watershed as the improvement of the water quality is a pre-condition for the life of aquatic biocenoses and water-related organisms. The construction of sewage treatment plants and the simultaneous transformation and cancellation of obsolete industrial technologies required a huge amount of funding for investments in water infrastructure and in industrial technologies using financing from the national sources (in the case of the unified Germany) and from the international financial institutions (in the case of the Czech Republic).

The initial objectives were summarised by "The first action programme to reduce the discharge of harmful substances to the River Elbe and its river basin" adopted in 1991 year, which was followed by the „Action Programme for the River Elbe“ in 1995 [4].The Contracting Parties, with the participation of the European Commission, which has been involved in the ICPER for the period up to the accession of the Czech Republic (and Poland) to the EU, committed to the objectives of both these programmes.

A very remarkable and certainly the right move from the current perspective was also the focus on the improvement and protection of the ecological conditions of the Elbe River ecosystem, in particular for hydromorphological structures of the riverbed and related flood prone areas. Thus, the working group "Protection and Formation of Water Structures and Bank Zones", known by the acronym WG "O", was set up in the structure of the ICPER. It was subsequently renamed as the WG "Ecology", however, the WG "O" sign remained.

The WG O has prepared several publications see [1, 2, 7, 8, 9] on the assessment of the state of the Elbe River ecosystem and on the components of its biocenoses (fish, macrozoobentos) in the course of the first 10 years of the ICPER existence. The results of explorations and assessments of the hydromorphological situation were published in the "Ecological study to protect and shape the water structures and bank zones of the Elbe" (1994) see [2], and they clearly indicated that the overall situation is far from bad, especially on the German section of the River Elbe. This was subsequently used to prepare the publication "The Elbe – a valuable jewel of Europe" published in 1995 (the 2nd edition in 1999), which disseminated these natural sceneries from the Elbe River basin to the public and substantially increased the general interest for the Elbe River and its surroundings [7]. Thus, the proclamation of the "Garden Empire in Dessau-Worlitz" as the protected area in November 2000, which was followed by its inclusion at the World Heritage List as the part of the UNESCO biosphere reserve "Landscape of the River Labe" was no surprise. The Czech section of the Elbe River is, in comparison with the situation in Germany, substantially heavily technically adapted for navigation with many transverse constructions (weirs, locks), which represent the character of the „heavily modified water body“. In spite of this, there has been designated National Park "Czech Switzerland" in this part of the catchment in 2000. In addition, revitalization measures are ongoing along the watercourse, in particular, the reconnection of back-waters and blind arms to the Elbe River flow.

In 1995, the International Measuring Programme was adopted (it includes the standard number of 10 profiles along the Elbe River and 5 profiles at tributaries), and data obtained by the unified methodologies were published annually in reports up to 2011 [11, 12]. These results confirmed significant improvements of chemical parameters already during the first 15 years of the ICPER activities and Tab. 1 contains the data on the decrease of concentrations of several chemical indicators from the profile of Schnackenburg. Communities of aquatic organisms responded to this positive development and number of species of selected groups of macrozoobentos increased from 52 identified in 1990 to 83 in the German section of the River Elbe. These findings start to approach the historical situation from the beginning of this century (when there were found 114 species). A similar trend of the biodiversity of macrozoobentos increase has been observed also in the River Elbe on the Czech territory.

The realization of two new fish ladders in Geesthacht weir (in 1998 and 2012) has opened the watercoarse of the River Elbe for migration of anadromous fish species again upstream after many past years and, as the consequence, the programme of "Salmon 2000" has been adopted. The fantastic return of salmons has occurred to the Saxony section of the River Elbe already within 4 years after the completion of the first fish ladder [13]. In addition, several catches of salmons were confirmed in the River Kamenice in 1998, too. The River Kamenice is the tributary of the Elbe River on the Czech territory and there were introduced juvenile specimens of salmons in it in 1994. Total number of fish species in the Elbe River increased by 14 species in 1997 – 98 as compared with the situation in 1991 – 93. The interest and effort for improvement of fish migration represent the important continuous target in the process of the achievement of the good ecological state. Compliance is rather slow as the planned numbers of the new fish-ladders are not being constructed due to the high costs of realization and problems with the ownership of existing weirs, which were built during the long term history of the industrial development along the River Elbe. There were published several evaluations of the Elbe fish fauna in early ICPER activities of 90ties [6, 7, 8].

The fulfilment of targets of the „Action Programme for the River Elbe“ was published gradually in reports at the 3-year intervals. Final report "The River Elbe is a living river again" (2010) has contained the achievement of the main objectives of the work of the ICPER for the 20-year period and documented the substantial improvement of the ecosystem quality of the River Elbe [15].

A significant change in the scope of monitoring started in the year 2000, when the Water Framework Directive (2000/60/EC – “WFD”) was adopted [10], and its objectives have been gradually implemented in subsequent years. The comprehensive and integrated assessment of aquatic ecosystems, requiring the significant expansion of the methods and numbers of monitored parameters, led to the change of the content of the International Measurement Programme. The number of chemical parameters has been steadily increasing due to the development of technologies of chemical analyses, which allow particularly determination of micropolutants. Similarly, the number of biological characteristics has expanded to 9 parameters for detail knowledge of the biota composition of the water ecosystem. The assessment of the status of water bodies has been carried out in the preparation and evaluation of Plans for the International District of the Elbe River Basin accordance with WFD requirements.

The ICPER issued two comprehensive evaluations of the ecological status of the Elbe for the period 2006 – 2012 [16] and for the period 2013 – 2018 [17]. However, the presentation of biological analyses consist only of few parameters. Data on chlorophyll concentrations presented in both publications show high values at tributaries and a gradual increase of concentrations along longitudinal profile the River Elbe, which indicate high nutrient concentrations (namely phosphorus compounds) at monitored places. The evaluation of 2006 – 2012 presents data on bacterial counts (numbers of the intestinal enterococci). The numbers of these bacteria exhibits gradually decrease in the longitudinal profile of the River Elbe, the highest numbers were found in tributaries. The 2013 – 2018 evaluation presents data on ichthyofauna. The fish fry (age category +0) was monitored in the Czech Republic and the fry of 13 species of fish has been caught in the border section of the River Elbe. The population of adult fish was sampled at the German profile of the Rive Elbe at Wittenberge, and 35 species of the total 41 species listed as reference population for the period 1995 – 2015 were found.

The evaluation of ecological status in Plans of the International District of the River Elbe Basin is subject to a uniform assessment procedure, in which the principle "one out – all out“ is strictly used. Therefore, in case of failure of any individual monitored parameter at the given water body, the water body is presented as non-compliant. This obviously causes an unfavourable view of any positive change/development in the evaluation the ecological state in the course of time. The situation is valid not only for the evaluation at the individual water bodies, but it is influencing the negative evaluation of the river basins in all EU Member States. The European Environmental Agency regularly evaluates and publishes the ecological state of bodies in all member states, and as a result of the above mentioned principle, the data on European waters represent very small positive change in improvement, and moreover, sometimes even decline from formerly achieved good status. The tightening of concentration limits for certain substances of concern (e. g. micropolutants) and also missing the unified methodologies for assessment of biota (some methods are still under development) are further causes of presented unsuccessful trends in the achievement of WFD goals. Thus, the only small positive progress in the achievement of good ecological status of rivers (and all surface water bodies) can be recognized in the latest report of the EEA on the situation of European waters [21] and the decrease of amount of bodies "with unknown ratings" is presented there as the successful development.

The proposal of the 3rd Plan of the international district of the River Elbe basin states that 290 bodies of surface waters are in good ecological condition, which means less than 10 % of the 3 933 designated water bodies. The good chemical condition achieved 201 bodies, (i. e. 5 %). The declining proportion of water bodies achieving good ecological status is evident from comparison with the data of the 2nd Plan (see Tab. 2). Even worse situation indicate the data on the chemical state of the River Elbe, which is unsatisfactory in all German profiles, as the limit of mercury concentration in the Ecological Quality Standard is exceeded. When this limit is not taken in account for the assessment, the chemical statute indicates substantially better situation and this has been shown at the map 4.3.1 at the publication of the 2nd Plan [19]. This clearly shows that the situation in water bodies in the international district of the River Elbe basin is not completely bad. Similarly, there are number of water bodies where the biodiversity of communities of organisms is improving, which people involved in the monitoring of the River Elbe confirmed. Unfortunately, these evaluations are not currently made and data contained in the Plans indicate the decreasing numbers of water bodies exhibiting good status. The public and policy-makers have no information about any positive changes of the River Elbe ecosystem, as the principle “one out – all out” completely covers the real situation. The information is also missing if continuously implemented measures for reduction of stressors in the River Elbe basins have positive effects on the evolution in designated water bodies. As a reaction to this situation, there is the recommendation in text of the proposal of the 3rd Plan [20] to evaluate individual components at the particular water body and illustrate their time development for recognition changes, which may show positive changes at least of some parameters.

There is even a question of whether an ad hoc group "ecology" should not be set up within the WG Water Framework Directive of the ICPER for designing, coordination and preparation of a publication of more detailed assessment describing continuous positive trend of the River Elbe ecosystem.

Tab. 1: *Changes in concentration of selected substances in the profile of Labe – Schnackenburg (compared averages from the two given years).*

parameter (mg/l)	BOD5	CODCr	NO3-N	NH4-N	Ptot.	AOX
2007- 8	3,0	22,8	3,35	0,12	0,13	30,7
1997- 8	4,2	30,4	4,28	0,43	0,24	52,7
change in %	- 30	- 25	- 22	- 72	- 45	- 42

Tab. 2: *Comparison of the changes in the number of sites with the achievement of good ecological and chemical status of surface running water in the Plans of the International District of the River Elbe Basin in the proposal of 2015 and evaluation in 2016 and proposal for the period after 2021 [18, 19, 20].*

Number of water bodies		Ecological state/potential				Chemical state			
2015	2021	2015	2021		2027	2015	2021		2027
			plan	reality	plan		plan	reality	plan
3 933	3 886	359	574	290	189	481	494	201	132
100 %	100 %	9 %	14,6 %	7 %	5 %	12 %	12,6 %	5 %	3 %

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Die Elbe in den Zeiten des Klimawandels

Helge Wendenburg

Die Elbe gehört zu den großen europäischen Flüssen, deren Einzugsgebiete sich durch die Einwirkung des Menschen zu intensiv genutzten Kulturlandschaften entwickelt haben. Nach Donau, Weichsel und Rhein ist sie der viertgrößte Fluss in Mitteleuropa. Ihr Einzugsgebiet ist dabei durch eine der kleinsten mittleren Abflussspenden im Mitteleuropa charakterisiert (5,75 l/s/km^2 im Zeitraum 1981 – 2010) [1]. Deshalb zeichnet sich das Elbegebiet auch durch ein hohes reguliertes Wasserdargebot aus. Ende 2020 befanden sich im Einzugsgebiet der Elbe 315 Talsperren, Wasserspeicher und Hochwasserrückhaltebecken mit einem Stauraum ab 0,3 Mio. m^3 und Gesamtvolumen von ca. 4,2 Mrd. m^3.

Aus den Beobachtungsergebnissen der klimatischen und hydrologischen Kenngrößen ist ersichtlich, dass es im Einzugsgebiet der Elbe zu Veränderungen kommt. Die in den letzten Jahren verstärkt aufgetretenen Starkregenereignisse und auch die seit mehreren Jahren deutlich über dem langjährigen Mittel liegenden Jahresmitteltemperaturen mit entsprechend weit verbreiteten Niedrigwassersituationen sind markante Erscheinungen des Klimawandels, die auch Einfluss auf die Handlungsfelder der Gewässerbewirtschaftung haben. Der zu beobachtende Klimawandel führt zu einer breiten Palette von Auswirkungen auf die Umwelt und die Gesellschaft. Er macht sich im Einzugsgebiet der Elbe durchsteigende Lufttemperaturen und häufigeres Auftreten von Temperaturextremen, durch erhöhte Wassertemperaturen sowie durch einen Rückgang der Niederschlagsmengen im Sommer mit Zunahme von Niedrigwasserperioden bemerkbar. Dies wird auch durch die Entwicklung der wasserwirtschaftlichen Situation im Einzugsgebiet der Elbe in den letzten Jahren deutlich: Nach dem extremen Hochwasser im Jahr 2013 kam es zu einer seit 2014 andauernden Niedrigwasserperiode. Äußerst trocken waren vor allem die Jahre 2015, 2018 und 2019, in denen regional sogar ganze Abschnitte kleinerer Fließgewässer trockengefallen sind.

Die Staaten im Einzugsgebiet der Elbe befassen sich auf der nationalen Ebene verstärkt mit den Auswirkungen des Klimawandels und notwendigen Anpassungsstrategien. Diese Arbeiten basieren auf rechtlichen und fachlichen Vorgaben auf verschiedenen Ebenen oder Empfehlungen der Europäischen Union, aber auch auf der faktischen Notwendigkeit, sich diesen Entwicklungen zu stellen. Konkret kann man die nationalen Anpassungsstrategien an den Klimawandel und die damit zusammenhängenden Aktionspläne aufführen. Ebenso ist die Strategie der Europäischen Union zur Anpassung an den Klimawandel von 2013 und ihre Aktualisierung von 2021 zu berücksichtigen. Zum Einfluss des Klimawandels auf die Gewässer wurden in den Staaten im Einzugsgebiet der Elbe auch zahlreiche, auf Klimaprojektionen basierende Studien und Forschungsprojekte durchgeführt.

Im Rahmen der IKSE wurden in vorigen Jahren gemeinsame Analysen von extremen hydrologischen Situationen ausgearbeitet, die eine wertvolle Informationsquelle bei Beurteilung der Auswirkungen des Klimawandels im Einzugsgebiet der Elbe sind:
- 2004: Dokumentation des Hochwassers vom August 2002 im Einzugsgebiet der Elbe
- 2007: Hydrologische Auswertung des Frühjahrshochwassers 2006 im Einzugsgebiet der Elbe
- 2012: Hydrologische Auswertung der Hochwasserereignisse im August und September 2010 im Einzugsgebiet der Elbe
- 2012: Hydrologische Niedrigwasserkenngrößen der Elbe und bedeutender Nebenflüsse
- 2014: Hydrologische Auswertung des Hochwassers vom Juni 2013 im Einzugsgebiet der Elbe
- 2017: Hydrologische Auswertung der Niedrigwassersituation 2015 im Einzugsgebiet der Elbe

Die Erkenntnisse und Ergebnisse der Arbeiten auf der internationalen und nationalen Ebene wurden bei der Berücksichtigung der Auswirkungen des Klimawandels in den Entwürfen des Internationalen Bewirtschaftungsplans Elbe [2] nach der EU-Wasserrahmenrichtlinie und des Internationalen Hochwasserrisikomanagementplans Elbe [3] nach der EU-Hochwasserrisikomanagementrichtlinie für den Zeitraum 2022 – 2027 verwendet. Allgemein ist festzustellen, dass die Veränderungen der Wasserhaushaltsgrößen sowie der Wasserqualität gegenwärtig zwar noch nicht präzise vorhersagbar sind, nichtsdestotrotz die Auswirkungen des Klimawandels im Rahmen der Bewirtschaftungsplanung angemessen berücksichtigt werden müssen.

Da die mit dem Thema Klimawandel verbundenen wasserwirtschaftlichen Herausforderungen in den letzten Jahren auch international zunehmend in den Fokus gerückt sind, wurden die Auswirkungen des Klimawandels (Niedrigwasser, Wasserknappheit, hydrologische Extremereignisse und weitere Auswirkungen) als eine der wichtigen Wasserbewirtschaftungsfragen nach der Wasserrahmenrichtlinie auf der internationalen Ebene für den Bewirtschaftungszeitraum 2022 – 2027 aufgenommen. Auf der internationalen Ebene (IKSE) werden im Bewirtschaftungszeitraum 2022 – 2027 folgende Aktivitäten geplant:

- Prüfung möglicher Belastungen und Auswirkungen des Klimawandels und der Wasserknappheit bei der Zustandsbewertung der Oberflächengewässer und des Grundwassers.
- Entsprechend der „Messstrategie der IKSE“ soll ein Internationales Sonderuntersuchungsprogramm für die Beobachtung der Gewässerqualität bei außergewöhnlichen Gewässersituationen etabliert werden. Die Ergebnisse und Informationen aus diesem Programm werden im Rahmen der IKSE ausgewertet und zur Beurteilung der Auswirkungen des Klimawandels genutzt.
- Hydrologische Auswertung der verstärkt auftretenden Niedrigwassersituationen im Einzugsgebiet der Elbe und Veröffentlichung entsprechender Berichte.

Im Rahmen der Maßnahmenplanung nach der Wasserrahmenrichtlinie kann man trotz großer Unsicherheiten über das Ausmaß und die Auswirkungen des Klimawandels Maßnahmen und Handlungsoptionen identifizieren, die für die Stabilisierung und Verbesserung des Gewässerzustands nützlich sind, unabhängig davon, wie das Klima in der Zukunft beschaffen sein wird. Dies sind insbesondere wasserwirtschaftliche Anpassungsmaßnahmen, die die Bandbreiten der Szenarien berücksichtigen, flexibel und nachsteuerbar sowie robust und effizient sind. Neben der Planung von Maßnahmen, die die Auswirkungen von Klimaänderungen auf die Wasserwirtschaft abmildern und die Resilienz der Gewässer erhöhen, sind auch die bisher ergriffenen Maßnahmen hinsichtlich ihrer Klimaänderungsrobustheit zu prüfen.

Was die Fragen des Hochwasserrisikomanagements betrifft, ergab sich aus den vorliegenden Erkenntnissen zu den zukünftigen Veränderungen extremer Hochwasserereignisse keine Notwendigkeit, den bisherigen Ansatz zu ändern. Zur Überprüfung der Bewertung der Hochwasserrisiken für den Bewirtschaftungszeitraum 2022 – 2027 wurden daher hydrologische Bemessungsgrößen (die Werte der T-jährlichen Abflüsse) verwendet, die ähnlich wie im vorherigem Zeitraum anhand einer statistischen Analyse der historischen Reihen der Hochwasserscheitelabflüsse abgeleitet wurden. Im Hinblick auf mögliche Auswirkungen des Klimawandels sollten bei der Maßnahmenplanung und -umsetzung Maßnahmen bevorzugt werden, die eine ausreichende Erhöhung ihres Wirkungseffekts bei akzeptablen Kosten ermöglichen. Infolge eines beschleunigten Meeresspiegelanstiegs ist zudem mit erhöhten hydrologischen Belastungen und in der Folge mit einem höheren Unterhaltungs- und Anpassungsaufwand der Küstenschutzanlagen zu rechnen.

Der Klimawandel und seine Folgen sind eine der großen Herausforderungen der heutigen Zeit. Je nach regionaler Ausprägung muss ihm mit entsprechenden Anpassungsmaßnahmen in den Bereichen Abwasserbeseitigung, Wasserversorgung, Gewässerschutz (z B. im Hinblick auf die negative Beeinflussung der Biozönose durch eine ansteigende Wassertemperatur), Gewässerentwicklung und Hochwasserschutz begegnet werden. Das Einzugsgebiet der Elbe mit seinem niedrigen spezifischen Abfluss und seinen großen deichgeschützten Gebieten (in Deutschland) ist im Hinblick auf den Klimawandel als empfindlich zu betrachten. Deshalb ist es in diesem Einzugsgebiet von besonderer Bedeutung, die Auswirkungen des Klimawandels weiterhin zu beobachten und zu analysieren sowie sich zu bemühen, diese mit geeigneten Maßnahmen zu reduzieren oder zu vermeiden.

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Labe v čase klimatické změny

Helge Wendenburg

Labe patří k významným evropským tokům, jejichž povodí se působením člověka změnilo na intenzivně využívanou kulturní krajinu. Po Dunaji, Visle a Rýně je čtvrtou největší řekou ve střední Evropě. Jeho povodí je přitom charakterizováno jedním z nejmenších průměrných specifických odtoků ve střední Evropě
(5,75 l.s-1.km^{-2} za období let 1981 – 2010) [1]. Proto se povodí Labe také vyznačuje velkými regulovanými zdroji vody. Koncem roku 2020 se v povodí Labe nacházelo 315 vodních děl s objemem nad 0,3 mil. m^3 o celkovém objemu cca 4,2 mld. m^3.

Z výsledků pozorování klimatických a hydrologických veličin je zřejmé, že v povodí Labe dochází ke změnám. Častější výskyt přívalových srážek v posledních letech a také průměrné roční teploty již několik let značně převyšující dlouhodobý průměr s odpovídajícími situacemi hydrologického sucha jsou markantními jevy klimatické změny, které mají také vliv na oblasti činnosti při nakládání s vodami. Pozorovaná klimatická změna vede k široké škále dopadů na životní prostředí a na společnost. Projevuje se v povodí Labe rostoucí teplotou vzduchu a častějším výskytem teplotních extrémů, zvýšením teploty vody a snížením letních srážkových úhrnů se zvýšeným výskytem hydrologického sucha. To dokládá i vývoj vodohospodářské situace v povodí Labe v posledních letech: Po extrémní povodni v roce 2013 přišlo období sucha, které trvá od roku 2014. Výrazně suché byly především roky 2015, 2018 a 2019, ve kterých dokonce regionálně vyschly celé úseky menších vodních toků.

Státy v povodí Labe se na národní úrovni ve zvýšené míře zabývají dopady klimatické změny a potřebnými adaptačními strategiemi. Tyto práce vycházejí z legislativních a odborných požadavků na různých úrovních nebo doporučení Evropské unie, ale i z faktické potřeby těmto projevům čelit. Konkrétně lze např. uvést národní adaptační strategie na klimatickou změnu a související akční plány. Rovněž je třeba zohlednit Strategii Evropské unie pro přizpůsobení se změně klimatu z roku 2013 a její aktualizaci v roce 2021. Ke vlivu změny klimatu na vody byly ve státech v povodí Labe také realizovány četné studie a výzkumné projekty vycházející z projekcí vývoje klimatu.

V rámci MKOL byly v minulých letech vypracovány společné analýzy extrémních hydrologických situací, které jsou cenným zdrojem informací při posuzování dopadů klimatické změny v povodí Labe:

- 2004: Dokumentace povodně v srpnu 2002 v povodí Labe
- 2007: Hydrologické vyhodnocení povodně v povodí Labe na jaře 2006
- 2012: Hydrologické vyhodnocení povodní v srpnu a září 2010 v povodí Labe
- 2012: Hydrologické charakteristiky malých průtoků na Labi a jeho významných přítocích
- 2014: Hydrologické vyhodnocení povodně v povodí Labe v červnu 2013
- 2017: Vyhodnocení hydrologického sucha v povodí Labe v roce 2015

Znalosti a výsledky prací na národní i mezinárodní úrovni byly využity při zohlednění dopadů klimatické změny v návrzích aktualizace „Mezinárodního plánu oblasti povodí Labe“ [2] podle evropské Rámcové směrnice o vodách a „Mezinárodního plánu pro zvládání povodňových rizik v oblasti Labe“ [3] podle evropské Povodňové směrnice na období 2022–2027. Obecně lze konstatovat, že změny v parametrech vodního režimu a jakosti vody v současné době sice ještě nelze přesně předpovídat, nicméně je při vodohospodářském plánováni nutné přiměřeně brát v úvahu dopady klimatické změny.

Jelikož se se na mezinárodní úrovni stále silněji dostávaly do popředí vodohospodářské výzvy spojené s tématem klimatické změny (mj. minimální ekologické průtoky, nedostatek vody, přívalové srážky, zvýšené teploty vody atd.), byly pro plánovací období 2022 – 2027 na mezinárodní úrovni mezi významné problémy nakládání s vodami podle Rámcové směrnice o vodách zařazeny také dopady klimatické změny (sucho, nedostatek vody, extrémní hydrologické jevy a další dopady). Na mezinárodní úrovni (MKOL) budou v plánovacím období 2022 – 2027 v souvislosti s klimatickou změnou sledovány následující aktivity:

- Prověření možných vlivů a dopadů klimatické změny a nedostatku vody při hodnocení stavu povrchových a podzemních vod.
- V souladu se Strategií měření MKOL má být ustaven mezinárodní mimořádný program měření pro sledování jakosti vody v případě mimořádných hydrologických situací. Výsledky a informace z tohoto programu budou v rámci MKOL vyhodnocovány a využívány pro posouzení dopadů klimatické změny.
- Hydrologické vyhodnocování častějších období sucha v povodí Labe a zveřejňování příslušných zpráv.

V rámci plánování opatření podle Rámcové směrnice o vodách lze i přes velké nejistoty ohledně rozsahu a dopadů klimatické změny identifikovat opatření a možnosti, jež jsou užitečné pro stabilizaci a zlepšení stavu vod, nezávisle na tom, jaké klima bude v budoucnosti. Jsou to především vodohospodářská adaptační opatření, jež zohledňují nejistoty scénářů, jsou flexibilní, schopná dodatečné reakce, robustní a efektivní. Kromě plánování nových opatření ke zmírnění dopadů klimatické změny na vodní hospodářství a zvýšení odolnosti vod je nutno přezkoumat dosavadní opatření ohledně jejich robustnosti vůči změně klimatu.

Co se týká otázek zvládání povodňových rizik v povodí Labe, z dostupných poznatků o budoucích změnách extrémních povodní nevyplynula nutnost změny dosavadního přístupu. Pro přezkoumání hodnocení povodňových rizik pro plánovací období 2022 – 2027 podle Povodňové směrnice proto byly použity návrhové hydrologické údaje (hodnoty N-letých průtoků) odvozené obdobně jako v předchozím plánovacím období ze statistické analýzy historických řad kulminačních průtoků. S ohledem na možné dopady klimatické změny je třeba při plánování a realizaci opatření upřednostnit opatření, která v budoucnu za přijatelných nákladů umožňují dostatečné zvýšení jejich účinného efektu. V důsledku zrychleného vzestupu hladiny moře je navíc třeba počítat s vyšším hydrologickým zatížením a tedy s vyššími nároky na údržbu a adaptaci objektů pobřežní ochrany.

Změna klimatu a její důsledky jsou jednou z velkých výzev dnešní doby. V závislosti na regionální situaci bude zapotřebí na ni reagovat příslušnými adaptačními opatřeními v oblastech likvidace odpadních vod, zásobování vodou, ochrany vod (např. s ohledem na negativní ovlivnění biocenózy vlivem stoupající teploty vody), vývoje vodních toků a ochrany před povodněmi. Povodí Labe se svým nízkým specifickým odtokem a svými velkými územími chráněnými protipovodňovými hrázemi (v Německu) je třeba s ohledem na klimatickou změnu považovat za zranitelné. Proto je v tomto povodí zvláště důležité dopady klimatické změny dále sledovat a analyzovat a snažit se tyto dopady vhodnými opatřeními snížit nebo jim zamezit.

Literatura:

[1] Labe a jeho povodí, MKOL 2005
[2] Návrh aktualizace Mezinárodního plánu oblasti povodí Labe (část A) na období 2022 – 2027, MKOL 2021
[3] Návrh aktualizace Mezinárodního plánu pro zvládání povodňových rizik v oblasti povodí Labe (část A) na období 2022 – 2027, MKOL 2020

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The International Commission for the Protection of the Elbe River (ICPER) and Magdeburg Seminars on Water Protection

Jiří Medek

The city of Magdeburg – the capital of the Elbe River. In 1988, the first Magdeburg Seminar on water protection in the former GDR took place in Magdeburg. The organisers certainly had no idea that this initiative would give birth to a major professional international conference that would continue for decades to come. A second event was also held at local or national level in 1989 on nutrient issues. The same team of organisers from WWD Magdeburg prepared the third sequel, to which for the first time a representative of Czech water managers was invited. Before this seminar took place, however, a number of major historical events and changes took place between 1989 and 1990 – the Iron Curtain fell in Europe and on the Elbe, the borders were opened, Germany was reunified on 3 October 1990, and the regime in the former Czechoslovakia changed. The Agreement on the Establishment of the International Commission for the Protection of the Elbe River (ICPER) between the Federal Republic of Germany, the Czech and Slovak Federal Republics and the European Economic Community was signed in Magdeburg on 8 October 1990. This was probably the first international agreement signed by the reunified Germany and the first agreement concluded between the Czech and Slovak Federal Republics and the European Community. Magde-

„Don't get me wrong – but what's in the glass?“
Fig. 1: *Cartoon of the 3rd Magdeburg Seminar in 1990*

burg became the seat of the ICPER-Secretariat and the Secretariat staff was actively involved in the preparation and conduct of the 3rd Magdeburg Seminar. This created a historical link between the International Commission for the Protection of the Elbe River and the Magdeburg Seminars that continues to this day. The Magdeburg Seminar suddenly transformed from a local event into a major expert conference, which, thanks to the first representative of the Czech Elbe, had an international character. With about 170 participants, more than 30 lectures, more than 50 poster presentations, expert excursions and a rich social programme, the conference was well received by the professional community and in the wider public and media too. Let me recall the period atmosphere with a cartoon on the occasion of this conference. The organisers (M.Beyer, St.Petzold, A.Prange, R-D.Wilken and members of the ICPER-Secretariat) did an excellent job and the participation was a great experience for all and an inspiration for further work.

I dare to say that this 3th Magdeburg seminar in 1990 marked a major milestone in the protection of the Elbe River. It brought mutual personal encounters and networking between people and experts as well as between institutions and companies involved in the Elbe River issues. At the same time, it gave birth to the idea that the Elbe River is our common river and that we will only be successful in protecting it if we do it together regardless of national and provincial borders. ICPER and its expert groups must play an important role in this process. A future expert platform should be the regularly organised Magdeburg Seminars, which will address current issues and challenges throughout the international Elbe River basin. Looking back, it is pleasing to note that these ideas have indeed come to fruition.

During the past 30 years 15 international conferences have been held, at which 1481 lectures and posters have been presented (of which about 650 lectures), and the konference proceedings have a total of 4794 pages of text. This is an impressive source of information and knowledge. During that time, of course, the seminars have undergone their own evolution and many changes. The venues have changed, 15 international editions have been held in 12 different cities in the German and Czech part of the Elbe basin, from the source in the Giant Mountains to the mouth of the North Sea in Cuxhaven. The atmosphere varied from the euphoria of the 90s (presence of important politicians, ministers, great media attention, rich accompanying programme) to a substantive professional conferences. The scope and duration varied, moreover some seminars included monothematic pre-seminars. The main themes changed, responding to professional and societal needs, changes in European legislation and current situations. The format changed – separate seminars, a seminar as part of a special fair, an attempt to expand to other river basins in Central and Eastern Europe, etc. However, the main values remained – high professional level, friendly personal meetings of Czech and German experts (representatives of water management companies, institutions, state administration, universities, research organizations,etc.) efforts to find common solutions and joint projects. And all this with one main goal – to find the best solutions for the Elbe River, which is a natural axis of a large international river basin with European significance and a natural link between countries, regions, cities and people living along the Elbe. The symbiosis between the Magdeburg Seminars and the International Commission for the Protection of the Elbe River has also remained, with the same people on the organising and programme committees and among the speakers as in the expert groups and other activities of the ICPER. And this makes me really happy as a participant of all the International Magdeburg Seminars.

In conclusion, let me express my conviction that the 19th Magdeburg Seminar, which will be held with a one-year delay due to the Covid 19 pandemic in October 2021 in Dessau, will be a successful continuation of the tradition of these seminars and that the 20th anniversary edition will also be held in the future.

Annex 1

Magdeburg Seminar on Water Protection – Overview of national and international conferences

1st	27 October 1988 Water protection in the GDR	Magdeburg
2nd	28 November 1989 Tendencies and activities to reduce the nutrient load on water	Magdeburg

3rd 28 – 30 November 1990 Magdeburg
Pollution of the Elbe
4th 22 – 26 September 1992 Špindlerův Mlýn
The situation on the Elbe
5th 1993 Magdeburg
Lakes after coal mining – risks and opportunities
6th 8 – 12 November 1994 Cuxhaven
The Elbe – a discrepancy between ecology and the economy?
6 – 8 November 1994 Cuxhaven Pre-seminar
Status of trace substance analysis on the Elbe
7th 22 – 25 October 1996 České Budějovice
The Elbe ecosystem – state, development and use
20 – 22 October 1996 České Budějovice Pre-seminar
Water management information systems, Data management and river basin modeling
8th 20 – 23 October 1998 Karlovy Vary (Carlsbad)
Water protection and use in the Elbe river basin
9th 25 – 27 October 2000 Berlin
ICPER: 10 years of integrated water management in the river basin
10th 22 – 26 October 2002 Špindlerův Mlýn
The Elbe – new horizons of river basin management
11th 18 – 22 October 2004 Leipzig
Magdeburg Seminar on Waters in Central and Eastern Europe:
Assessment, Protection, Management
12th 10 – 13 October 2006 Český Krumlov
Water Framework Directive (WFD)
13th 7 – 10 October 2008 Magdeburg
A quarter of a century of change in the Elbe basin (on the Elbe), Climate change in the river landscape, Applied research of lakes, Managemnt of watercourses, WFD
14th 4 – 6 October 2010 Teplice
Impacts of climate change on the water regime, including adaptation measures, Lakes after coal mining and their impact on the water regime of the landscape, River basin management focusing on hydromorphological aspects
15th 10 – 11 October 2012 Hamburg
The Elbe river and its sediments
16th 18 – 19 September 2014 Špindlerův Mlýn
The status of water in the Elbe river basin – new challenges
17th 6 – 7 October 2016 Dresden
The Elbe and its streams influenced by the urban environment
18th 18 – 19 October 2018 Praha (Prague)
Drought and water use requirements in the Elbe river basin
19th 7 – 8 October 2021 Dessau
Water revitalization and water regime in the Elbe river basin

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Fachbeiträge **Odborné příspěvky**

Magdeburger Gewässerschutzseminar 2021
Magdeburský seminář o ochraně vod 2021

Gewässerrevitalisierung und Renaturierung
Revitalizace a renaturace vod

40 Jahre UNESCO-Biosphärenreservat Mittelelbe

Guido Puhlmann

Einführung

Biosphärenreservate sind seit fast 50 Jahren Teil des Programmes „men and biosphere“ der UNESCO. Sie sind als weltweites Netz nach aktueller Definition Modellregionen der UNESCO für nachhaltige Entwicklung.

Der „Steckby-Lödderitzer Forst“ als Kerngebiet des heutigen Biosphärenreservates „Mittelelbe“ (BRME) ist, neben dem „Vessertal“ im Thüringer Wald, das älteste deutsche BR. Es wurde bereits im Jahr 1979 von der UNESCO anerkannt. Dem folgten in den 80er Jahren verschiedene, jeweils von der UNESCO bestätigte Erweiterungen zum BRME. 1990 begann mit der Verordnung des BR „Mittlere Elbe“ mit ca. 43.000 Hektar im Rahmen des Nationalparkprogramms der DDR, der Installierung einer BR-Verwaltung ein neues Kapitel in der Ausgestaltung des Reservates. Es steht international repräsentativ für großräumige Flusslandschaften des Tieflandes in Mitteleuropa

Die UNESCO bestätigte 1997 die seit 1990 von mehreren Bundesländern intensiv betriebene Erweiterung des Reservats zum länderübergreifenden BR „Flusslandschaft Elbe“ (BRFE) auf ca. 375.000 Hektar (ha). Auf das BRME

Abb. 1: *Räumliche Entwicklung des UNESCO-Biosphärenreservates und UNESCO-Welterbes an der Elbe*

in Sachsen-Anhalt entfallen dabei ca. 190.000 ha und 300 von 400 Flusskilometern der Elbe. Mit Erweiterung des bis dahin bestehenden Reservates „Mittlere Elbe“ wurde 1997, abgesehen vom sächsischen Elbelauf, der gesamte Flussabschnitt über 400 Flusskilometer in ein fünf Länder überspannendes Biosphärenreservat (BR) eingebunden – Sachsen-Anhalt (BR Mittelelbe), Niedersachsen (BR Niedersächsische Elbtalaue), Mecklenburg-Vorpommern (BR Flusslandschaft Elbe – Mecklenburg-Vorpommern) und Brandenburg (BR Flusslandschaft Elbe – Brandenburg) sowie Schleswig-Holstein (mit < 200 ha). Damit ist ein Verbund von nationalen Biosphärenreservaten unter einem gemeinsamen international anerkannten Prädikat entstanden. Der vorliegende Beitrag berichtet kurz über das größte, sich nahezu über 300 Flusskilometer erstreckende BR „Mittelelbe“ im Land Sachsen-Anhalt. Das BRME ist hinsichtlich seiner Ausdehnung und Größe im Management sowie der Gebietsbetreuung in der heutigen Größe eines der anspruchsvollsten europäischen Schutzgebiete. Die Elbauen im Reservat sind hinsichtlich der Naturausstattung und der Qualität sowie Großräumigkeit des Ökosystems mindestens in Deutschland einzigartig.

Hervorzuheben ist, dass im Jahr 2000 das Gartenreich Dessau-Wörlitz auf ca. 14.300 ha als Weltkulturerbe von der UNESCO anerkannt wurde. Die Kulturlandschaft ist beispielgebend für die historische Gestaltung und aktuelle Pflege des Kulturerbes und fügt sich als harmonische Kulturlandschaft mit großen Auenwäldern hervorragend in das BR ein.

Die BR-Verwaltung erfuhr mit der flächigen Ausweitung des BR eine ständige personelle und strukturelle Entwicklung. Waren 1991 nur fünf Personen beschäftigt, erhöhte sich deren Anzahl einschließlich Naturwacht auf zwischenzeitlich 70 und bis heute auf ca. 50 Mitarbeiter. Neben der zentralen Verwaltung im ebenfalls zum Weltkulturerbe gehörenden Kapenschlösschen bei Oranienbaum-Wörlitz, bestehen Außenstellen in Steckby, Arneburg, Havelberg und Ferchels. Unweit der Verwaltung wurde im Rahmen der EXPO 2000 (EXPO-Projekt in der Korrespondenzregion Bitterfeld-Dessau-Wittenberg) mit dem „Auenhaus“ das erste Informationszentrum aufgebaut, welches 2019 noch eine räumliche Erweiterung erfahren konnte. Das „Haus der Flüsse“, Natura-2000-Informationszentrum des BRME, folgte im Rahmen der BUGA 2015 (Havelregion) in Havelberg. Infostellen befinden sich in Magdeburg, Arneburg und Buch (NABU/ZÖNU).

Rückblick – Arbeitsschwerpunkte und Aktivitäten im Biosphärenreservat

UNESCO-Biosphärenreservate müssen nationale und internationale Kriterien der UNESCO erfüllen, die regelmäßig alle 10 Jahre im Rahmen einer Evaluierung überprüft werden. Mit der Erweiterung des BRME von 1997 wurde ein anderes Vorgehen als im kleineren BR Mittlere Elbe für die Erfüllung der Kriterien notwendig. Die Zusammenarbeit mit Partnern, wie bspw. aus Bundes-, Landes- und kommunalen Einrichtungen, Verbänden sowie Landnutzern der Privatwirtschaft ist seitdem wesentlich umfangreicher und zum strategisch bedeutsamsten Arbeitsschwerpunkt geworden.

Nahezu alle international, national und regional herausragenden „Kultur- und Naturwerte“ im Reservat sind abhängig von den besonderen Wasserverhältnissen in einer überflutbaren Flussaue mit dem Wechsel der Wasserführung und der auf großer Fläche wirkenden dynamisch-gestaltenden Kraft des fließenden Wassers. Insofern war und ist das Management des Wassers im Reservat der besondere Schwerpunkt der Arbeit. Neben der erfreulichen und nachhaltigen Verbesserung der Gewässergüte aller Flüsse im Reservat nach 1990, sind die typischen dynamischen hydromorphologischen Prozesse in der rezenten Aue sowie in der Elbe selbst, die abschnittsweise nur noch 20 % der ehemaligen Fläche besitzt, teilweise und in „schleichend zunehmendem Maße“ eingeschränkt.

Die Erweiterung der rezenten Aue einschließlich der Verbesserung und Wiederherstellung typischer Strukturen, hydrologischer Bedingungen und dynamischer Prozesse im Fluss und in der Aue waren und sind deshalb eng verbunden mit dem Arten- und Biotopschutz, der Regionalentwicklung sowie dem Gebietsmarketing und damit ein wesentlicher Teil der Schutz- und Entwicklungsstrategie.

Die enge Zusammenarbeit mit den Schifffahrts- und Wasserbauinstitutionen des Bundes und des Landes zur Integration von naturschutzfachlichen Zielstellungen bei verschiedenen Investitionsvorhaben und regelmäßigen Unterhaltungsarbeiten wird intensiv gepflegt. Die Reservatsverwaltung koordiniert dabei fachlich nach der Erstellung auch die Umsetzung des Sohlstabilisierungskonzeptes und des Gesamtkonzeptes Elbe. Sie vertritt dabei den Naturschutz der Elbeländer in den entsprechenden nationalen und regionalen Gremien. Dies war in den nationalen Gremien zur Erstellung des Nationalen Hochwasserschutzprogrammes nach den schweren Hochwasserereignissen 2013 ebenso der Fall.

Daneben wurden und werden in eigener Verantwortung und gemeinsam mit Partnern wie dem WWF, NABU, BUND, DBU, LHW, EUROPARC Deutschland (heute NNL e. V.), den WSÄ etc. eine Vielzahl von Naturschutzpro-

jekten unterschiedlicher Größe mit dem Ziel der Verbesserung der Wasserverhältnisse vorbereitet und umgesetzt. So verfolgt die BR-Verwaltung seit 1990 die Erarbeitung von teilweise sehr großflächigen und langandauerndn Naturschutzprojekten, die zunächst in Eigenregie und seit der letzten umfangreichen Erweiterung des Gebietes gemeinsam mit verschiedenen starken Partnern entwickelt und umgesetzt werden. Ein erstes großes Projekt war die Sanierung und Rekonstruktion des über 30 ha großen Altwassers Kühnauer See bei Dessau mit besonderer Unterstützung der ALLIANZ-Umweltstiftung. Gemeinsam mit dem WWF als Träger und mit späterer Unterstützung durch den Landesbetrieb für Hochwasserschutz und Wasserwirtschaft Sachsen-Anhalt (LHW) wurde von 2001 bis 2019 das zu 75 % vom Bund geförderte Naturschutzgroßprojekt „Mittlere Elbe“ betrieben. Dieses Projekt von gesamtstaatlich repräsentativer Bedeutung zielte auf die Entwicklung eines Verbundes echter überfluteter Auenwälder (mehr als 9.000 ha), aber vor allem auf die Rückverlegung des Lödderitzer Deiches zur Schaffung von 600 ha neuem Retentionsraum mit flächigen Auenwaldbeständen.
Seit 1994 besteht in bewährter enger Zusammenarbeit mit dem Landesbetrieb für Hochwasserschutz und Wasserwirtschaft Sachsen-Anhalt (LHW) für das Gesamtgebiet eine Konzeption für Deichrückverlegungen, die mittlerweile an mehreren Stellen, insbesondere nach den verheerenden Hochwasserereignissen 2002 und 2013, umgesetzt wurden und werden. Daraus erwuchs das aktuelle wie zukunftsweisende Landesprogramm „mehr Raum für Flüsse“. An der unteren Havel wurde gemeinsam mit dem brandenburgischen Naturpark „Westhavelland“ ein ebenfalls vom Bund gefördertes Naturschutzgroßprojekt zur Renaturierung der Havel erarbeitet. Dieses wird seit 2005 gemeinsam mit dem NABU-Bundesverband als Träger auf einer Fläche von mehr als 16.000 ha umgesetzt. Dort stehen flussökologische Aspekte im Mittelpunkt.

Seit nun 40 Jahren erfolgten im BR mehr als 20 Altwassersanierungen teils mit erheblichem Umfang, ein deutschlandweit wohl einmaliges Ergebnis. Darüber hinaus sind die nun drei Naturschutzgroßprojekte sowohl in fachlicher Qualität als auch im Umfang in Europa einzigartig. In der Oranienbaumer Heide initiierte und befasste sich die BR-Verwaltung gemeinsam mit der Hochschule Anhalt, der Deutschen Bundesstiftung Umwelt und der Primigenius gGmbH auf einer Fläche von ca. 900 ha mit einem Projekt zur Etablierung einer halboffenen Weidelandschaft mit Heckrindern und Konikpferden. Zahlreiche Auenwaldentwicklungs-, Flutrinnenmanagement- und Artenschutzprojekte in verschiedener Größe, mit unterschiedlicher Finanzierung und verschiedenen Partnern waren und sind ständig in der Umsetzung.
Der Biber, einst bedroht, ist heute Sinnbild für erfolgreichen Artenschutz. Durch Bejagung und Lebensraumverlust war er Ende des 19. Jh. in Deutschland nahezu ausgestorben. An der mittleren Elbe überlebten wenige Individuen. In den 1920er Jahren nahm der Biberschutz in Steckby unter Amtmann Behr seinen Anfang und begründete eine einzigartige Erfolgsgeschichte des Naturschutzes in Deutschland. Von den 1970er Jahren bis nach 2000 konnten Elbebiber aus dem Biosphärenreservat innerhalb Deutschlands und in mehreren europäischen Ländern wieder angesiedelt werden. Heute ist die Verwaltung des
BRME auch Biberkompetenzstelle des Landes Sachsen-Anhalt und kümmert sich um den Schutz der Biber, die Erfassung des Bestandes und um Konflikte zwischen Biber und Mensch.
Das BRME profitiert in enger Zusammenarbeit mit den zuständigen Institutionen im Monitoring sowie in der Maßnahmeplanung und -umsetzung maßgeblich von der Einführung und Umsetzung von NATURA2000, der EU-Wasserrahmenrichtlinie und EU-Hochwasserrisikomanagementrichtlinie.

Ausblick – Auswahl von Schwerpunkten

Die Entwicklung und das Management eines mit 300 Kilometer Länge sowie der Einbeziehung von fast zwei Dritteln aller Kreisstrukturen des Landes außergewöhnlich strukturierten Schutzgebietes erinnert eher an großflächige Staaten und ist eine in Deutschland bisher beispiellose Aufgabe. Hier kann, darf und muss in anderen Maßstabsebenen als in den anderen Nationalen Naturlandschaften gedacht und gehandelt werden. Daraus erwächst die Chance zur besseren Bewältigung der auch vor Ort spürbaren Herausforderungen des Klimawandels und des Artenschwundes. Wasser ist in der Landschaft knapp und wird zeitweise noch weniger als bisher zur Verfügung stehen. Es muss in den Auen des Reservates und im gesamten Einzugsgebiet der Elbe zurückgehalten und möglichst natürlich gespeichert werden, wenn es da ist. Da die meisten gebietstypischen Lebensräume, Lebensraumtypen und Habite der typische Tier- und Pflanzenarten im BRME sehr wasserabhängig sind, kommt den hydrologischen Verhältnissen, soweit man sie in einem BR beeinflussen kann, in Zeiten des Klima- und Nutzungswandels höchste Priorität zu.

Dies und der großräumige Schutz der Natur, der typischen Lebensräume, der natürlichen Prozesse und der Artenvielfalt ist eine Kernkompetenz des BRME und steht dabei wie deren weitere Entwicklung in enger Zusammenarbeit mit den im Reservat lebenden und arbeitenden Menschen im Mittelpunkt. Die Reservatsverwaltung versteht sich dabei insbesondere im Management von Natur, Gebietswasserhaushalt und Landschaft als umsetzungsorientierte Institution.
Zur Sicherung und Entwicklung der wasserabhängigen Arten- und Biotopvielfalt sowie zur Umsetzung von Anpassungsstrategien an den Klimawandel sollen weiter in bewährter Weise und in Verknüpfung mit regionaler Entwicklung, großräumige Projekte u. a. im Rahmen der Bundesprogramme Chance Natur“, „Biologische Vielfalt“ und „Blaues Band“ entwickelt und mit verschiedenen Partnern umgesetzt werden. Die Erhaltung und Entwicklung Hartholzauenwälder, mehr als 80 % des Bestandes in Deutschland befindet sich im BRME, ist dabei besonders wichtig.

Mit dem Gesamtkonzept Elbe wurde durch die gemeinsame intensive Zusammenarbeit der Interessenvertretungen der Umwelt- und Wirtschaftsseite mit den Verwaltungen des Bundes und der Länder ein gemeinsamer Handlungsrahmen für die Entwicklung der Elbe in den kommenden 20 bis 30 Jahren definiert. Nun werden Maßnahmen zur Bekämpfung der Erosion und zur Verbesserung der Schifffahrtsbedingungen sowie zur Erhaltung des wertvollen Naturraums auf noch breiterer Basis als bisher in Angriff genommen.
Das Sohlstabilisierungskonzept Elbe, welches von einer Bund-Länder-AG unter direkter Mitwirkung der BR-Verwaltung als Vertreter Sachsen-Anhalts entwickelt wurde, bedarf prioritär zügiger Umsetzung. Die über die bisherige Geschiebezugabe von bis zu mehr als 100.000 Tonnen pro Jahr hinausgehende aktive Eindämmung der andauernden Sohlerosion der Elbe zwischen Mühlberg und der Saalemündung ist für den Bestand zentraler Werte des Gartenreiches Dessau-Wörlitz und des BR von entscheidender Bedeutung. Das BRME arbeitet weiter koordinierend für den Bereich Naturschutz der Elbeländer in der Bund-Länder-Kommission und Gremien an der Umsetzung dieser beiden abgestimmten Elbekonzepte.

Abb. 2: *Touristische Schifffahrt auf der Elbe. Foto: G. Puhlmann*

Abb. 3: *Rückbau von sehr massiven Uferbefestigungen an Elbe, Mulde und Havel schafft Biotope und lässt natürliche dynamische Prozesse wieder zu, hier Uferrückbau im Rahmen des Bundesprogrammes Biologischen Vielfalt-Projektes Wilde Mulde (Träger WWF). Foto: G. Puhlmann*

Zukünftig sollen in der Erosionsstrecke der Elbe mit dem Pilotprojekt „Klöden“ zwischen der Ortschaft Pretzsch und der Mündung der Schwarzen Elster Maßnahmen zur Sohlstabilisierung umgesetzt werden. Träger des Vorhabens ist das Wasserstraßen- und Schifffahrtsamt Elbe. Über die sohlstabilisierenden Maßnahmen im Flussbett hinaus wird im unmittelbaren Umfeld des Flusses das vom BRME initiierte und 2020 gestartete „Naturschutzgroßprojekt Mittelelbe−Schwarze Elster“ in den kommenden Jahren umgesetzt. Träger des Naturschutzgroßprojektes ist die Heinz-Sielmann-Stiftung. Hauptaugenmerk dieses Projektes liegt auf der Vernetzung der Elbe mit ihrer Aue.

Die Fortsetzung guter Zusammenarbeit mit den Kommunen, den Landkreisen, den kreisfreien Städten, Bewohnern und Landnutzern, der Wasserstraßenverwaltung des Bundes, dem Landesverwaltungsamt (LVwA), dem Landesbetrieb für Hochwasserschutz und Wasserwirtschaft (LHW), dem Landesforstbetrieb (LFB), der Landwirtschaftsverwaltung, den regionalen Naturschutzorganisationen und nationalen Umweltverbänden, dem Nationale Naturlandschaften e. V.(NNL), dem Bundesamt für Naturschutz (BfN), dem Umweltbundesamt Dessau (UBA), den Bundesanstalten für Gewässerkunde und Wasserbau (BfG, BAW), Universitäten, Hochschulen, Forschungsinstitutionen, den Naturschutzbehörden, Kirchen, Bürgerinitiativen wie „Pro Elbe“, Nutzerverbänden und zahlreichen Akteuren aus Politik, Wirtschaft und Verwaltung ist weiter von besonderer Bedeutung.

Die BR-Verwaltung wird auf Grundlage des bestehenden Kooperationsvertrages die enge Zusammenarbeit mit der KSDW im Gartenreich Dessau-Wörlitz weiter gestalten. Gleiches gilt für die auch international sehr beachtete Kooperation beider Institutionen mit den Stiftungen Bauhaus Dessau und Luthergedenkstätten Sachsen-Anhalt.
Entwicklungen sind notwendig für die Ausweisung von weiteren Auenpfaden und für die Organisation des Naturtourismus. Ausgewählte, dafür geeignete Teile der naturnahen und natürlichen Dynamik überlassene Bereiche füh-

ren bei rücksichtsvoller Erschließung zu bleibenden Naturerlebnissen und emotional hergeleiteten Überzeugungen zum Schutz der Natur.

Die im Rahmen eines vom BfN geförderten Projektes der Universität Greifswald als Ergebnis einer Bevölkerungsbefragung 2011 ermittelte hohe Akzeptanz des BRME in der Bevölkerung und bei kommunalen Entscheidungsträgern motiviert alle Akteure im BRME. Diese soll wie bisher durch vertrauensvollen Umgang und glaubwürdiges, berechenbares Agieren immer wieder neu errungen und gefestigt werden. Letztlich soll auch damit das große BRME im Sinne der UNESCO-Strategie dazu beitragen, gern, besser, nachhaltiger und bewusster in, mit und von der Elbelandschaft zu leben. Das gilt natürlich neben uns Menschen auch für die typische Tier- und Pflanzenwelt der Flussaue

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Abkürzungsverzeichnis

Abb.	Abbildung
AG	Arbeitsgemeinschaft
ALFF	Amt für Landwirtschaft, Flurneuordnung und Forsten Anhalt
BAW	Bundesanstalt für Wasserbau
BfG	Bundesanstalt für Gewässerkunde
BfN	Bundesamt für Naturschutz
BIMA	Bundesanstalt für Immobilienaufgaben
BR	Biosphärenreservat
BRFE	Biosphärenreservat Flusslandschaft Elbe
BRME	Biosphärenreservat Mittelelbe
BUGA	Bundesgartenschau
BUND	Bund für Umwelt und Naturschutz Deutschland e.V.
bzw.	beziehungsweise
ca.	circa
DBF	Dauerbeobachtungsflächen
DBU	Deutsche Bundesstiftung Umwelt
DDR	Deutsche Demokratische Republik
Dr.	Doktor
ELER	Europäischer Landwirtschaftsfonds für die Entwicklung des ländlichen Raums
etc.	et cetera
EU	Europäische Union
FFH-Gebiet	Fauna-Flora-Habitat-Gebiet
FÖLV	Förder- und Landschaftspflegeverein „Mittelelbe“ e. V.
ha	Hektar
ILN	Instituts für Landschaftsforschung und Naturschutz Halle
Jh.	Jahrhundert
KSDW	Kulturstiftung Dessau-Wörlitz
LAU	Landesamt für Umweltschutz Halle
LFB	Landesforstbetrieb
LHW	Landesbetrieb für Hochwasserschutz und Wasserwirtschaft
lt.	laut

LVwA	Landesverwaltungsamt
MAB	Man and the Biosphere (Mensch und Biosphäre)
MULE	Ministerium für Umwelt, Landwirtschaft und Energie des Landes Sachsen-Anhalt
NABU	Naturschutzbund Deutschland
NGO	Nongovernmental organisation (Nichtregierungsorganisation)
NNL	Nationale Naturlandschaften
NSG	Naturschutzgebiete
NSG-VO	Verordnung über das Naturschutzgebiet
SUNK	Stiftung Umwelt, Natur und Klimaschutz
u.a.	und andere
u.a.m.	und andere mehr
UBA	Umweltbundesamt
UNESCO	United Nations Educational, Scientific and Cultural Organization
WWF	World Wide Future for Nature
z.B.	zum Beispiel
ZÖNU	Zentrum für Ökologie, Natur- und Umweltschutz e.V.

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The concept for river bed stabilization of the river Elbe – the first building activity at the Erosion Reach

Elke Kühne

1. Introduction

In a section of the river Elbe between Mühlberg and mouth of the river Saale (km 120 to 290,7) the riverbed suffers from a steady degradation process for more than 100 years on average about one metre (up to max. 1.80 m). This part of the river Elbe is called the Erosion Reach.

The increased erosion trends pose a threat to the stability of constructions, such as bridges and to the river regulation structure. On the other hand, water level situation will be changed with progressive erosion. This reduction involves to lowering of groundwater levels in the flood plains. As a result of this process this leads to a creeping devaluation of the ecological system of River and flood plains, corresponding to a drop in habitats, animal and plant species of the flood plains.

The causes of erosion are many like a deficit of bed load in the upper reaches of the river Elbe, the restriction of discharge area by dykes and the regulation of the river bed and navigation channel.

To occur the progressive erosion, at first activity realized is to compensate for deficit of bed load by artificial bed load supply since the mid-90s. In addition the Federal Waterways and Shipping Office designs several projects to modify the river structures. The first one is the project Klöden.

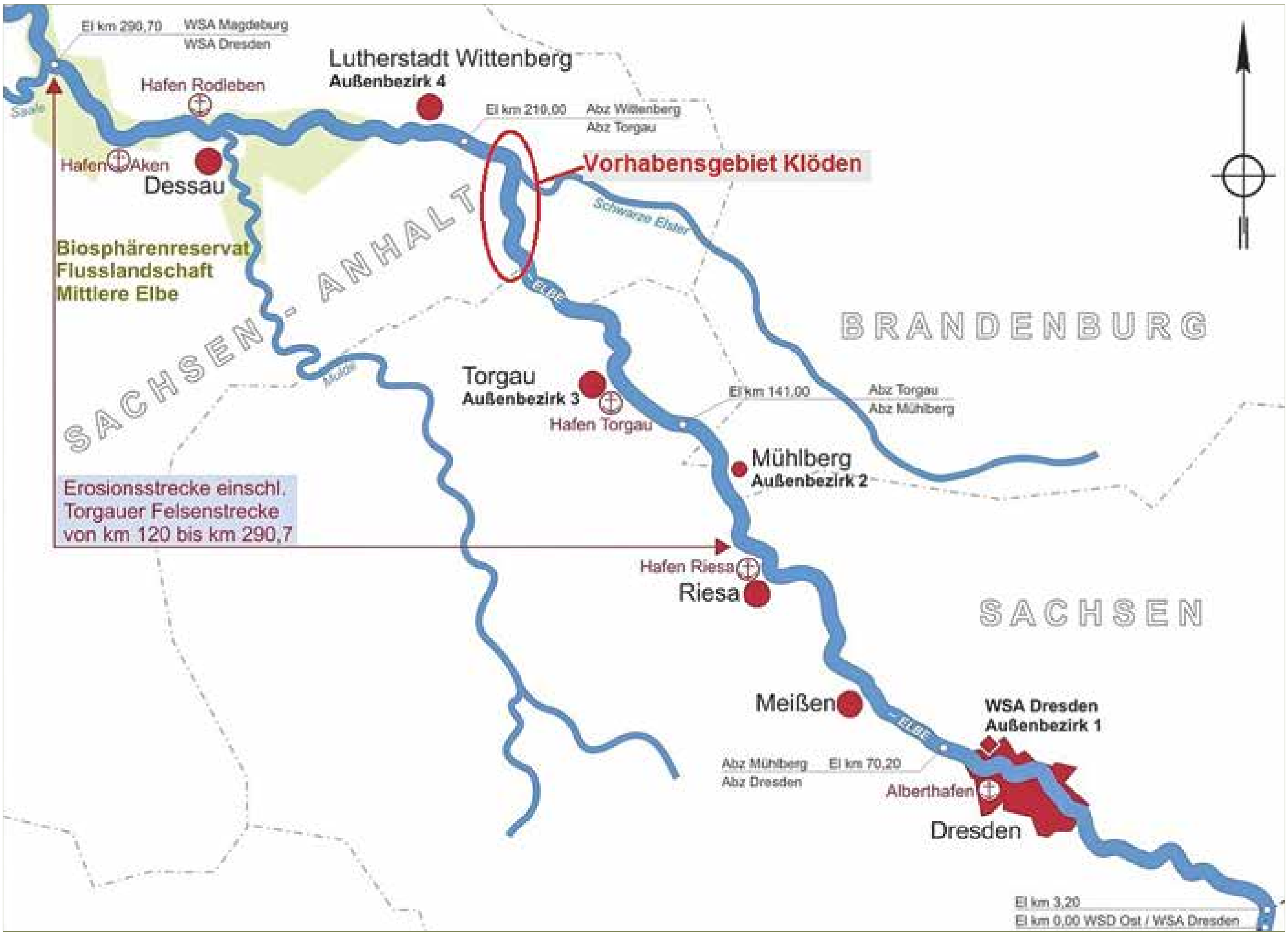

Fig. 1: Plan of the erosion reach of the river Elbe und the pilot project Klöden (WSV, 2009)

The project Klöden is located in the river section between km 184 near Pretzsch-Mauken and km 198,5 near Elster. There the groynes and bank protections will be adapted to the current state of hydrology with the view to minimize the river bed erosion. The project planning is just finished and in the next years the planapproval procedure will be taking place. Fig. 1 shows the erosion reach and the reach of Klöden.

2. Content and implementation of the concept for river bed stabilization of the river Elbe

The concept for riverbed stabilization was developed in 2009 by the Waterways and Shipping Administration (WSV), the Federal Waterways Engineering and Research Institute (BAW) and the Federal Institute of Hydrology (BfG) in cooperation with the federal states of Saxony and Saxony-Anhalt. The aim of the concept is to stabilize the average elevation of the river bed by means of river engineering measures and bedload management measures. Based on a description of the actual condition of the erosion reach, packages of measures were identified that have an erosion-reducing effect while maintaining the existing navigation conditions and taking flood neutrality into account. In addition, from an ecological point of view, the measures described aim to increase the structural development and dynamics between the river and floodplain.

The measures include, for example, adjustments to river structures, the removal of bank elevations that have developed over time, the reactivation of flood channels and the reconnection of old branches. This relieves the river bed and reduces the flow attack on the river bed during discharges above mean water.
The bed stabilization concept is the basis for planning and action for the WSV's maintenance measures in the erosion reach. It is also part of the overall concept for the Elbe, which was drawn up in 2017 and confirmed by the German Bundestag in 2018.

The measures are implemented depending on the respective sections characteristics along the river, such as erosion intensity and the type of control structures affected. The packages of measures adapted to these characteristics are intended to achieve an optimum effect in terms of erosion reduction. Three pilot sections were defined in the concept. These are the sections Klöden, Wittenberg/L. and Coswig/A.

3. The Klöden pilot project – current implementation status

In the Klöden section, the middle river bed has deepened by about 1.6 meters since the end of the 19th century.

Fig. 2: The Elbe with a view of the Klödener Bogen (aerial survey in May 2011 on behalf of WSA Dresden, photo Andreas Hilger).

The following objectives should be considered in the planning process:

- Maintaining or restoring the defined navigation conditions.
- stabilization of the mean bed heights while maintaining and promoting the morphological dynamics
- Equalization of the bedload transport with the result of the reduction of the bedload discharge quantities
- Consideration of the influence on the groundwater balance and the flood neutrality of the applied measures as well as ecological requirements
- Stronger structuring and dynamization of the riverbed and the floodplain (allowing structure-forming processes, interconnection of river and floodplain).

This is to be implemented through the following packages of measures:

1. in the river bed:

- Regulating structures will be lowered by up to 0.7 meters to the current mean water level and the building distance from the left to the right bank will be increased to 105 m.
- Local discontinuities will be eliminated – widen discharge area at Klöden curvature by excavation on inner bank, make transitions from stretches with groynes to revetments more uniform.
- Groyne fields will be cleared to restore their function.

2. in the floodplain area:

- Old arms and side channels are reactivated. These measures can reduce the flow velocity in the river bed and thus the load on the bed.

For the further planning process, the following work was commissioned and supervised by the WSA Dresden (now WSA Elbe):

- Update of the digital terrain model oft he watercourse (DGM-W) for the project area incl. new flight of the project area with recording of the shallow water areas (groyne fields) – handover DGM-W II. Quarter 2018,
- Determination of the fine sediment layers in the old waters 2011,
- Hydrogeological survey of the project area in 2012 and 2014,
- Preparation of the concept for the groundwater (GW) monitoring network and preparation of GW model (2018) incl. establishment of 21 new GW monitoring sites and reactivation of 15 old GW monitoring sites 2018,
- Establishment of 6 OW monitoring sites in old water bodies 2017,
- Creation of a construction site network 2016.

The following studies were commissioned and carried out to assess the environmental impact of the pilot measure:

- Pollutant surveys in tributary waters and sampling in groyne fields 2011,
- Recording of biotopes and soil species in the project area in 2009, supplementary investigations in 2018 (hardwood floodplain), coordination of the update and supplementation of mapping with Saxony-Anhalt State Office for the Environment in 2018,
- Recording of fish in the project area 2009,
- Fish monitoring in scours in the section from El-km 180 to 240 August 2019/21.

For data management, the project GIS is currently being converted to multi-user operation as WEB-GIS with the participation of the Federal Information Technology Center (ITZ) and an IT company. This will create the basis for project staff to be able to log on to the project GIS via an Internet application and view, download or change and enter data in accordance with their user rights. This will eliminate the need for multiple data storage. In a second step, the Internet application will also be used for public relations to make information about the project available to the public.

As part of the further planning, the environmental planning was put out to tender in 2020. Currently, the surveys of flora and fauna in the project area are being carried out.

4. Outlook

The aim is to complete the technical planning by the end of 2021 and to compile the approval documents by the second quarter of 2022. Due to the amendment of the Federal Waterways Act 2021 and thus changes in the scope of tasks of the WSV, there may be revisions and additions to the technical planning.

Due to the complexity of the packages of measures, the following experience has been gained in the course of the project to date:

- Extensive experience has been gained in theoretical preparation / technical discussions, which can also be incorporated proportionally into maintenance measures.
- Creation of a large data pool that can also be used outside the project as more understanding of processes and accuracies is gained.
- Expert broad discussion processes provide many ideas.
- Testing of new techniques generates synergy for further projects.

Based on the aforementioned evaluation of the planning process, it will be easier in the future to determine the effort required for meaningful and moderate data collection for further projects; freely following the principle "not everything that is possible is also necessary". Also, the project process chosen now is a template for subsequent pilot projects, so that the planning process can be accelerated and faster implementation of measures will then be possible.

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The Spree River in Bautzen – Conversion of an urban watercourse to a near-natural river landscape

Stefan Jentsch

Bautzen is more than 1,000 years old. The town is characterized by its history, industry and architectural monuments. From the 16th century, the hydropower of the Spree River was used industrially. Numerous transverse structures were built and the watercourse was canalized by bank walls on both sides. The Spree River did not only lose its ecological continuity, its natural dynamics were almost completely restricted as well. This condition prevailed until modern times.

The flood of 2010 caused devastating destruction on the riverbanks in Bautzen's old town. Unused buildings close to the river as well as eroded weirs and old bank walls in poor structural condition were particularly affected. The State Reservoir Administration of Saxony promptly decided to repair the damage sustainably in accordance with the European Water Framework Directive. It was both essential and demanding to upgrade the inner-city watercourse ecologically.

This measure is special for its complexity. Various water management requirements such as flood protection, creation of continuity, renaturation and fish protection had to be considered as well as aspects of recreation, nature conversation, monument protection and the concerns of residents and land owners.

The project started in February of 2011. On a 1.5-kilometer section of the Spree River in Bautzen 89 different cases of flood damage were reported. To date, about 770 meters of bank walls, two weirs, a sill and an industrial brownfield site at the banks of the river have been removed.

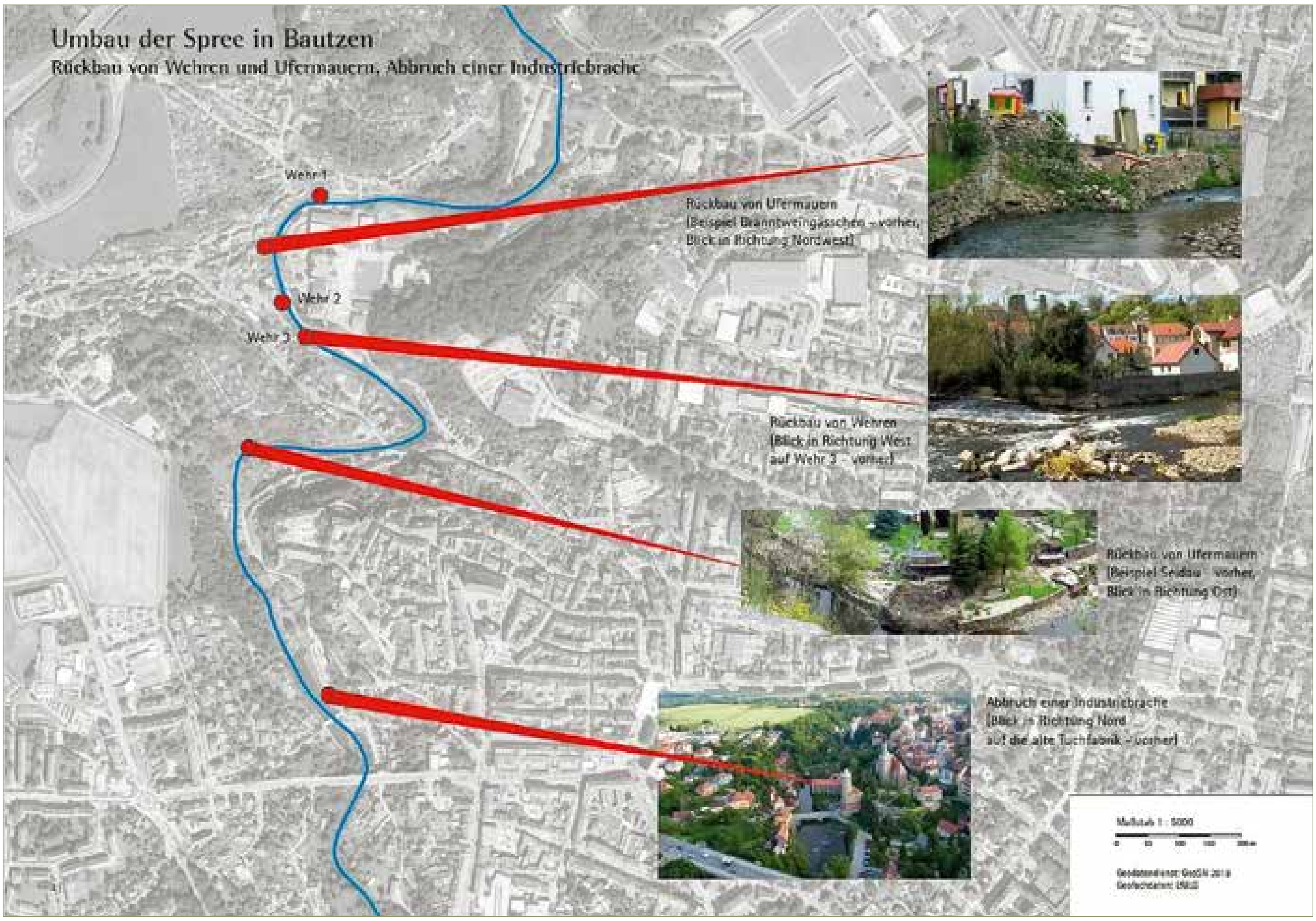

Fig. 1: *General plan of the measures*

In July of 2012, planning for the deconstruction of embankment walls began. This first sub-project was part of the flood damage repair. The data necessary for the planning had to be updated such as survey data and water level calculations. For this watercourse section, a protection target corresponding to HQ 100 was defined.

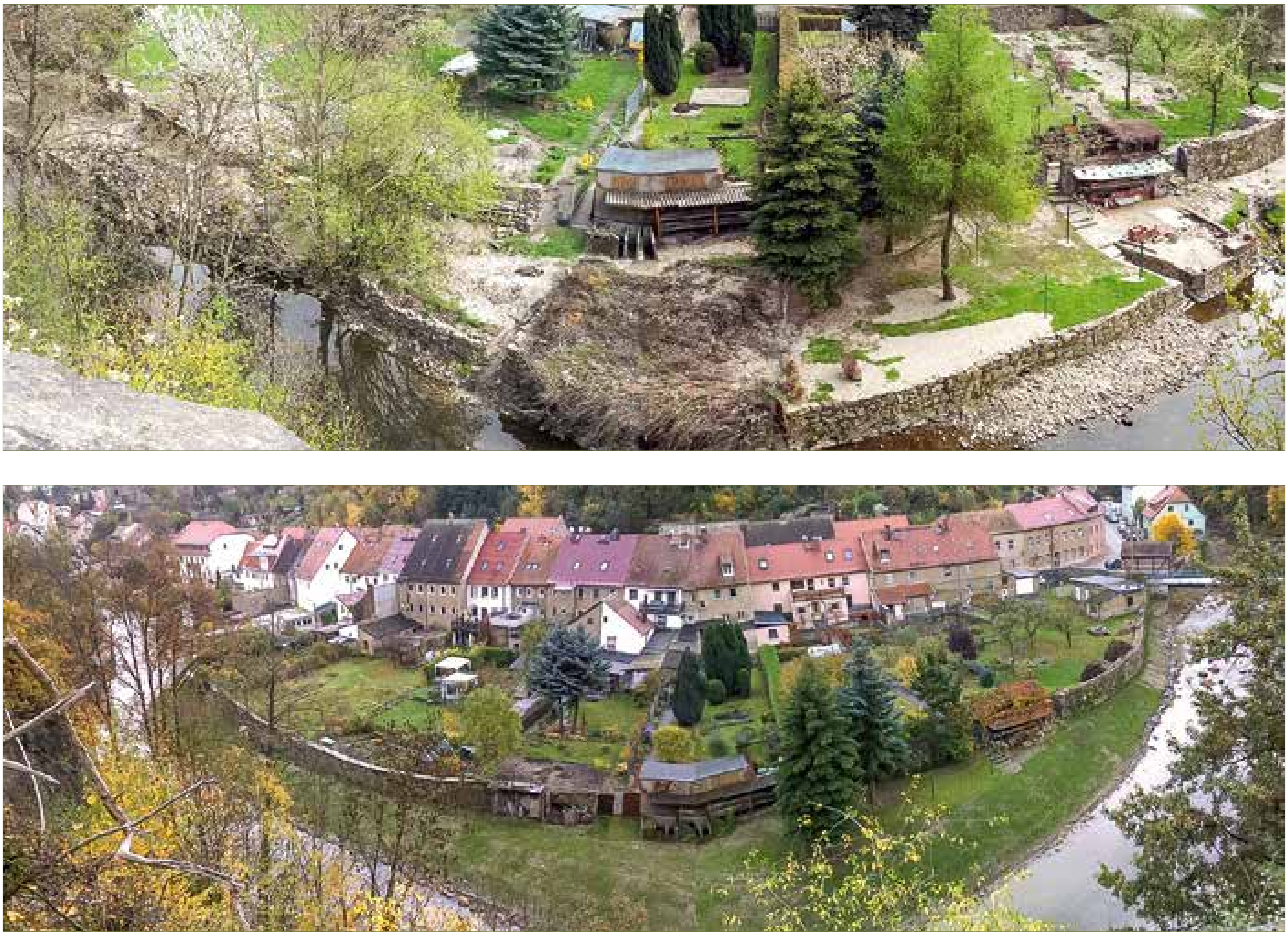

Fig. 2: *Deconstruction of the bank wall below Protschenberg; above – before; below – after*

By redisigning the banks and watercourse, near-natural structures were created. The uniform flow profile was dissolved and the natural development of the watercourse and vegetation initiated. Construction work began in mid-June of 2013, directly after another flood and in compliance with the closed season regulations for fish species.

Fig. 3: *Deconstruction of the bank wall at Branntweingässchen; left – before; right – after*

To protect the historical building fabric vibration measurements had to be carried out throughout. The old narrow alleys of the town made the work even more difficult. Not only were they difficult to access, but their load-bearing capacity was also limited. Therefore, only vehicles with low cargo volume could be used.

All work was carried out from the riverbed. A construction road was built on one half of the riverbed, allowing the mean water flow to be maintained. The construction road was partly built on so-called big bags to avoid compacting the riverbed considerably.

Fig. 4: *Construction road on big bags*

Fig. 5: *Gravel bank with sunflowersr*

Structural elements such as gravel banks, groynes, stone spurs and sturgeon stones create a variance in flows and depths, allowing new habitats for animals and plants to develop.

While the first section was under construction a second sub-project was being planned. The industrial wasteland of an old cloth factory was to be deconstructed. The building was an enormous hydraulic obstacle in the watercourse. About 1,200 m^2 of the industrial complex stood in the drainage profile of the Spree River. In the confined Spree Valley every space or retention area is needed to drain floodwaters as is the two-way bridge "Schafenstegbrücke" characterized by backwater during floods.

Fig. 6: *Industrial wasteland before*

In addition, the structural condition of the old industrial building was questionable, having been washed out by the 2010 and 2013 floods. Demolition work began in June of 2014. Nearly 8,000 cubic meters of enclosed space with a maximum height of 15 meters were demolished. About 7,500 tons of construction waste including hazardous materials were professionally disposed of.

Extensive hydraulic engineering work in this area began the following year. The newly designed section of the waterway is located in a popular area of the old town of Bautzen, directly at a bicycle path. Many tourists and locals use this place for recreation. That is why the stones of the dismantled industrial site were used to build seating steps that are eleven meters wide and make the river accessible and recreational.

Fig. 7: *left – demolition of the industrial wasteland; center – new embankment with seating steps; right – bank of the Spree after deconstruction of the industrial wasteland*

As part of a third sub-project three weirs at the river bend „Spreebogen" were dismantled, allowing the continuity and the hydromorphological conditions of the river to be restored. Structural deficits according to the European Water Framework Directive could be sustainably eliminated.

The State Reservoir Administration of Saxony decided on a rough open conduit. Several dilapidated and non-functional bank walls were also removed. Stones for the new riverbanks were obtained from the deconstructed bank walls and weirs. On the right bank, a maintenance path was laid out with gravel grass. This path was used for transporting materials during the construction.

Fig. 8: *Deconstruction weir 1 – left before – right afterer*

Fig. 9: *Deconstruction weir 2 – left before – right after*

The construction was supervised by a fisheries expert. Two screw groynes were to be installed to reduce the flow velocity of the Spree River. Significantly reduced discharge values show that this measure has been very effective. After installing the first screw groyne the flow velocity had already been significantly reduced so that the installation of the second groyne could be passed.

Fig. 10: *Construction of the screw groyne*

In Bautzen 1.50 kilometers of urban space were turned into a near-natural river landscape with recreational value for people and a basis for the preservation and improvement of habitats for animals and plants. We will monitor the development of the Spree River in this section and draw conclusions for further river restorations. Currently, further redesign measures of the Spree River in the old town area of Bautzen are being planned.

In 2019, the project was awarded the Water Development Prize of the German Association for Water, Wastewater and Waste (DWA).

Fig. 11: *Deconstruction weir 3 – above before – below after*

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Restoration of river arms within the scope of Povodí Labe, state enterprise

Michal Vávra, Petr Ferbar, Darina Šitinová

1. Introduction

Old river arms are extremely valuable elements of landscape and serve as a sanctuary for many species of plants, fungi and animals. From the water-management point of view river arms also serve as a water retention in landscape. River arms disappear due to stream regulations, loss of active flow and ecological succession. In the regulated parts of watercourses and floodplains, in the absence of natural dynamics, technical measures must be taken to maintain and restore the ecological and water-management functions of river arms and pools. This is preceded by high-quality biological surveys, together with a design for measures to restore degraded parts and to preserve valuable parts. These measures may include, for example, restoration efforts in terms of connectivity between main streams and river arms, restoration of river beds to its original state, sediment removal, creation of pools, restoration of riparian stands, ensuring successful migration of water animals, special measures to support rare species of organisms or solution to biological invasions. Essential aspects in the selection of sites for revitalization of river arms are also solvable property-legal relations, technical feasibility of an intervention and funding source choice.

2. Restoration of river arms and oxbows of the Elbe River and other watercourses

Management interventions strengthen and restore the ecological and water-management functions of river arms and pools in the context of the Elbe river floodplain. Water retention ability of the floodplain can be restored by the creation of nature-friendly measures such as the restoration of river arms or oxbows, restoration of the original riverbeds, creation of nature-friendly lateral riverbeds or creation of pools.

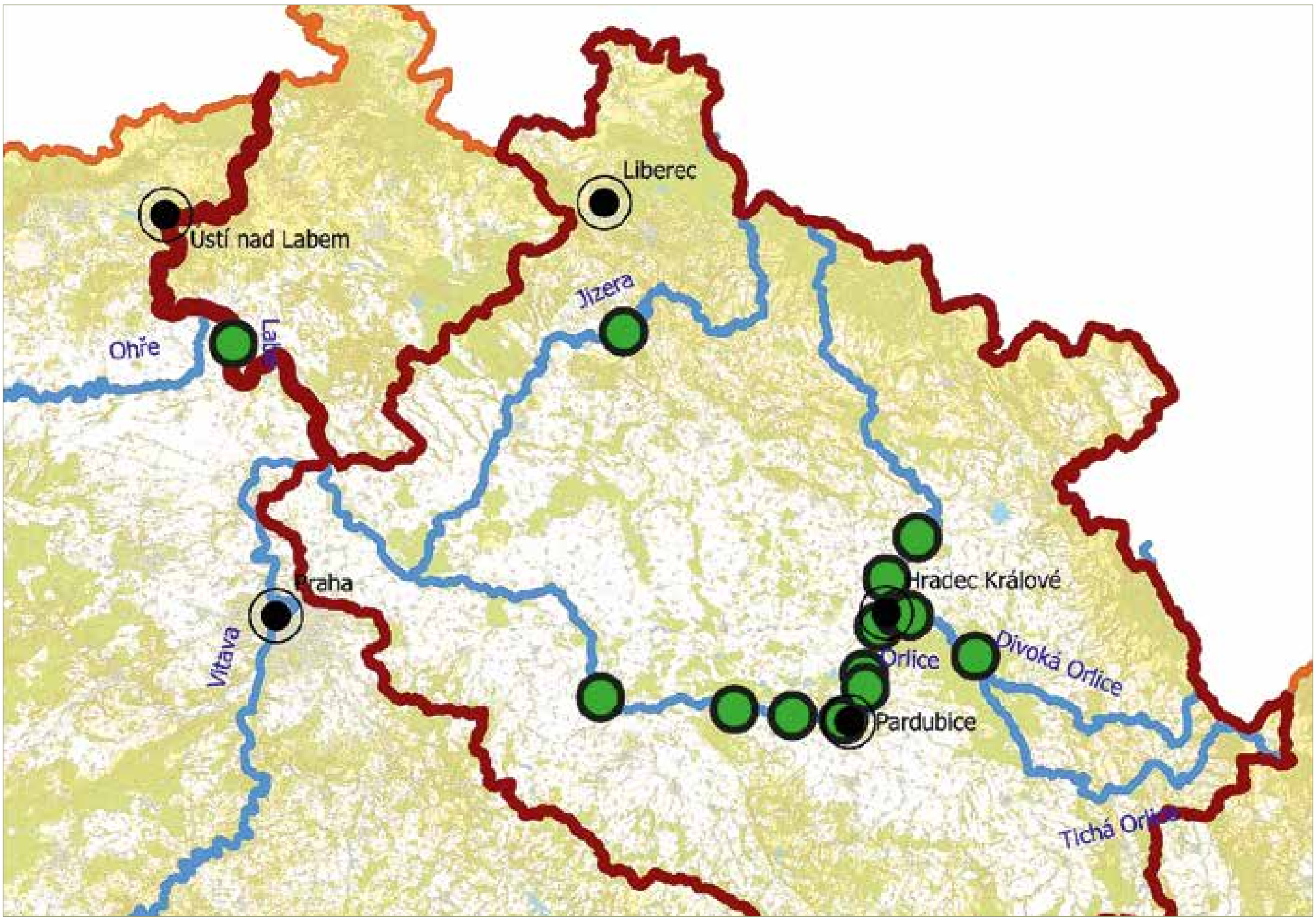

Fig. 1: Places of restoration activities of Povodí Labe, state enterprise

Project realization is preceded by the collection of input data, their processing and evaluation. It is necessary to choose a suitable methodology for revitalization solutions with the possibility of processing a variant solution. The findings and conclusions of biological surveys are one of the basic starting points in designing, assessing and planning the dates of the entire revitalization intervention. The aim of revitalization should be to support stable landscape elements.

Due to the fact that the Elbe River has nowadays in the significant length the character of a canalized course, the only solution for maintaining the species diversity of degraded aquatic and wetland habitats is the ecological restoration of river arms or individual oxbow lakes or their complex in the form of wetland restoration. The disturbed river continuum together with the current land – use do not allow forming of new oxbow lakes of the Elbe, and therefore comprehensive wetland restoration and optimization of the water regime of associated tributaries of this fluvial Elbe landscape is a way to preserve the natural values of these valuable wetlands.

3. Selection of sites to revitalization

When selecting suitable river arms for revitalization activities, the following criteria must be taken into account: biodiversity of the area, presence of biological invasions, stage of ecological succession, type of sediment and its regime, character and condition of riparian vegetation, hydromorphological characteristics of watercourse and its floodplain, flood protection, solvable property relations and presence of migration barriers.

Fig. 2: *Restoration of river arm Orlice called Jordan near Týniště nad Orlicí, January 2021*

Primarily are chosen river arms or oxbows, which are located in specially protected areas, which provide refuge to rare species of organisms, whose populations will benefit from restoration activities, such as habitat restoration or increasing habitat diversification.

River arms and pools are often invaded by alien species. Plant invasions have a massive negative impact on ecosystems. In the riparian vegetation of the Elbe River basin, we most often encounter black locust *(Robinia pseudoacacia)*, box elder *(Acer negundo)* and non-native poplar species – such as plantings of Canadian poplar *(Populus × canadensis)*. Important invasive herbs include Japanese knotweed *(Reynoutria japonica)*, Himalayan balsam *(Impatiens glandulifera)*, small balsam *(Impatiens parviflora)*, goldenrods

(Solidago sp.) mostly native to North America, wild cucumber *(Echinocystis lobata)* and Jerusalem artichoke *(Helianthus tuberosus)*. Through appropriate intervention populations of native species of plants, fungi and animals are supported.

Restoration interventions are planned in localities that are in late-succession stages with a large amount of sediments. We prefer to select river arms or oxbows on regulated watercourses or their parts, where it is impossible to create new river arms naturally. We are restoring river arms owned by Povodí Labe, state enterprise. These arms are the simplest for discussing and the actual implementation of the restoration plan. Property relations are often the cause of the failure of stream restoration, so we direct our activities in this way.

When solving the restoration of river arms, we pay attention to migratory routes for fish and other migrating aquatic organisms. Migratory obstacles to the movements of fish and other aquatic organisms are mainly transverse structures, dams and places with insufficient depth of the water column.

From an environmental point of view, the restoration of river arms has the highest priority in areas with valuable habitats and landscape, and also in the basic framework of the ecological network TSES.

To ensure the highest possible level of species richness of a certain locality, it is appropriate to help create the most diversified habitat and to support the variability of successional stages.

Planning restoration activities at the site of a specially protected area need appropriate approach, the management plan for the specially protected area must be followed and all interventions should be consulted with the locally competent nature conservation authority. Natura 2000 is a network of protected areas covering Europe's most valuable and threatened species and habitats. Aquatic and wetland ecosystems are among the most endangered, due to their importance, these places are declared as The Sites of Community Importance (SCI) or Special Protection Areas (SPA) selected for protect of valuable birds.

Deadwood is an important component for the preservation of the species diversity of the river environment. It is an environment for saproxylic organisms. Saproxylic organisms are species that are at least at some stage of their life cycle dependent on dead and decaying wood to varying degrees of decomposition. These are, for example, saproxylic insects or fungi. We can support these organisms by leaving deadwood on the site, by leaving fallen trunks in the water (where it is possible), by proper care of old hollow trees or by making the proper trees to living or dead torsos. Trees with cavities are also excavated by bird species or bats.

Fig. 3: *Restoration of river arm Opočínek as a part of Elbe River near Pardubice city*

The creation of pools along rivers is an essential tool for the protection of amphibians. Newly created pools are important as new sites for colonization of amphibians, for strengthening their local populations and for maintaining the metapopulation structure of amphibians in the area.

Among the most endangered habitats are those where the initial stages of succession are formed. These are sand and gravel deposits, sands or newly created bodies of water. Restoration plans can be prepared to support these particular habitats. Although these habitats are ephemeral in nature, they are very important for the conservation of species diversity.

Restoration of river arms can also help to realize a rescue programme. An example of this is the restoration of the river arm of the Orlice River in Malšova Lhota near Hradec Králové, where the last original population of the aquatic vascular plant of long-stalked pondweed *(Potamogeton praelongus)* exists.

The selection of restoration sites is based on approved The Upper and Middle Elbe River Basin District Plan and national part of the Elbe River Basin, where measures to improve status (potential) of the surface water bodies are included, measures are also in line with objectives from International Management Plan for the Elbe River Basin District. Restoration of river arms is one of the measures to preserve or improve the ecological status (potential) of the important localities.

4. Examples of completed restoration projects

In 2012 Povodí Labe, state enterprise successfully completed the restoration of the left river arm at Kmoch Island in Kolín. In 2013 the restoration of oxbow lake of the Jizera River in Nudvojovice near Turnov city was completed. In 2015 the restoration of the river arm Polabiny in the inner part of Pardubice city was successfully completed.

In 2019 Povodí Labe, state enterprise completed the restoration of river arm Orlice River near Hradec Králové city, where is situated the last original locality of critically endangered long-stalked pondweed (*Potamogeton praelongus*) in the Czech Republic.

In 2021 were finished restoration projects of river arm Jordan (Fig. 2) as a part of Orlice River near Týniště nad Orlicí city and also of river arm Opočinek (Fig. 3) as a part of Elbe River near Pardubice city. Localities were in late-succession stage with a large amount of sediments and degraded habitats. Biological surveys have showed that these restoration projects helped to protect nature and landscape values of Elbe River floodplain and its tributaries.

5. Conclusion

The benefits of restoring river arms or oxbows are many, restoration of river arms is essential for maintaining biodiversity, preserving landscape structures and improving the ecological functions of the floodplains. Restoration of river arms is currently one of the priority green activities for the Povodí Labe, state enterprise.

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Fachbeiträge **Odborné příspěvky**

Magdeburger Gewässerschutzseminar 2021
Magdeburský seminář o ochraně vod 2021

Monitoring und Bewertung von Revitalisierungs- und Renaturierungsmaßnahmen
Monitoring a hodnocení revitalizačních a renaturačních opatření

Effects of small-scale river restoration measures focused on hydromorphology and water quality

Milada Matoušková, Zdeněk Kliment, Miroslav Šobr, Jana Hujslová, Kateřina Fraindová, Miroslav Jonáš

1. Introduction

The hypothesis of our research is that the applied restoration measures will bring improved conditions from the hydromorphological, hydrochemical and hydrobiological status of streams. In many cases, one of the drawbacks is the missing evaluation of the initial status of the explored river reach before restoration, which is quite of crucial importance for the purpose of comparative analysis and assessment of the applied measures. To assess the restoration effect, comparison to another reference locality of a similar stream type is necessary where the initial status of the water body is not available. Our study presents ecohydrological survey of a restored streams of Sviňovický and Bouřlivec Streams in the Elbe River catchment.

2. Data sources and the applied methods

The restored channels were hydromorphologically assessed using the method EcoRivHab [1] and HEM method [2]. The characteristics of the channel of the brook, riparian belt and flood plain were mapped during the field survey. Hydrometeorological data series of the Czech Hydrometeorological Institutes were used and also data from automatic gauging stations of the Charles University or hydrometric measurement using flow tracker was applied. At the same time, the quality of the surface water was monitored with respect to hydrochemical parameters. The samples were classified based on the following indicators: temperature, dissolved O_2, dissolved and undissolved substances, pH, conductivity, $N\text{-}NH_4$, $N\text{-}NO_2$, $N\text{-}NO_3$, Cl, Fe, Mn, Ca, $P\text{-}PO_4$ and total phosphorus. Hydrobiological survey was based on macroinvertebrates sampling.

3. Study areas

Both case study catchments are located in the Czech part of the Elbe River basin. The area includes the basins of Svinovicky Stream (Fig. 1) in the upper Blanice River catchment in Southern Bohemia and Bourlivec stream in

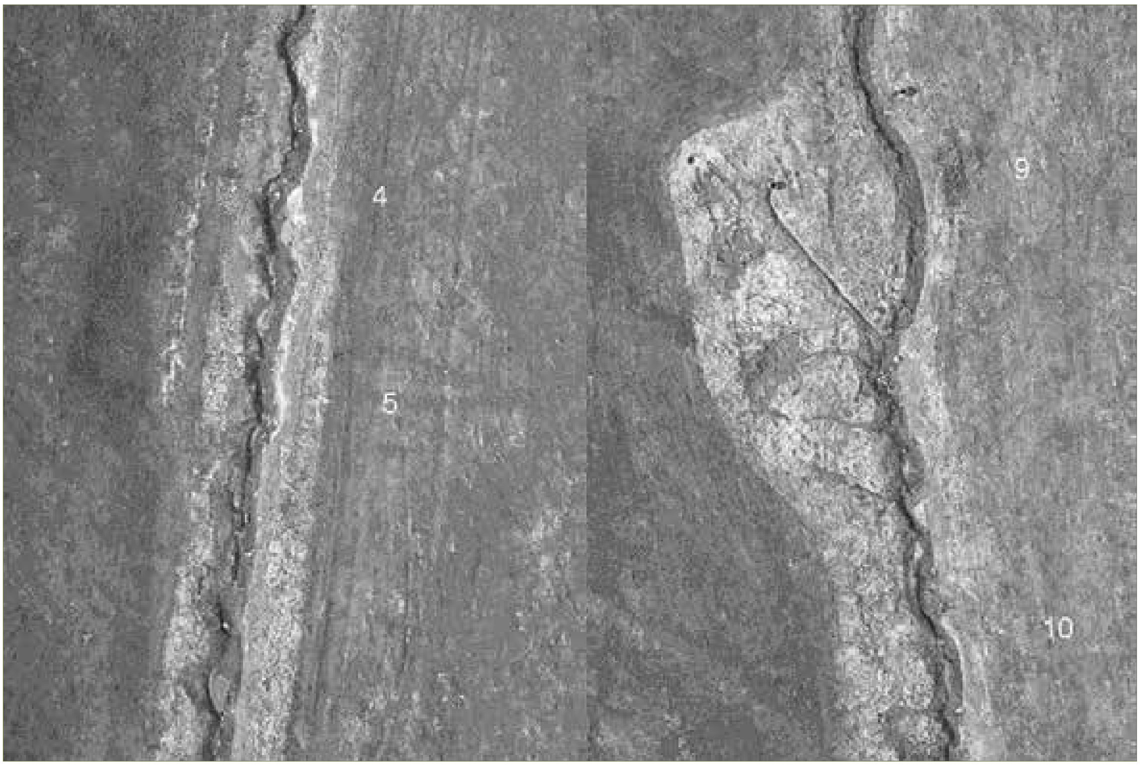

Fig. 1 Channel of the restored Sviňovický Stream

the Eger River catchment in the North-western part of Bohemia. Because of the abbreviated abstract, results are presented only for the Svinovicky Stream.

4. Results

4.1 Development Stream Modifications

The analysis of maps of the past 160 years revealed changes to the position of the Svinovicky Brook bed. The position of the stream saw almost no changes until the 50ies of the 20th century. The original bed showed natural characteristics with mild folding meanders. In the 70ies, the bed was straightened and concreted during amelioration modifications to create a uniform trapezoidal profile with the slope inclination of 1:1.5. In the lower part of the stream, the original bed was replaced with a new, straightened concreted bed, and its mouth to Zbytinsky Brook was shifted about 290 m along the stream from the urban area of Zbytiny. However, the modified channel course became reduced by 18.7 % compared to 1843. In the spring of 2005, the middle and lower course of the Svinovicky Brook was restored along, approx. in the length of 1.1 km. The concreted fortification of the bed was removed, but its position of the course was largely preserved. The old bed was released in this segment and covered up with soil after the placement of the drainage pipelines. Stone thresholds (up to 30 cm of height) were placed in the restored bed, and alluvial bank vegetation was planted. The upper course of the channel remained fortified with concrete blocks of the 70ies. The immediate effect of restoration on the channel course of Svinovicky Brook was very low. The stream was extended by about 30 m through its release and formation of meanders, thus approximately by 2.7 % compared to the length in 1982. However, the overall length of channel course was reduced by 224 m, i.e. 16.5 % compared to 1843.

4.2 Fluvial Dynamics Monitoring

During the first year after the restoration in the spring of 2005, mild up to moderate deepening (up to 20 cm) associated with broadening of the profiles at the bottom of the bed (up to 20 cm at the maximum) predominated along the whole length of the freshly disintegrated bed. Important rainfall-runoff events in the summer of 2006, with the highest water level measured so far of 589 mm on July 12, 2006, started intensive erosion and accumulation processes. Significant erosion of the bed was manifested predominantly in the upper part of the monitored reach where the area of the flow profile of the bed increased up to three times. The instable bed deepened at places by additional more than 30 cm. The lateral erosion at some sectional banks reached 60 cm – 100 cm (See Fig. 2, 3). On the contrary, some reaches were clogged with a sediment layer thick up to 30 cm and thus reached the level of the spring of 2005 or even higher. Alternating erosion and accumulation reaches were formed in the longitudinal profile of the stream whose layout has remained until today. At the end of 2007, the largest bank scours in a part of restored bed above the road bridge were stabilized using quarry stones. The whole river profile of the bed was adapted at several places to form a regular trapezoidal shape. The lower segment of the bed was then left for spontaneous development.

The surveys from 2010 including the last one in the spring of 2020 showed no significant fluvial-morphological changes of the bed. Some significant rainfall-runoff events occurred e.g. in 2009, 2013, 2021, which confirmed that a certain stability of the bed had been achieved. The banks in scoured reaches continue retreating in the lower course of the stream. However, the collapsed banks of the bed prevent further scouring of the bed banks. New tiny manifestations of depth erosion and subsequent accumulation can be seen especially at the beginning and end of transportation reaches. Together with stabilization of active shelves and banks by vegetation cover, the width of the bed bottom keeps narrowing gradually, which supports further deepening of the bed. The overall flow capacity of the bed does not change much and keeps rather declining slightly compared to the maximum situation after the flood in the summer of 2006.

4.3 Hydromorphological Survey

The overall hydromorphological condition of the water body after the restoration can be classified as being in the 2nd hydromorphological class (HC), which means that it is near natural, affected only mildly by anthropogenic activity. The 1st HC has not been achieved mainly because of altered runoff (the influence of the subsurface drainage and the alterations left on the upper course of the brook), banks in some reaches reverted by scattering quarried stone, lower diversity of microhabitats and absence of group vegetation of potentially natural variety in the riparian belt. The restorations carried out have concentrated on the channel release and planting bank vegetation which was previously planted mainly in line along the banks. However, due to the instability of the banks, some planted trees have died. Unstable banks at the upper and middle course were later stabilized artificially. The restoration did not

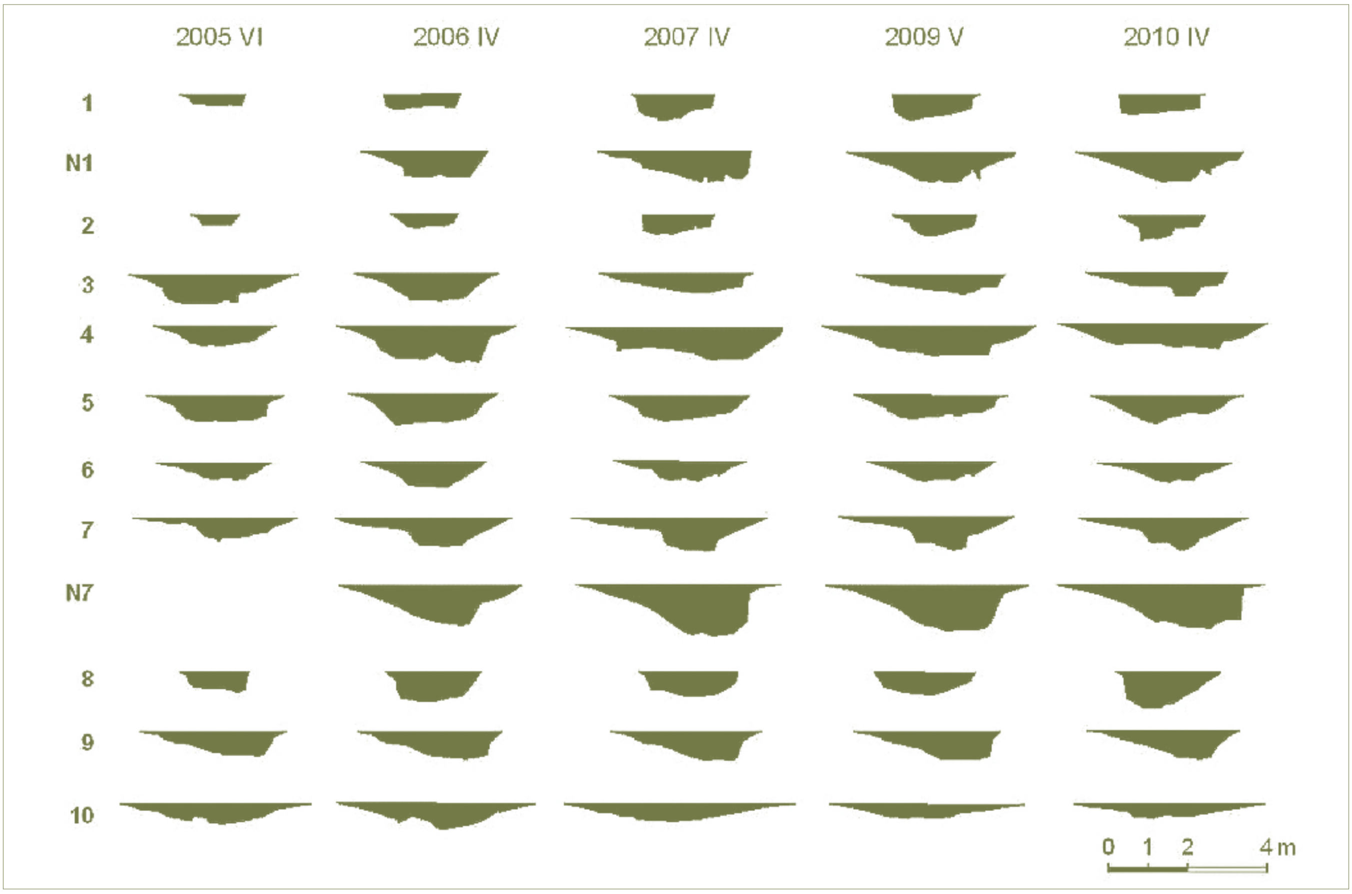

Fig. 2: *Fluvio-morphological changes of cross-section profiles of the Sviňovický Brook*

include planting the riparian belt in the wider surrounding of the channel. Bank and riparian vegetation have been restored thanks to natural succession and raids from surrounding areas. The 4th EC was recorded in only one assessed section (in SVI011). This is a section where the brook flows through the bridge culvert under the road II/165 Prachatice-Zbytiny. The alteration carried out affects the low diversity of hydromorphological mesostructures and microstructures in the given reach and in the adjacent reaches. The character of the habitat of the originally modified channel can be classified as 3rd HC, which means a medium level of anthropogenic influence. The channel zone of the brook received the worst evaluation due to the concrete fortification of the banks and stream bed, low diversity of channel depth and width, and low diversity of microhabitats. It scored mainly 3rd and 4th HC. The fortification carried out is broken in some reaches and the banks are unstable. The existing riparian belt has, above all, a positive influence on the evaluation of the character of the whole habitat of the brook.

As part of the ecohydrological survey, the rates of flows were also measured in the restored sections SVI001, SVI 005, SVI010 and in the modified section SVI032. The fastest flows were recorded in the fortified section. They were between ¼ and ½ higher.

4.4 Hydrochemical and Hydrobiological Condition of Water Quality

The quality of water in Sviňovicky Brook ranges between quality classes I and II based on classification of individual indicators using the Czech National Standard CSN727521, while CODMn is the only one that corresponds to quality class IV-V, and total phosphorus to quality class III. Contamination of the restored stream is also caused by agricultural activities, specifically by cattle breeding in adjacent pasture areas and blanket drainage of the surrounding areas. Compared to the reference localities, the restored stream differs only in slightly higher concentrations of N-NO3 and total phosphorus. The undertaken restoration measures thus have not had any positive effect yet on surface water quality in Sviňovický Brook.

Based on quality evaluation using the family-level biotic index (FBI) [4], “very good” water quality results, as well, with possible mild organic contamination (biotic index values 3.59 and 3.73). These results clearly show that macroinvertebrates have responded very well to the change of the physical habitat in the restored locality in first years after the restoration, evidenced by the finding of a representative of *Cordulogaester boltoni* (Odonata). Taxons of the dipterous order dominate in Sviňovický Brook, namely 25 % (the families *Chironomidae* and *Simuliidae*) and stone flies, also 25 % with the family *Nemouridae* (See Fig. 10). More considerable representation is also shown by the family *Gammaridae* of the scud order, 20 %, and mayfly order, 15 %. *Caddisfly* groups are less numerous, 5 %.

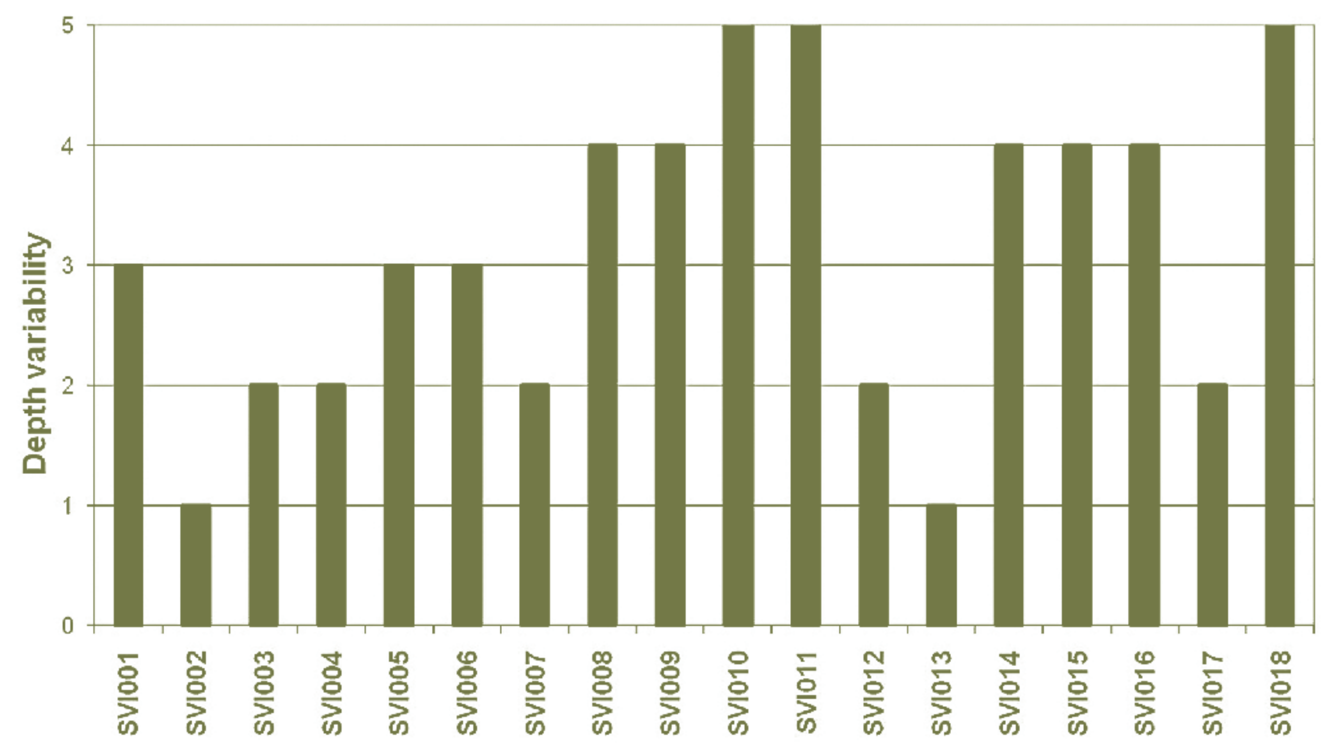

Fig. 3 *Depth variability of the restored channel*

5 Conclusion

The restoration result can be positive evaluated from the point of view of the instant increase in the habitat diversity and morphological variability but from the other side negatively because of relative high erosion and accumulation processes. These morphological adjustments potentially decrease the possibilities of assessing the short-term effects of the restoration. The assessment of the restoration effect is also limited due to the lack of data before the restoration. However, time and space are the essential limiting factors of the success of restoration measures.

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Assessment of the Evolution of the Revitalisation of Watercourses through the Macrozoobenthos Biological Component

Luboš Zelený, Libuše Barešová

1. Introduction

The assessment of watercourses according to their macrozoobenthos community derives from the requirements of the European Water Framework Directive, which, inter alia, aims to establish a uniform methodology for assessing the ecological status of watercourses while defining their target status. To improve the ecological status, the Povodí Vltava State-Owned Enterprise implemented Stage 1 of the revitalisation of the Stropnice River below Nové Hrady (partial basin of the Malše River) in 2012 – 2014 and, in 2015, the revitalisation of the Loděnice River near Nenačovice in the partial basin of the Berounka River. The paper shall focus on the assessment of the ecological status of the macrozoobenthos biological component at a revitalisation site or in its vicinity and its comparison with a reference status, defined on the basis of the prediction of natural communities for the corresponding territories. At the same time, it will try to assess the benefits of watercourses revitalisation to biological components.

2. Methodology

Macrozoobenthos samples were collected and processed by the staff of the water management laboratories of Povodí Vltavy in Pilsen and České Budejovice through the PERLA method, which was approved by the Ministry of Environment as a method binding for surface water monitoring programmes [1]. It is a standard method of three-minute semi-quantitative multi-habitat sampling for fordable courses using a manual bentos net in the spring and autumn sampling seasons.

The lists of species and their abundances identified at the individual sites was produced in the quality database of the Povodí Vltava State-Owned Enterprise and assessed according to the valid methodology for assessing the ecological status of macrozoobenthos for the Water Framework Directive [2]. The macrozoobenthos assessment is based on a multimetric index comprising six to seven biological metrics per the course type from the following list:

- Percentages of individuals (EPT Abu, Jep Abu, Pos Abu) and the total number of taxons (EPT Tax) in the groups of mayflies, scabies, and caddis flies, and the number of midge taxons,
- Total number of families in the sample,
- Margalef’s diversity index,
- Czech saprobic index,
- Percentage of the individuals of the species preferring gravel and stone substrate, epiritral (watercourse sections of large gradients, very coarse bottom substrate and significantly prevailing turbulent flow), metaritral (shallow courses whose flow line depth does not exceed 1 m and where the rapid flow sections prevail), and/or hyporitral (deeper foothill courses),
- RETI index (proportional representation of food strategies),
- And for the autumn samples, proportional representation of the food strategy of grazers and scrapers.

The B index from the prediction model is added to the multimetric index in every type. The prediction model allows to predict the composition of the macrozoobenthos community composition at specific locations based on seven environmental variables. The B index is then obtained by a subsequent comparison of the predicted community (so-called reference community, located on the site under natural conditions) and the assessed site.

The multimetric index or EQR (Ecological Quality Ratio) features values from zero (destroyed condition) to one (very good condition), the individual ecological status classes have the limit of 0.8 (for very good condition), 0.6 (for good condition), 0.4 (for damaged condition), and 0.2 (for destroyed condition).

3. Loděnice River near Nenačovice

The revitalisation of the Loděnice River took place in the cadastral area of the Nenačovice Municipality in the Beroun region at locations where, in the 1970s, the course got directionally straightened and reinforced with lath fences [3]. Due to inappropriate adjustments, the riverbed was significantly deepened, its riparian vegetation was exposed, and sediment was transported to the urban area of the Nenačovice Municipality. After ten long years of preparations, building works started in February 2015. The original technically modified riverbed was backfilled, the revitalisation created a new one, meandering with a number of accompanying ponds, shuts, and fords. The total length of the revitalisation is 1.84 km with the width of the new riverbed 20 m (the original riverbed was 6-8 metres wide). Nearly 10,000 pieces of woody plants were planted in the newly created riverbed of the Loděnice River [4].

Fig. 1: *The Loděnice River before the revitalisation (left) and after the revitalisation in 2015 (right)*

4. Stropnice River

The revitalisation of the Stropnice River was carried out in the cadastral area of the Štiptoň and Byňov Municipalities in Southern Bohemia in places where capacity regulation was carried out in the 1980s on six kilometres of the original riverbed [3]. The trapezoidal riverbed was fortified with semi-vegetative concrete blocks, and quarried stone paving was intended to facilitate agricultural activities on the adjacent meadows; however, this solution reduced the flood protection level of the area located downstream. The revitalisation construction works started in the Stropnice River in September 2012. The original regulated riverbed was abolished, and a new one was created with meanders and several ponds separated from the original riverbed and the possibility of spilling large amounts of water on the surrounding lands [5]. The total length of the revitalisation is 4.2 km; it was completed in 2014. Stage II of the revitalisation of the Stropnice River is included in the plans of the partial basin of the Horní Vltava River and depends on the execution of land improvements and settlement of property relations.

Fig. 2: *The Stropnice River before its revitalisation (left) and after the revitalisation in 2014 (right)*

5. Comparison of the Loděnice and Stropnice Rivers per the EQR index

The macrozoobenthos samples were taken in the longitudinal profile of the Loděnice River (Bezděkov – 2012, 2014, and 2020, Nenačovice – 2018, 2019, and 2020 and, Hostim – 2006, 2008, 2011, 2014, and 2018) and the Stropnice River (Údolí u Nových Hradů – 2012 and 2014, Nové Hrady below the water-treatment facility – 2016 and 2017, Štiptoň revitalisation start – 2016, 2017, 2019, and 2020, Štiptoň revitalisation end – 2016, 2017, 2019, and 2020, and Pašinovice – 2006, 2007, 2009, 2010, 2014, and 2010) from the upper stream towards the mouth into a higher order course.

The resulting EQR index of the monitored profiles is expressed separately for the spring and autumn seasons, as the average of the EQRs in the relevant sampling years. The averages were selected because the results from the individual years, for the time being, do not feature any significant positive trends.

The upper stream of the Loděnice River is significantly influenced by a set of ponds (the largest is the Turyňský Pond with the area of 51 ha). The issue is also higher population density, insufficient waste water treatment, and greater proportion of arable land susceptible to erosion. The result is a long-term damaged condition in the Dolní Bezděkov profile (r. km 32.2). As a result of the stream's self-cleaning capacity, greater forestation percentage, and probably even the partial revitalisation of the stream, the opening profiles of Nenačovice (r. km 13.6) and closing Hostim profile are on the medium ecological condition scale, and slowly approach the limit value of 0.6 (good ecological condition) [Fig. 3]. The worse condition of the autumn samples at the Dolní Bezděkov locality may result from the low summer flow rates and presence of ponds, whose vapour contributes to the lack of water in the streams, and when drained, they deliver to the stream a large amount of fine sediment rich in nutrients. Streams that are in hydromorphologically good condition can better handle low flow rates thanks to the presence of pools and other refugiums. The physical-chemical parameters not meeting the objectives of good ecological condition in this water body include parameters like nitrate nitrogen, total phosphorus, and phosphate phosphorus.

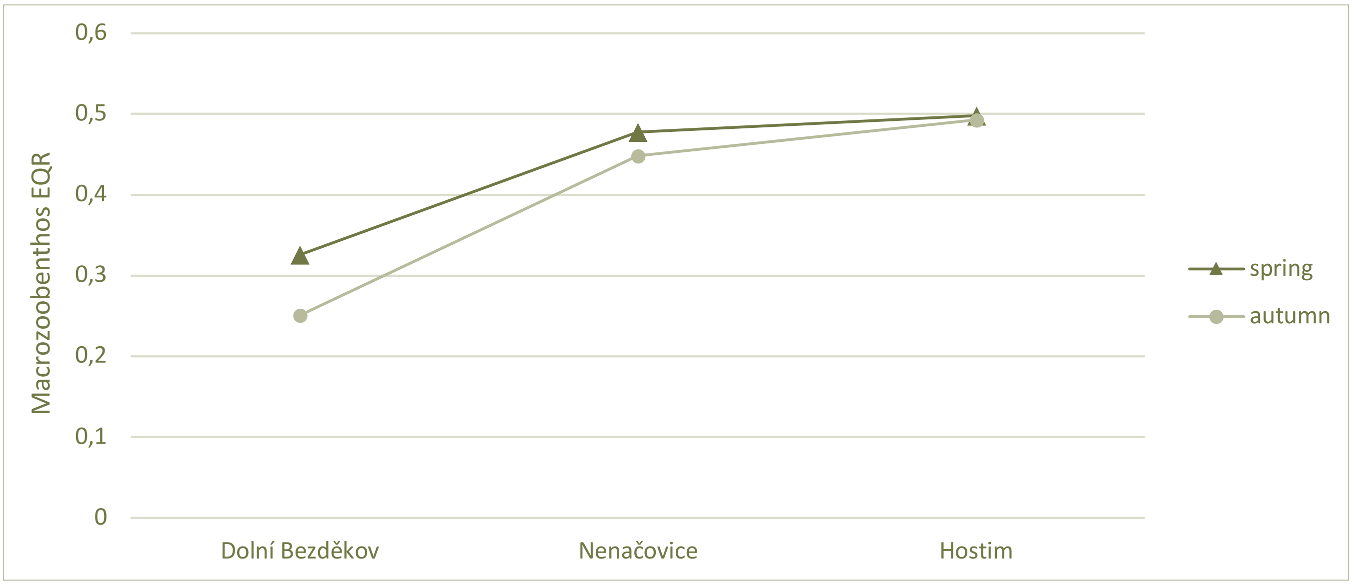

Fig. 3: *The macrozoobenthos EQR in the longitudinal profile of the Loděnice River (EQR = 0.6 is the limit of good ecological condition) – averages over the monitored period (see Chapter 5)*

The water quality and macrozoobenthos composition in the upper stream of the Stropnice River are impacted by the Humenice water body and its small hydraulic power plant. This impact is obvious in the Údolí u Nových Hradů profile (index value about 0.6). The waste water from the Nové Hrady WWTP (in particular its relief) and pond management (fish and poultry) in the ponds between Janovka and Štiptoň are essential to the decrease of the EQR index. The drought also had an unfavourable impact between 2015-2019, when the natural flows were small, and the large part of the water flow came from the WWTP and nurseries in Štiptoň. The EQR index will not improve even at the end of the newly revitalised section (r. km 37.5) where it reaches the values of about 0.3 (damaged condition), although at the beginning of the revitalisation or in its first third, the condition is slightly better, probably due to a better hydromorphological state [Fig. 4]. A significant improvement only occurs in the closing Pašinovice profile (r. km 3.5). There may be several reasons for this condition. The Stropnice River flows from Petříkov to Borovany through an extensive wetted area with a developed river floodplain, where self-cleaning processes take place. The geomorphology of the riverbed in relation to the geology (sandy subsoil facilitates communication with groundwater) or the absence of large pond systems directly connected to the riverbed can have a certain impact as well. It is also possible to see in the results that in the locations affected by waste water discharges from the WWTP, the autumn samples are in a worse condition than the spring ones, as opposed to two locations outside this area (Údolí u Nových Hradů and Pašinovice). This may be due to the greater proportion of waste water in the stream during the low summer flow rates period, as well as due to the discharge of water from the ponds during hauls and from hatcheries located above the WWTP. The physical-chemical parameters not meeting the objectives of good ecological condition include the parameters like biochemical oxygen consumption, ammoniacal nitrogen, total phosphorus, phosphate phosphorus, and water oxygen saturation in this water body.

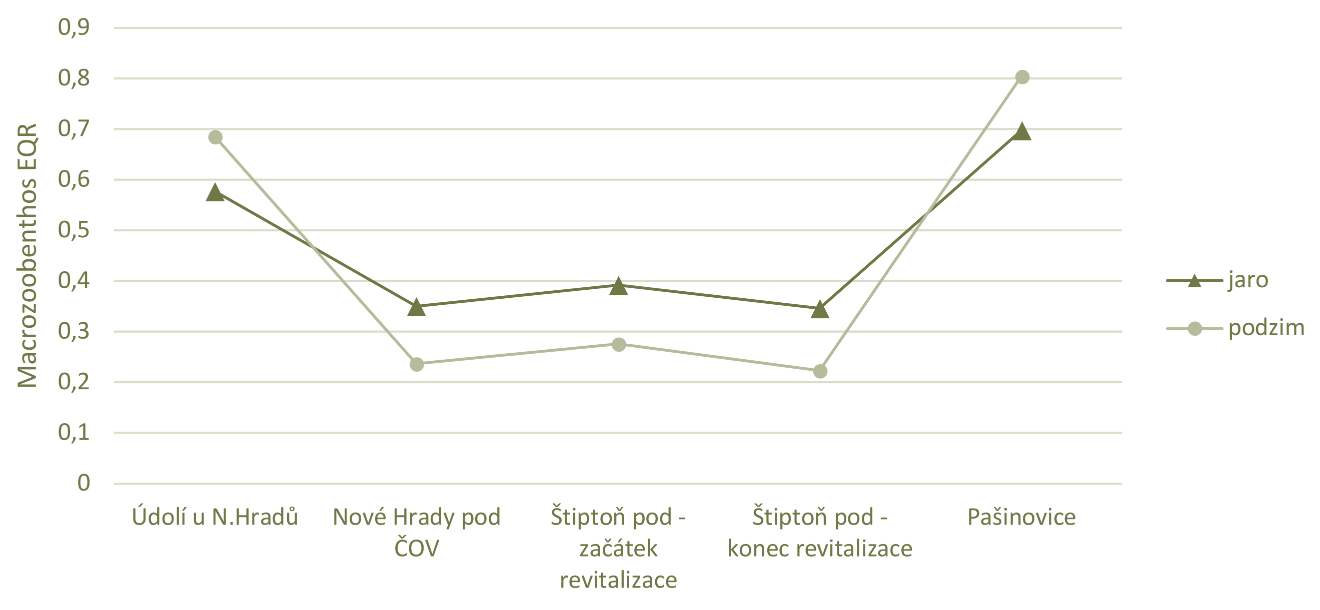

Fig. 4: *Macrozoobenthos EQR in the longitudinal profile of the Stropnice River (EQR = 0.6 is the limit of good ecological condition) – averages over the monitored period (see Chapter 5)*

6. Comparison of the Loděnice and Stropnice Rivers based on Bindex

It is very interesting to look at the assessment of the revitalised sections, related to the comparison of the actually identified macrozoobenthos community with the predicted community (Bindex).

In the Loděnice Nenačovice profile (revitalisation end), the Bindex gradually increases in the autumn sampling, and the spring sampling Bindex stays at approximately the same values [Fig. 5]. Of the total number of 36 predicted macrozoobenthos taxons, the total of 13 taxons were found during the spring and autumn samplings (during the monitored period).

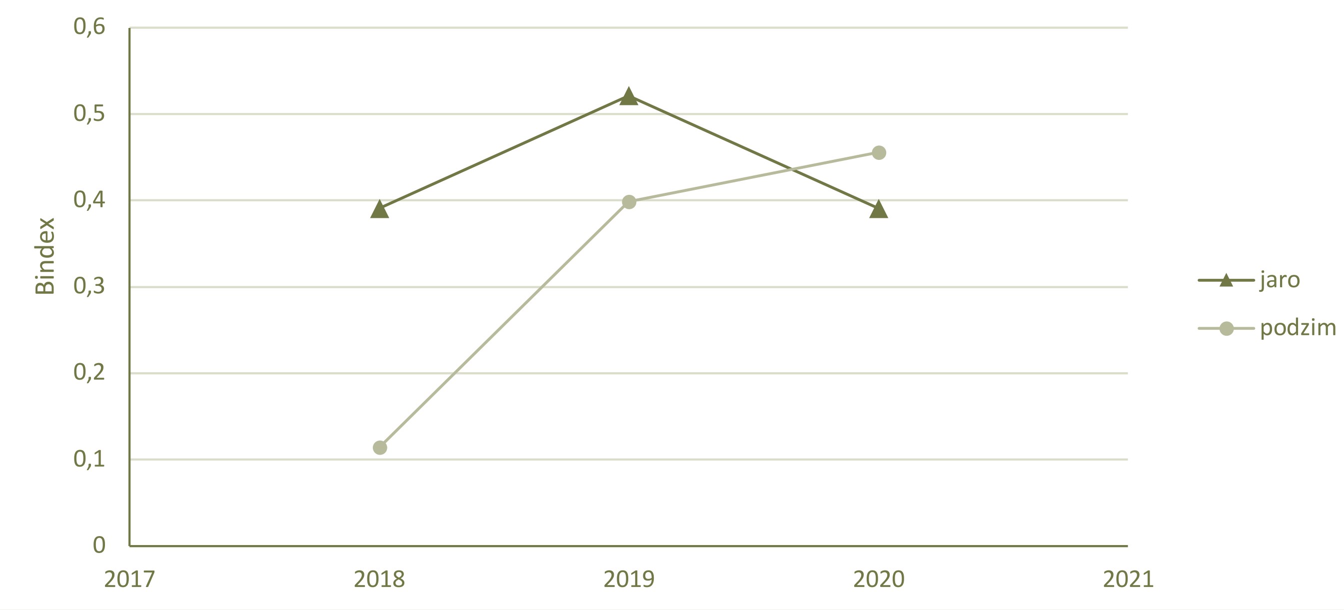

Fig. 5: *Bindex (EQR) in the Loděnice Nenačovice profile (the greater the index value, the closer the found community is to the reference one) – post-revitalisation condition*

There is a completely different situation in the Stropnice River. Due to the revitalised section length (4.2 km), the profile above the revitalisation was compared with the profile below the revitalisation [Fig. 6] and [Fig. 7]. The results clearly indicate that the best condition of the macrozoobenthos community was in 2016, i.e. one year after the completion of the stream revitalisation works. Gradually, the Bindex value decreases, while the spring communities are more than twice as well off as the autumn ones, yet the Bindex value (for the 2019–2020 period) reaches approximately a half of the values, compared to the Loděnice Nenačovice profile. Of the total number of 48 predicted macrozoobenthos taxons (spring and autumn samplings together), 11 were found at the beginning of the revitalisation; in the case of the section at the end of the revitalisation, of a total of 44 predicted, only 8 were actually found. The unfavourable situation on the revitalised section of the Stropnice River is the result of the aforementioned impacts, especially the contamination from the WWTP and nurseries, the overall fluctuating flow regime (ponds in the river basin) and the consequences of drought between 2015–2019. Adding to the complexity of the situation is the fact that the typical riverbed for the Stropnice River in this area is narrow (up to 2–4 m), sunken, meandering in the

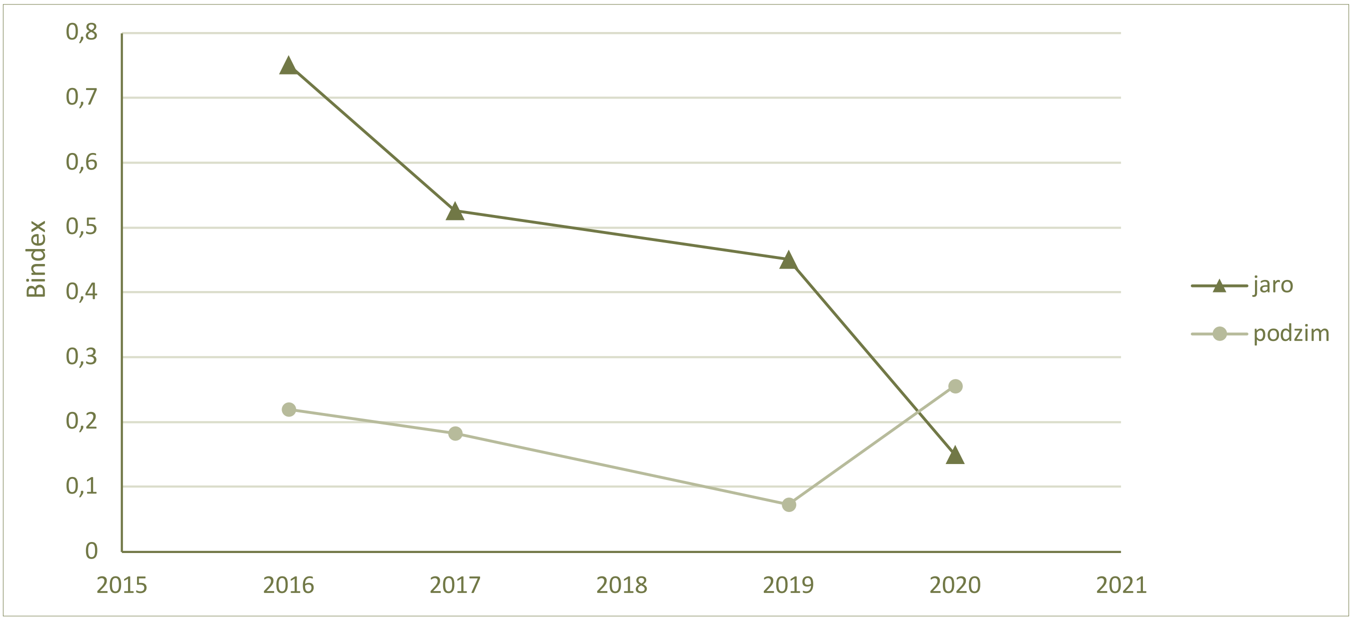

Fig. 6: *Bindex (EQR) in the Stropnice revitalisation start profile (the greater the index value, the closer the found community is to the reference one) – post-revitalisation condition*

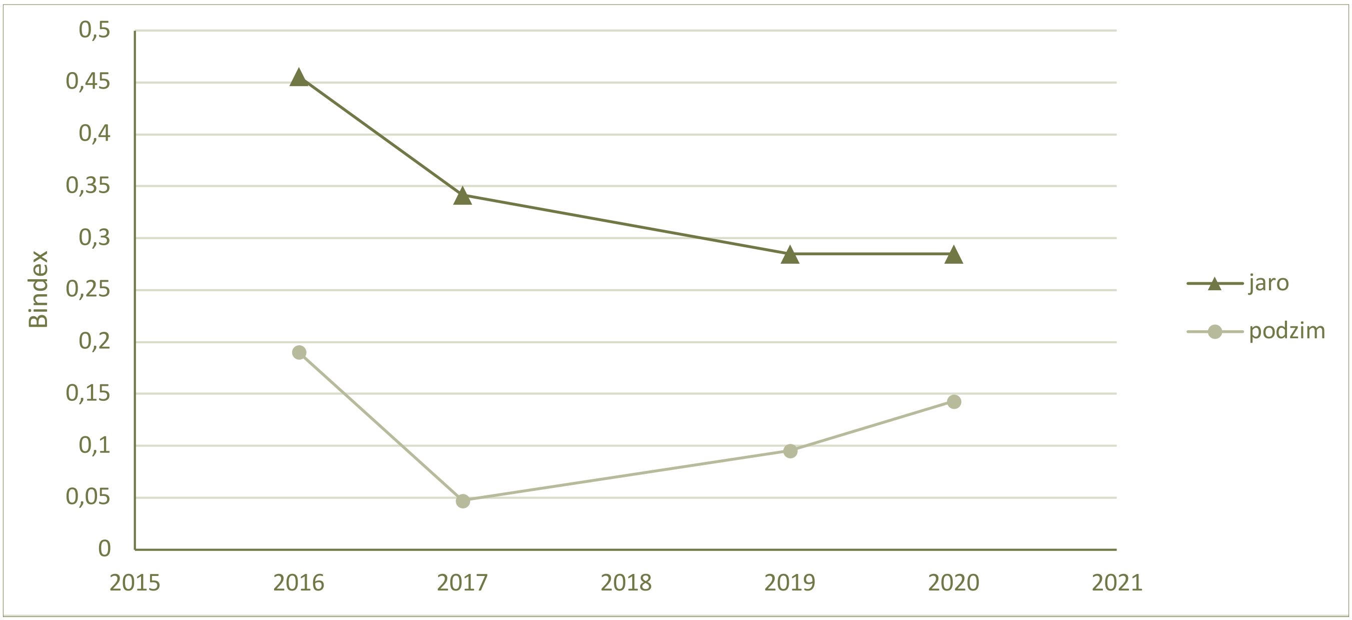

Fig. 7: *Bindex (EQR) in the Stropnice revitalisation end profile (the greater the index value, the closer the found community is to the reference one) – post-revitalisation condition*

full plane among pastures and wetlands, with fine-grained substrate (sand, clay, soil) and only sliding current (glide). It; therefore, naturally features low levels of microhabitats. This fact may not be fully covered by the methodology used to assess the ecological condition of macrozoobenthos and may feature a worse condition, compared to the actual one in this area. This also needs to be verified and, where appropriate, taken into account in further assessments of the success of the completed revitalisation.

7. Macrozoobenthos Communities in the Monitored Profiles

During the hydrobiological surveys in the Loděnice Nenačovice profile, a total of 87 macrozoobenthos taxons were recorded, of which the dominant groups are *Chironomidae* (23 taxons) and *Trichoptera* (15 taxons). However, in terms of abundance, the most numerous groups include *Ephemeroptera* (*Caenis luctuosa, Baetis rhodani*) and *Coleoptera* (*Oulimnius tuberculatus, Elmis* sp. div.). The caddis fly that builds its shell prevails (genus *Athripsodes*),and the *Hydropsyche* genus with trapping nets. Regarding the other groups, there are species that tolerate higher levels of organic contamination, numerous representatives of annelidas (*Tubificidae*), leeches (*Hirudinea*), aquatic molluscs, dicotyledonous insect larvas, and dragonflies (*Odonata*). In recent years, the frequencies of the invasive species of the *Potamopyrgos antipodarums*nail have been increasing.

During the hydrobiological surveys in the Stropnice revitalisation end profile, a total of 65 macrozoobenthos taxons were recorded, of which the dominant groups are *Chironomidae* (24 taxons) and *Diptera* (9 taxons). From the abundance point of view, the most numerous species are *Simulium erythrocephalum* (*Diptera*) and *Conchapelopia* sp. (*Chironomidae*). The caddis fly species that builds shells prevails (*Anabolia furcata and Limnephillus* sp. div.). Regarding the other groups, there are species that tolerate higher levels of organic contamination, numerous representatives of annelidas (*Tubificidae*) and *Asellus aquaticus*. Compared to the Loděnice site, the community features almost no representatives of mayflies (*Epheroptera*), water beetles (*Coleoptera*), and molluscs (*Molusca*). On the contrary, there are species that prefer standing waters, embedded water vegetation, and deeper bottoms (*Sigara falleni, Anabolia furcata, Galba truncatula*). The finding of several individuals of the invasive *Proasellus coxalis*crustacean is interesting.

8. Summary and Conclusion

As part of the processing of the results of the exploratory monitoring of the Povodí Vltavy State-Owned Enterprise at two revitalised localities, the following facts were derived:

a) After five years from its revitalisation, the revitalised section of the Loděnice River is in a medium condition as regards its macrozoobenthos community. Another improvement may only be expected after water quality increase;

b) The revitalised section of the Stropnice River is the longest revitalisation in the Vltava basin; nevertheless, the situation is very complicated there, the revitalised section is in a damaged condition six years after its revitalisation according to macrozoobenthos, and its condition is more likely to deteriorate (see Bindex); any other measures to improve the ecological condition of the course must be focused on the impacts mentioned in Chapters 5 and 6,

c) In terms of the development of the species composition of the macrozoobenthos community, a positive trend can be seen at the Loděnice Nenačovice site, which can be attributed to the well-developed hydromorphology of the water course in the given section,

d) The majority of the samples taken after the revitalisation of both courses come from the hydrologically poor period of 2015 – 2019, which may have negatively impacted the macrozoobenthos composition, especially in the case of the Stropnice River revitalisation,

e) The process of assessing the success rate of the revitalisation is long-term and complex process; it cannot be assessed only according to whether a water course looks nice; the quality of its water, its hydrological regime and its fluctuations, communication with the surrounding floodplain, and other contexts remain important.

Watercourse revitalisation will improve the hydromorphological condition of watercourses, especially by restoring their natural banks and bottoms of watercourses, diversifying the depth and flow of water at normal and low flows (rapids, ponds and shoals as important habitats for aquatic organisms), increasing shelter for aquatic organisms, restoration of migratory permeability, slowing down of runoff at normal and flood flows and natural retention of flood waters in the floodplain, i.e. restoration of spills into the watercourse floodplain.

The macrozoobenthos community is a very good indicator of both water quality and watercourse hydromorphological condition. Therefore, it cannot be expected that the improvement of the hydromorphological condition due to the revitalisation of a watercourse section will automatically improve the condition of a macrozoobenthos community if the water quality condition is not good yet. This was confirmed by the presented results. In the technical implementation of the revitalisation itself, the important factor is whether a revitalised stream is located in the original riverbed, where the original river sediments are present, which unfortunately was not the case with any of the aforementioned revitalisations (in the case of the Loděnice River due to land ownership; in the case of the Stropnice River, its revitalisation took place in a contour furrow).

In future, it is necessary to extend the monitoring of revitalised locations and process a more representative data set. Due to the small number of revitalisation actions implemented so far, it is also necessary to place more emphasis and facilitate (legislatively) the possibility of letting the watercourse self-renaturate. It is also necessary to favour less costly revitalisations, e.g. the insertion of suitable structures into the riverbed (big stones, anchored dead wood) leading to the creation of interesting habitats for aquatic organisms.

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UAV monitoring of stream restoration sustainability

Jakub Langhammer

1. Introduction

High-resolution imaging using unmanned aerial vehicles (UAV, UAS, drones) opened up in the last decade a new potential for a detailed, reliable, operable, and affordable approach for riverscape monitoring. Rapid development of UAV imaging platforms and photogrammetric algorithms resulted in a mature technology, able to bring new type of spatial information for hydrological science and water management.

In hydrological research and applications, UAV imaging is typically used for detailed analysis of quantitative aspects of stream geometry, such as changes in river length, sinuosity or meander properties [1]. However, for the assessment of sustainability of stream restorations and their hydroecological functions, there is vital objective information on their qualitative aspects [2]. Besides the quantitative features, such as geometric properties of stream or channel, based on 2D orthoimagery, the photogrammetric reconstruction of UAV data can provide 3D information as well as calculation of vegetation indices, allowing determination of qualitative features of stream restoration [3]. The aspects of fluval dynamics, hydrological connectivity, water quality or riparian vegetation are essential for appropriate function of restoration and its sustainability. The UAV-based assessment protocol was applied for monitoring of three restoration projects on urban streams in Prague, Czech Republic in the period 2015 – 21.

2. Material and methods

The key role of UAV monitoring in hydromorphological and ecohydrological assessment is to provide a detailed, reliable and objective source of spatial information, applicable for further geospatial analysis, classification and interpretation of hydromorphological quality [4]. UAV imagery provides spatial data of unrivalled spatial resolution, ability for 2D and 3D reconstructions, repeatability, reliability and operability of surveys. As an optical method, UAV imaging has limitations, based mainly in the passive nature of sensing and thus need for direct visibility of features, and limited possibility for reconstructions of submerged zones. The assessment system thus should reflect two aspects: (i) compliance with the existing assessment method or national standard, and (ii) selection of monitoring parameters, where UAV data can provide a reliable basis for assessment and interpretation.

We have proposed and tested new UAV assessment protocol, distinguishing four critical aspects of stream restorations, where UAV monitoring provides detailed information, enabling objective assessment of stream restoration quality. The distinguished aspects are: (i) Restoration effect, (ii) Fluvial processes, (iii) Hydrological

Tab. 1: *Aspects and indicators, used for assessment of restoration effect from UAV monitoring*

Aspect	Indicator	Assessment
Restoration effect	Fit to the plan	Difference in stream length
		Difference in sinuosity and meander count
	Magnitude of changes	Difference in stream length
		Difference in sinuosity and meander count
Fluvial processes	Channel modifications	Intensity of channel modifications
	Bank stability	Extent of bank erosion and fluvial accumulations
	Bed variability	Variability of channel depths, abundance of pools
Hydrologic processes	Flow connectivity	Connectivity of streamflow in longitudinal profile
	Floodplain connectivity	Connectivity between the stream and floodplain
	Water quality	Intensity of water turbidity and / or eutrophication
Riparian vegetation	Streambank vegetation	Coherence of stream bank vegetation
	Riparian shading	Stream coverage by overhang canopy

processes, and (iv) Riparian vegetation. The assessment is done in segments, corresponding to the principles of hydromorphological assessment and thus allows objective assessment, scoring, and location of the features. Based on the framing principles of ecohydrological assessment and the limiting aspects of UAV imaging, we propose four critical aspects of stream restorations, where the UAV monitoring can provide reliable information on stream restoration success or failure, given in Table 1. For each aspect, there could be derived relevant indicators, allowing quantitative assessment and/or scoring. The applied framework uses a mix of quantitative and qualitative aspects. The aspects of restoration effect and comparison of the fit of the restoration to the plan is based on quantitative information, derived from the orthoimagery by digitization and GIS analysis of channel properties. Qualitative approach is then used for the parameters of fluvial processes, hydrologic connectivity, water quality and riparian vegetation (Tab. 1).

The framework was tested on three streams, where UAV monitoring of stream restoration projects was done for a period of five years since 2015. Monitoring was done on the three stream segments in metropolitan region of Prague, Czech Republic, specifically in Rokytka (ROK), Hostavický brook (HOS), and Lipanský brook (LIP), where stream restoration projects were realized in the last decade. Two imaging platforms were used for monitoring, the DJI Inspire 1 Pro , equipped with the 16-megapixel Zenmuse X5 RGB camera, and since 2019 the DJI Mavic 2 Pro, featuring a 20 megapixel Hasselblad L1D-20c RGB camera (Fig. 1).

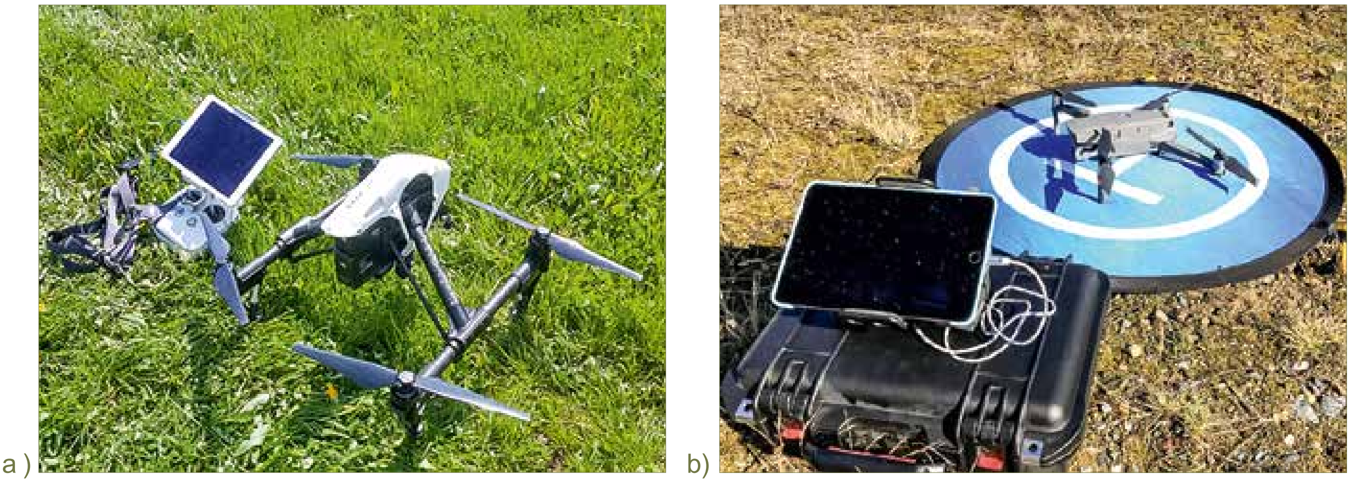

Fig. 1: *Imaging platforms, used for monitoring. a) DJI Inspire 1 Pro, b) DJI Mavic 2 Pro.*

3. Selected results

Photogrammetric analysis of the multi-temporal UAV monitoring enabled performing the quantitative assessment, based on the geometric features of streams and their changes as well as the qualitative assessment, based on detection of qualitative properties, such as hydrologic connectivity, water quality or riparian vegetation [2,3,4]. The selected aspects, illustrating the potential of UAV monitoring for the assessment of the symptoms of restoration success or failures are given below.

In all studied cases, the stream restoration was proposed in the form of highly sinuous meandering channels corresponding to the stream types. In all streams, the restoration resulted in significant improvements of the hydromorphological state of streams in terms of their geometric properties, compared to the regulated state. The stream length increased from 15 to 32 %, stream sinuosity raised from 20 to 38 %. However, there were found significant discrepancies in the geometric properties of newly built channels from the restoration plans. In all streams, most of the new stream meanders were built in different locations, with different size, number and amplitudes (Fig. 2). The deficient magnitude of potential restoration extent, compared to the plans, reach almost a half of the extent, when compared the difference between the initial and realized status.

In the newly shaped channels without artificial bank reinforcement, the fluvial activity was restored. In all streams, there were identified traces of channel instability, with different extent. The initiation of bank erosion and stream wandering were highly affected by the hydrometeorological situation and conditions for stabilization of stream banks

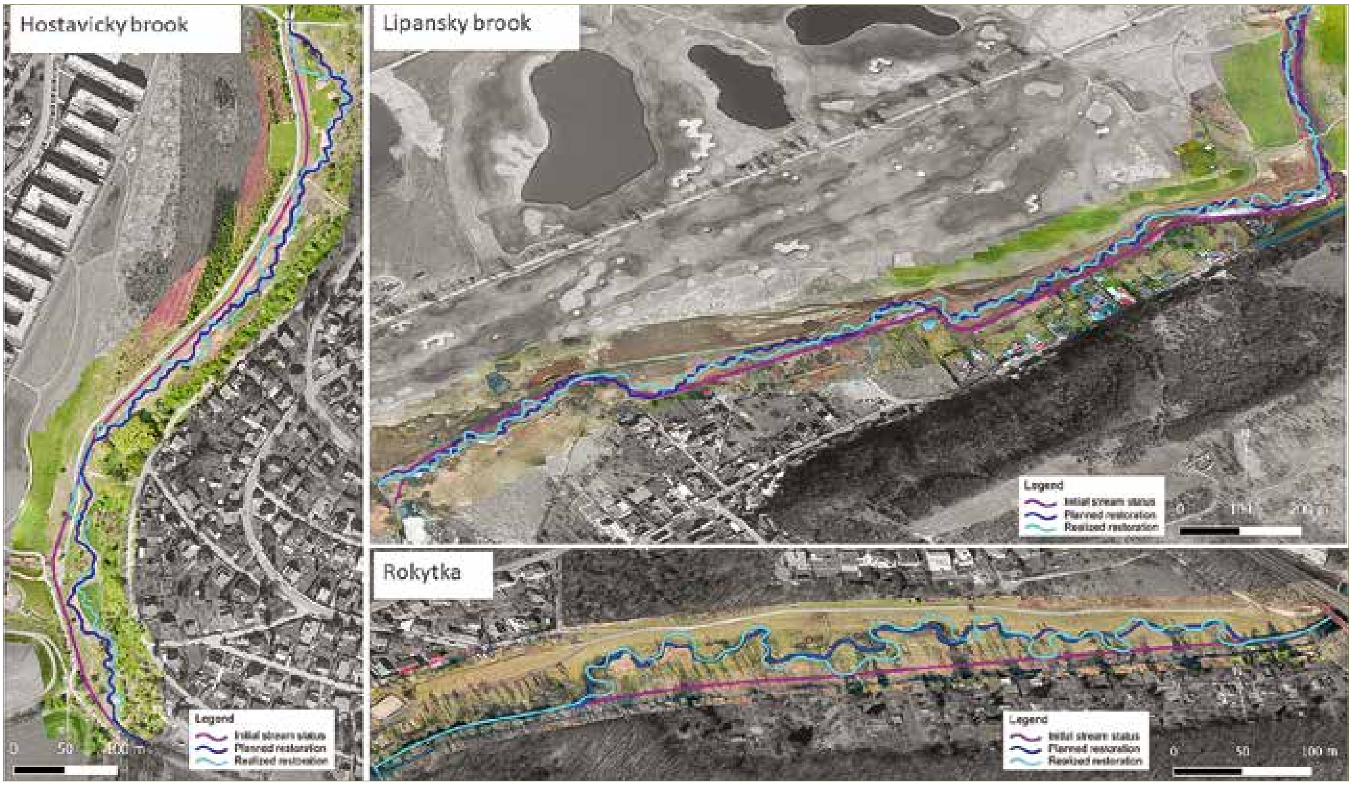

Fig. 2: *Difference of the realized stream restorations to the planned and initial status.*

in the period after completion of restoration projects. The stream wandering was initiated by the storm floods, but to a limited extent, proving the stability of the newly shaped channels.

UAV monitoring allowed identification and objective assessment of qualitative aspects of hydrological processes. All restored channels are free from the obstacles in the longitudinal profile, such as weirs and steps. However, in all streams, UAV monitoring identified issues of flow connectivity and water quality, caused by inappropriate design, water use and intense development of the riparian zone.

a) b)

Fig. 3: *Lipanský brook in August 2020. a) Dry channel, b) In-stream eutrophication.*

Example of a coincidence of multiple issues with flow connectivity emerging after restoration, is Lipansky brook (Fig. 3). Its new channel was built with a higher capacity, corresponding to the hydrological conditions. The reshaped channel is almost twice as long as before, has a wide and shallow profile, and is built in a highly permeable soil. Moreover, the stream is subject to water abstraction. As a result, the channel dries at most of the restored segment from spring to autumn. VDVI index, tested for detection of water eutrophication from RGB UAV imagery in ponds [2] was used for detection and multitemporal assessment of the intensity of eutrophication in streams and adjacent ponds.

4. Conclusions

We proposed a new framework for UAV monitoring of the quantitative and qualitative aspects of stream restoration projects, significant for their long-term sustainability. We tested the methodology for five years of monitoring on three

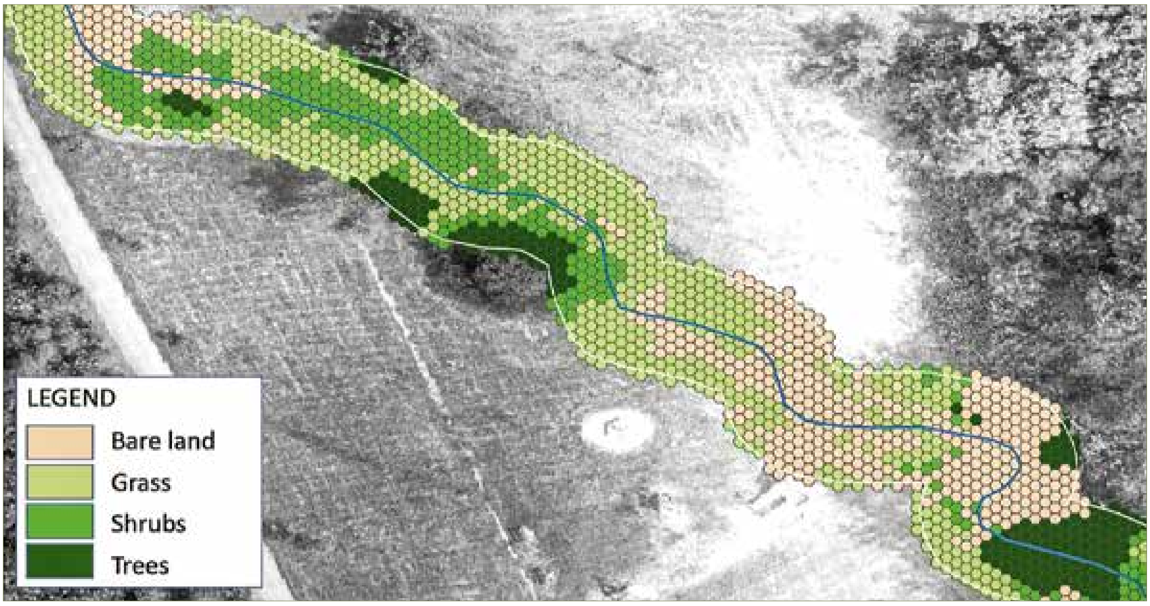

Fig. 4: *Riparian shading model, based on UAV monitoring. Hostavicky brook, August 2020*

urban streams in the metropolitan area of Prague, Czech Republic, which were subject of revitalization in the past decade.

The recurrent UAV monitoring campaigns enabled tracking the restorations since their completion and identifying the aspects critical for sustainability of the projects. The high spatial resolution of UAV imagery, ability to perform 2D and 3D reconstructions and calculation of spectral indices enabled complex assessment of stream restoration effects, including features that would be difficult to assess by the conventional mapping techniques.

Analysis on three streams proved both improvement of the geometric features, but also significant discrepancies between realized and planned restorations, when the restored channels have overall simpler and less complex geometry than planned. UAV assessment indicated stream segments, featuring bank instability after the restoration. Imaging in low flow periods revealed disruptions of hydrological connectivity. Even with the RGB sensors, UAV imagery was able to quantitatively assess the extent of eutrophication as well as to classify the riparian shading by vegetation.

The application of the proposed framework proved it to be an efficient and practically applicable tool for monitoring of stream restorations, providing accurate, operable and objective spatial information for the assessment. UAV technology, after rapid evolution, became a mature method of remote sensing, with potential to improve the process of monitoring and management of water resources.

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Fachbeiträge

Odborné příspěvky

Magdeburger Gewässerschutzseminar 2021

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Wasserrückhalt in der Fläche

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Comparison of soil retention before and after 1950 and comparison of projected and actual changes in the hydrological regime in the Elbe basin

Roman Kožín, Ladislav Kašpárek

1. Introduction

In the Czech Republic, as in other European countries, there are obvious changes in air temperature and precipitation. In most of the catchment areas, there is evidence of intense warming since 1980. From 1995 to the present, a number of climate scenarios, based first on Global Circulation Models (GCMs), and since 2007 on Regional Circulation Models (RCMs), have been used successively in different projects to estimate the impacts of climate change on runoff from the basin. In their application, different scenarios of long-term emission trends and their corresponding magnitude of warming were used. The scenarios may also differ in the choice of the period from which climate change is considered. Calculations were mostly performed by each of the models used for two alternatives of the projected emission development – optimistic and pessimistic.

In the successive projects, different time scales were chosen for which climate change projections and their impact on runoff from the basin were examined. The set of the catchments considered were also different, but they all lay within the Elbe catchment. More than 20 years have elapsed since 1995, when the first calculations using climate change scenarios were used, and now it is possible to compare them with the present.

In addition to climate change, the Elbe basin has also been undergoing landscape cover change. In particular, the occurrence of extreme drought in 2015 was often justified by the reduced water retention capacity in the soil. To test whether such a phenomenon has occurred on a large area scale, the BILAN model which simulates the basic processes of hydrological balance, was applied. Calculations were performed on different sections from the period 1851 – 2016 and the results compared with each other.

2. Data and Methods

The period 1961 – 1990 has usually been regarded as a period characterised by a climate not yet affected by global warming. For the comparison of scenario projections with observed variables, the period 1991 – 2016 was used, i.e. 26 years in length, with the midpoint falling in 2004. The runoff series are recalculated from the observed series of mean monthly flows. For each of the study catchments, average runoff (R) was calculated for the entire periods 1961 – 1990 and 1991 – 2016.

The change in runoff (DR) is defined as the ratio of the averages for each period:

$$DR = (R_{1991-2016} / R_{1961-1990} - 1)*100$$

Thus, the relative changes were related to the characteristics of the 1961 – 1990 period. The DR was calculated for each climate change scenario based on the results extant from the various projects, see Tab. 1. In the considered projects, the period 1961 – 1990 was considered as the period not affected by climate change. The projected changes were made for much more distant time levels than the midpoint of the period 1991 – 2016. Changes were reduced to the 1991 – 2016 period level assuming that they occur linearly in time from 1991 to the year chosen as the midpoint of the scenario period. When this year is denoted by yearP, the reduction to the 1991 – 2016 period is determined by the ratio 13/(yearP-1991), as the midpoint is 13 years away from 1990.

To estimate how the change in soil water retention will affect groundwater recharge and runoff from the basin, a model that incorporates the basic structure of the terrestrial hydrologic cycle must be used.

The change in land cover and the associated change in soil water retention is characterized by one of the eight parameters of the Bilan model. The parameter Spa has a water column dimension [mm] and expresses the water retention capacity of the soil. When there is more than Spa mm of water in the soil profile, percolation of water from the soil into the aquifer occurs. One part of this water drains relatively quickly (in the model in the same month) into watercourses, the other part percolates into groundwater reserves. The Spa parameter can therefore be used as an indicator of the average soil retention capacity of the soils in the catchment. The Bilan model is discussed in more detail in [1, 2, 3].

The extraordinary length (165 years) of the observed flows in Děčín gauge station allows the series to be divided into sub-sections and to assess whether the values of the parameters describing the behaviour of the catchment have changed significantly in the long term. The sub-sections can be quite long, so that the possible influence of random fluctuations of the variables used in the calculation of the model parameters is significantly suppressed. Thus, the resulting optimised parameters are more stable than when shorter series are used. It should be noted that only estimates can be obtained, which also vary according to the optimization procedure used.
After 1951, there were major changes, particularly in the way agricultural land was used. To assess whether and how the model parameters changed and whether they affected runoff generation, sets of Bilan model parameters were calculated using data from 1851–1951, 1851–1900, 1901–1951 and 1951–2015. In addition to runoff, monthly temperature and precipitation at the Elbe basin were used to calibrate the model.

Tab. 1: *List of utilized projects included for data processing*

Project ID	Implementation year	# of basins in the project	Model Type	Time horizon of projection
P1 [4]	1994–1995	1	GCM	2030, 2075
P3 [5]	2000–2001	6	GCM	2050
P4 [6]	2007	29	RCM	2085
P5 [7]	2008	15	RCM	2085
P6 [8]	2009	7	RCM	2025, 2085
P7 [9]	2015–2018	3	RCM	2030

3. Discussion and Results

Table 2 shows the Spa parameters and hydrological balance characteristics calculated from data from 1851–1900, 1901–1951 and 1951–2015. The decrease of 28.8 mm in Spa parameter in the post-1951 period is significant. Yet the characteristics of the hydrological balance – long-term averages of rainfall, runoff and evaporation do not change significantly. The development of the Spa parameter is shown in Figure 1.

Tab. 2: *Spa parameter and long-term characteristics of hydrological balance for the selected time periods*

Period	Spa [mm]	Precipitation [mm/year]	Observed runoff [mm/year]	Modelled runoff [mm/year]	Evapotranspiration [mm/year]	Air temperature [°C]
1851–1900	70.4	671	185.2	183.6	485.8	7.31
1901–1950	72.4	688.7	192.6	193.3	496.1	7.46
1951–2015	43.6	670.2	190.8	192.3	479.4	7.56
1981–2015	40.6	677.5	192.7	195.0	484.7	7.94

Fig. 1: *Spa parameter development*

Using the hydrological balance model of the Elbe basin in Děčín, see [10], it was found that a 30 mm change in retention capacity corresponds to an increase in the volume of water retained in the soil of 1.54 billion m^3. Even this considerable volume is only 4.4 % of the average annual rainfall, 6.2 % of the average annual evaporation and 15.5 % of the average annual runoff from the basin, respectively. The change in soil retention capacity considered was based on a model analysis of the hydrological balance for the period before and after 1951, when major changes occurred in the basin, particularly in the use of agricultural land. The data refer to the basin as a whole, so the change must have been much greater on agricultural land, which occupies about 30 % of the basin area.

Model calculations showed that if the retention capacity of soils could be increased, this would have a positive effect in mitigating and reducing the length of agricultural drought when long-term rainfall decreases occurred. The implications for runoff and groundwater recharge are the opposite. Less water will percolate through soils with increased water retention capacity into aquifers, see Fig. 2. The long-term annual average of base and total runoff would change, in the example considered, by about 10 %, see Tab. 3.

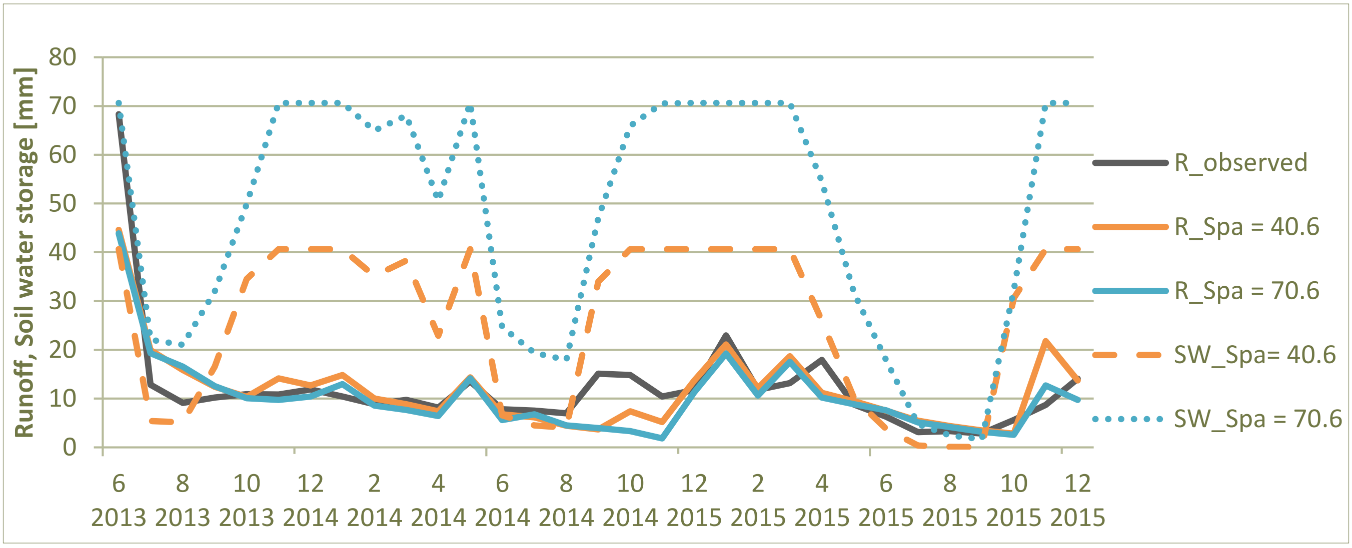

Fig. 2: *Development of modelled runoff (R) and soil water storage (SW) for Spa 40.6 mm and 70.6 mm respectively for period 06/2013 – 12/2015 in the Elbe catchment (Děčín gauge station)*

If the soils can be improved in the future to hold more water, this will slightly reduce runoff from the catchment. When long-term drought occurs, the effect of different retention capacities of soils on runoff is very weak, but when flows fall to extreme minima, the effect is almost insignificantly.

Tab. 3: *Average annual values of balance variables and storages over the period 1981 – 2015 using different Spa parameters*

Spa [mm]	Modelled runoff [mm/year]	Soil water storage [mm]	Evapotranspiration [mm/year]	Percolation [mm/year]	Ground water storage [mm]	Baseflow [mm/year]
70.6	176.6	50	501.5	159.3	47.1	111.6
40.6	193.9	27.3	483.7	179.8	53.3	126.0
Difference	17.3	-22.7	-17.8	20.5	6.1	14.4
Change [%]	10	-45	-4	13	13	13

Figure 3 shows the changes in average runoff for the respective projects and models, which were calculated according to the above methodology. These are therefore the changes in the averages from 1991 – 2016 compared to the averages from 1961 – 1990. The decrease in runoff has been underestimated in most projects by between 1 % and 6 % on average. It is evident that the more pessimistic variants of the climate change scenarios correspond to reality (at least for the time being).

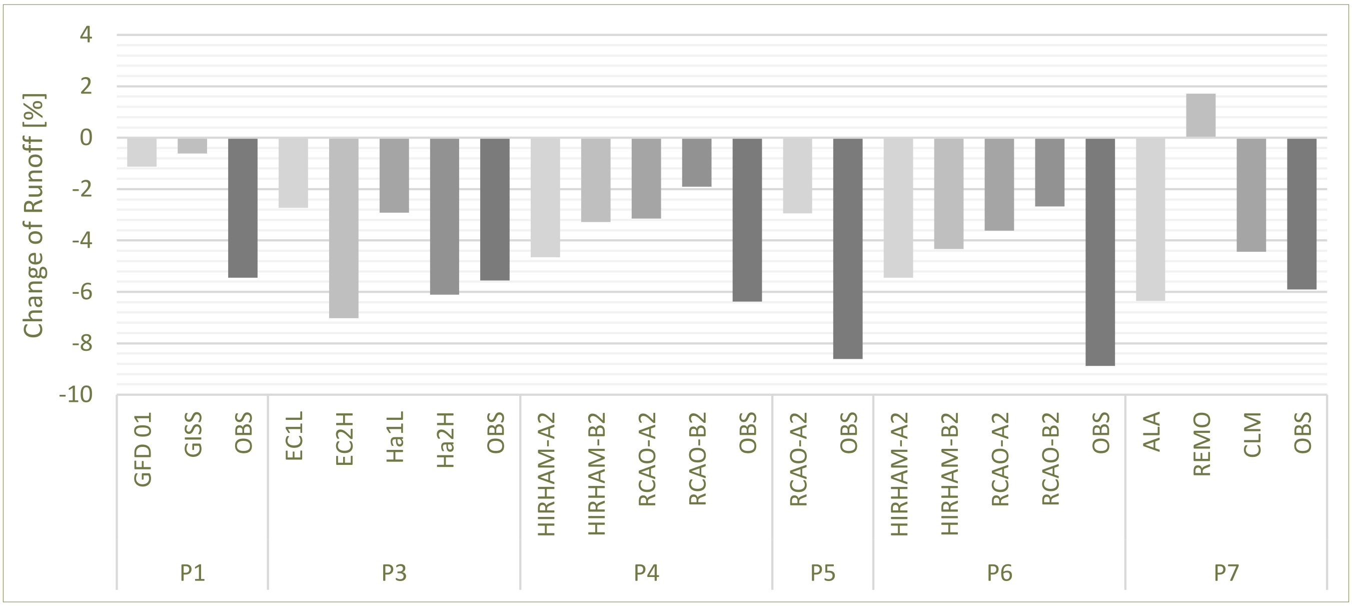

Fig. 3: *Changes in average runoff (between periods 1991–2016 and 1961–1990) for the projects and models listed in table 1. OBS – changes in observed runoff.*

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Sustainable flood protection – dyke relocation and flood polders – the state program "More space for our rivers" in Saxony-Anhalt

Martin Freimuth

1. Starting position

The state of Saxony-Anhalt has an extensive length of rivers, which are partly of supra-regional importance. The Elbe, one of the largest rivers in Central Europe, flows through Saxony-Anhalt over a distance of 302 kilometres. On this stretch, three of the four largest tributaries of the Elbe in Germany flow into the Elbe (Schwarze Elster, Mulde and Saale). The Havel, the fourth major tributary, flows into the Elbe in the state Brandenburg. The opposite bank of the river mouth belongs to Saxony-Anhalt.

With almost 600 kilometres of Elbe dykes, Saxony-Anhalt has the largest part of Elbe dykes of German states. Almost 97 % of the area of Saxony-Anhalt (19,752 km²) are assigned to the catchment area of the Elbe. This represents the second largest catchment area of a German federal state in the German Elbe catchment area. In total, approximately 6 % of the area of Saxony-Anhalt is floodplain. Without flood protection systems, the proportion of floodplain would be almost three times higher. Or, to put it another way, for a rare HQ200 flood, the affected land area is around 3.500 square kilometres large, which equates around 17 percent of the state area.

In accordance with the EU directive on the assessment and management of flood risks currently a potentially significant flood risk is shown for rivers with an overall length of 1.848 kilometres [1]. Based on the state-wide actually recorded river length for the consideration of the WFD (approximately 8.500 km) over 20 percent of the rivers of Saxony-Anhalt are classified as flood risk waters.

As a small and poorly populated federal state, Saxony-Anhalt is above average responsible for flood protection within the state, but also for flood protection for those downstream. The recent flood disasters, e.g. in August 2002 (Elbe and Mulde) and in June 2013 (Elbe, Mulde, Saale and Weiße Elster) and summer 2017 in the Harz Mountains have impressively shown, that the flood risk along the rivers of Saxony-Anhalt is real. The measured water levels and discharge water were partly the highest recorded so far and caused damage in all areas of existence due to flooding. It has to be feared, that such events will also take place in the future with similar or even more extreme dimensions due to climate change.

2. The program

Achieving future-proof and sustainable flood protection is a central goal of the state policy of Saxony-Anhalt. Sustainable flood protection means more than just the rehabilitation of dykes. Saxony-Anhalt, as a "flood transit country", has a special key position here. Preventing increasing extreme flood situations only by scaling the dykes can lead to flooding in the federal states below and does not correspond to modern, future-proof flood protection.

In addition to the further strengthening of the dyke systems in Saxony-Anhalt, therefore measures have been planned and implemented to create retention space in the form of dyke relocations and flood polders. Only these kind of measures offer the possibility of buffering flood waves and reducing peak waves that are above the protection limit of the flood protection systems.

The same is recommended by the Conference of the Elbe Ministers. Due to the currently undetermined effects of climate change and to strengthen resilience in the event of extreme events, reserves are to be made available. For this purpose, additional retention areas and, if necessary, structural reserves for the dimensioning of flood protection systems are to be created as “climate reserves” according to the resolution of the 6th Elbe Ministerial Conference on December 5, 2013 [2].

The program “More space for our rivers” [3] in Saxony-Anhalt is a component for realizing this objective. It is focused on an interlinking of technical flood protection measures with natural water retention in the area. In the program, possible locations for measures to create additional retention space in Saxony-Anhalt are identified and described.

3. From the areal analysis to the implementation of individual measures

The basis of the current state program “More space for our rivers” is the 2014 project and feasibility study “Potential locations for flood polders and dyke relocations on the rivers Elbe, Mulde, Saale and White Elster in the state of Saxony-Anhalt”. The study was presented for the first time in August 2014 by the State Office for Flood Protection and Water Management (LHW). It included a comprehensive location search and location analysis.

Potential locations for 42 measures with a total amount of around 22.000 hectares of potential additional retention area on the Elbe, Mulde, Saale and Weiße Elster were identified as a result of this study.

In a second study, in January 2016, the “Implementation concept for realizing the potential locations for measures” was presented on the basis of the results of the 2014 study. When creating the implementation concept for the realization of the potential locations for the measures, all locations identified in the 2014 study were examined and evaluated on the basis of a significantly improved planning depth. Potential flood polders and dyke relocation were compared and prioritized on a water-specific basis.

In the coalition agreement 2016 – 2021, the aspects of sustainable river development and dynamic and optimized flood risk management moved even more into focus. This resulted in the main task of linking flood protection measures with the restoration of natural rivers and the revitalization of natural floodplains. With this objective in mind, building on the results of the Implementation concept from 2016, the plans were summarized and published in the paper "More space for our rivers – possible locations for water retention in the area" in 2017 [4]. For this document, a detailed nature conservation assessment of the potential measures was carried out. In particular with regard to the positive effects in terms of nature conservation (synergy effects). This was necessary not only to recognize the conflicts at an early stage, but also to identify possible synergies so that measures can be implemented in an integrated manner. Based on this detailed assessment, the study also updated the prioritization of the measures.

When it was republished in April 2020, the state's plans for the creation of additional retention areas were updated in the program of measures “More space for our rivers, a task for generations”. The program currently comprises 23 dyke relocations and 10 flood polders. They are distributed across the rivers Elbe, Mulde, Saale, Havel, Weiße Elster and Schwarze Elster.

With the overall 33 measures, around 16,000 hectares of retention space can be regained. The over 200 million cubic meters of water that can be retained in the flood polders corresponds to twice the storage volume of the largest dam in Germany, the Rappbodetalsperre. Figure 1 shows the distribution of the individual measures, further detailed information’s on the individual projects, are available at the link https://hochwasser.sachsen-anhalt.de/startseite/.

The planning of measures is not final, but is continuously supplemented and updated. All dyke relocation and polder projects are checked for their suitability to meet the objectives described above and fit into the overall concept accordingly.

The measures cannot all be implemented at the same time. The processing of the measures from the program ”More space for our rivers” is rather gradual. A prioritization of the projects based on the main criteria of effectiveness, synergies and processing status is the basis for the implementation order of the projects. In order to take measure-specific characteristics into account, such as the hydraulic effectiveness, nature conservation development potential or the human and financial resources used, the main criteria are subordinated to sub-criteria. In addition to factors such as the condition of the existing dyke or the hydraulic capacity, the equally decisive poten-

Fig. 1: *Location of the 33 measures of the program More space for our rivers*

tial for nature-friendly flood protection was assessed. As a result, for each of the projects in the program has been established one of three priorities:

- High priority (in approval / planning / early planning start),
- Medium priority (medium-term start of planning) or
- Low priority (long-term start of planning).

4. Balance sheet and outlook

By relocating eleven dykes at the Elbe, Mulde, Saale and Havel, already around 1,666 hectares of retention space have been created in Saxony-Anhalt since 1996. A flood polders and two further dyke relocations are currently under construction. Further 714 hectares of retention areas will be available for flood protection as well as nature conservation after completion these measures. Further measures have reached different planning stages and will follow.

First evaluations of the possible effects of the program-measures using hydraulic models have shown, that by relocating dykes the water level can be decreased locally up to several decimetres in the event of a flood. The planned polders can also lower high water peaks up to several decimetres. The flood peak lowering effect due to the flood polders ranges downstream, well beyond the states borders.

The implementation of the measures from the "More space for our rivers" program affects a wide range of population groups such as agriculture, forestry, local residents and nature conservation. Accordingly, when the LHW implements the measures, it is necessary to inform and involve the public from the outset. About the measures should be informed transparently from an early stage on and the public should be actively involved. This is the only way to develop an understanding of the holistic and cross-regional approach of the "More space for our rivers" program.

In order to develop sensible solutions with as few conflicts as possible, it is necessary that the plans are explained and discussed on site in a comprehensible manner from the beginning. The MULE therefore developed an accompanying public relations concept at the beginning of 2017. The concept includes three levels of public information and participation:

- the medial level (conveying general goals),
- the nationwide level (dialogue-oriented communication on the program at information and consultation events) and
- the local level (individual project-related public participation)

and is implemented by the LHW.

As a first component of public participation the program was presented at three dialogue events at Halle (Saale), Dessau and Tangermünde. In the future, the measure-related dialogue and participation processes will increasingly be in the foreground.
Only if a continuous dialogue with the public succeeds in raising the awareness of climate change and the associated flood risk and objectifying the necessary and important debates and thereby incorporating local knowledge into planning, the acceptance of the plans and the program can be increased and conflict can be reduced.

We understand the implementation of the program as a generational task that involves significantly more than just water management aspects.

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Investigations on the Feasibility of Rainwater Management for Degraded Peatland Rewetting

Petra Schneider, Heinrich Reincke

1. Introduction

A bog is a landscape in which peat is created by soil that is saturated with water. The prerequisite for peat accumulation is that the water is on average close to the surface, leading to anaerobic conditions. Peat therefore has a high organic content of ≥ 30 % by mass [1,2]. If the peat layer is at least 0.3 m thick, the soil is called bog. If the thickness of the peat layer is 0.1 to < 0.3 m, the soil is classified as Moorgley, if the surface is H-horizon with a thickness of < 0.1 m, it is referred to as a humus shape [1,2]. Bogs are divided into two types: moors and fens. While the moor is fed by nutrient-poor precipitation, the fen is created by the influx of ground and surface water. A fen is therefore richer in nutrients and can have a higher biodiversity of plants [1,2]. The management of bog areas has undergone extensive changes in the past centuries. While in the past the focus was on the extraction of peat, and numerous peatland areas in Germany and around the world were drained with the aim of supporting agricultural activities, the focus now is on the conservation of peatlands [3,4]. This primarily includes rewetting measures and nature conservation protection with the aim of restoring biodiversity. Intact bog areas fulfil important water management functions in the natural cycle, such as water storage and as nutrient and pollutant sink. This means, bogs are characterized by multifunctional ecosystem services [3,4].

2. Need for Peatland Restoration and Conservation

In Germany, peatlands are threatened in their existence due to past drainage to serve as arable land or pasture [3,4]. This situation has climate consequences: greenhouse gases (GHG) escape from dry peat [5]. Other peatlands are used for peat mining. Nowadays, 92 % of the German peatland is drained, causing 47 mill tons of CO$_2$ equivalents and accounting for more than 1/3 all GHG emissions that can be attributed to agriculture [3,4]. The Federal Environment Ministry (BMU), together with the Federal Agency for Nature Conservation (BfN), has drafted a National Peatland Protection Strategy (NPPS) that has undergone public participation in 2021 [4]. The scope is to reduce GHG emissions from the agricultural and forestry use of peatland by at least 5 mill tonnes of CO2 equivalents by 2030. Main measures of the NPPS are [4]:

- expansion of the bog protection areas with sufficient buffer zones,
- rewetting of unused federally owned bogs by 2030,
- rewetting of agriculturally used federal peatlands by 2030 and adapting the form of use
- abolishing incentives for moor-sapping use and infrastructures (e.g. building stables) in agriculture,
- creation of new agricultural and forestry guidelines for bog protection, including the waiver of drainage expansion and further drainage lowering.

As underlined in the NPPS, rewetting is a substantial measure to ensure bog rehabilitation [4]. For that reason, a fundamental activity is to identify sufficient water sources for rewetting, and their allocation the bog areas. Several water sources might be taken into consideration for bog rewetting, including ground and surface water, and waste water. However, a particular challenge is to ensure water availability in marsh areas.

3. General Approaches for Degraded Peatland Rewetting

Agricultural drainage of peatlands leads to sagging, shrinkage and swelling, humification, leaching, and finally peat shrinkage. Rewetting means to re-infiltrate water into the peat material, and the main question is how to do it technically. Experiences with rewetting of peatlands have been collected only since a few years. The conception of water management is therefore a major task in rewetting, where each area must be considered as an individual case study. It should be noted that a potential rewetting project requires firstly a comprehensive investigation of the peatland alteration status, and particularly the mineralisation level. This is the base to identify the likelihood for successful bog restoration. For instance, peatland investigations in the Süppling area in Saxony-Anhalt [6] showed that the former bog area was almost completely mineralized by the long term agricultural drainage and that a peatland restoration is no longer feasible because the peat body is almost completely degraded. A rewetting with year-round water saturation of a maximum of 20 cm level would not lead to a restoration of the peatland, but could initiate a renewed peat formation (0.5 – 1.5 mm/year) [6].

Several guidelines have been developed in the last years to support the conceptual design of degraded peatland rewetting [7 – 16]. The general rewetting approaches comprise:

- Ditch damming without water supply: dam structures are used to restrict the drainage of surrounding areas, but without the supply of water via the ditch system. This variant is therefore feasible for high precipitation areas. Groundwater does no longer drain the trench and can reach the same water level.
- Ditch damming with water supply: water is also dammed up however additional water can be supplied to the rewetting area via the ditch system from the catchment.
- Ditch overflow: if the relief is heterogeneous, it is possible to combine various irrigation measures. For example, a higher part of an area can be trickled over and the lower part can be flooded. Several different water regimes are thus created.

However, the rewetting success depends on the hydrological parameters. If the soil permeability is too low, systems must be installed to counteract this, for instance through (underground) drainage pipes. The experiences from the last years illustrate that the feasible approach is usually site specific. Further supplementary measures might be soil loosening, surface profiling, prevention of further dewatering through cut-off wall, and water level regulation. The design might be combined with rainwater collection and retention basins for temporarily storage, and as other solution underground irrigation ("reverse pipe drainage").

4. Show Cases

Several investigations have been performed in the last years by several actors, among them Magdeburg-Stendal University of Applied Sciences and Unterhaltungsverband Kehdingen to collect project experiences with rewetting of degraded peatlands [6,12,13]. Some of them from Northern Germany are illustrated hereafter.

Mecklenburg-Vorpommern: Bargischow peatland [12]

The show case of a dewatered fen is located near Bargischow close to Szczecin Lagoon in the North East of Germany. It is part of several fens to be rewetted in that area [14]. The fen is a pilot site for a future use through paludiculture [15], a special type of agricultural and forestry use of wet bogs. This type of use was developed in the last years to prevent the soil from degrading and, depending on the vegetation, it is feasible that new peat will be generated. It thus offers a good alternative to continue to cultivate rewetted bogs with economic benefits. A concept was drawn up for an area of around 8.5 hectares, which enables rewetting up to a level of around 10 cm above the ground. The site condition indicated that the project area is fed by uncontrolled seepage water, there is no exchange between surface water and groundwater and drainage takes already place via the ditch in the south. If this trench is filled in, the rewetting state increases accordingly. In addition, it was found that the area is already partially below the water level of the adjacent lagoon. This is due to the peat sagging caused by the drainage. Therefore, a wooden sheet pile wall was foreseen to be built north of the existing ditch in order to avoid further dewatering and peat sagging. In order to get the area dry for mowing, a drainage ditch is foreseen. It is primarily intended to drain the seepage water from the close by road embankment. The dam should be slotted at certain intervals or, alternatively, pipe passages are built in.

Schleswig-Holstein: Combined district drainage and peatland rewetting in the City of Lübeck [13]

In [13] were investigated the drainage system of an urban district of Lübeck City and the adjacent Great Moor. In the project area, the drainage consists for the most part of a mixed system that relieves the pressure on the adjacent bog due to frequent overloads. The moor thus functions as a receiving water body and is negatively influenced by the mixed water discharges. Since the Great Moor has lost its natural state due to a large number of human impacts and has largely dried up, a remediation strategy was developed. After the construction of the sewage treatment plant, the moor has been influenced by the runoff from the settlement. Changes to the current construction of the sewer system therefore always have an effect on the water balance and nutrient input of the bog. For the current state, the water balance determined that the mixed water discharge represents an important bog inflow, but there is also groundwater outflow. The inflow can be increased by construction of a separate sewer system, and used for rewetting. As remediation strategy, a concept was created that provides for vertical compaction around the moor from the north in a clockwise direction to the west, and the installation of a geo-membrane. Furthermore, the river area will have to be rehabilitated, whereby the garbage must be removed. Typical bog plants such as bulrushes are initially to be planted in the bank areas, and dried out peat residues are to be incorporated into water sinks. Since it is assumed that the soil water content will increase over time, the existing ditch in the south is being converted for a new storage target. Since the moor is affected by changes in the drainage system, as described above, the moor shall be rewetted in the course of rehabilitation of the sewer system, so that the moor there will be no further mixed water discharges.

***Lower Saxony:* Rainwater Use for Hemmoor Rewetting near Großenwörden**

In the present feasibility study, it should be examined whether and, if so, how rewetting measures can be extended to rainwater management, particularly in marsh areas. For this purpose, the area between the Oste and Elbe in Lower Saxony was examined as pilot study, involving Hemmoor in Northern Lower Saxony. The area under investigation is located in the marshes of the Elbe river near Harburg between the Oste tributary of the Elbe and the Lower Elbe. The area is dominated by peat extraction activities, and only a part is protected for nature conservation purposes. There was performed a variant assessment for an open water transfer to the peatland, considering both water supply from the low-salt Oste river, and rainwater to the peatland for rewetting and intermediate storage, as well as a potential extraction for irrigation purposes for agriculture and groundwater recharge. In the current planning stage, the water transfer shall be done through a 15 km channel from the Oste river to the peatland areas. Starting at the Oste at Großenwörden, the existing river beds (Moorkanal) are initially used until the Hemmoor is reached. The Hemmoor can benefit from the inflow of the Oste water in the sense of rewetting. Surface water does not exist there, so a channel has to be built. After passing the peatland, the newly developed water channel runs on a watershed. The designed route follows existing terrain structures and strips of wood.

5. Conclusions

Intact peatlands are of great importance as carbon stores and thus for climate protection. Their functions in the landscape water balance, retention of nutrients and pollutants, and the special habitat for flora and fauna are also important. Moor protection is a long-term task for the society as a whole, in which several goals and a number of land use types are affected. Measures must be regionally differentiated and implemented taking into account various actors. Existing bogs must be protected and conserved, degraded bogs must be restored as much as possible, and peat mining areas must be rehabilitated. It is generally accepted that the vegetation of former peat extraction areas with sphagnum restores the carbon storage capacity. This could also be shown for areas dominated by Eriophorum [21]. Moreover, in urban areas the ecological aspect is gaining importance, in particular the infiltration of precipitation runoff on site instead of relief via a sewage treatment plant. This process is a step towards the natural urban water balance. The design of rainwater management is to be adapted for sealed areas and the options are determined by the infiltration capacity of the soil, the availability green space areas, the types of roofs and the pollution level of the precipitation runoff. If properly designed, discharged rainwater from urban areas can be used as water source for peatland rewetting, particularly in areas with limited fresh water resources like marsh areas. Water transfer solutions are needed to complement the management system, as well as optimisation investigations for the peatland as peak storm water storage system. Further investigations are foreseen on the quantification of the ecosystem services improvement through degraded peatland rewetting, particularly on the GHG emission balance.

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Water retention in cities – great potential benefit for ecological status of streams during dry years

Jindřich Duras, Michal Marcel

1. Introduction

What are the issues concerning water quality we have to handle with? Eutrophication based principally on phosphorus is our ever(blue-)green topic for decades, but situation of our waters is still far from what we would like. Organic microcontaminants appeared to be very important for aquatic environment and microbial agents esp. ATB resistant bacteria (and in last years also viruses) are considered to be very risky directly for our population. Moreover, we say we will make a great effort to reach good ecological status of our surface waters, but in many cases biotic components are worse than good despite chemical parameters exhibit acceptable results.

One of very important sources of pollution that is not properly monitored thus not calculated or balanced are sewage water overflows from cities (and villages, too). Overflows from sewerage represent rich mixture of all types of pollutants mentioned above and many others (BOD, COD, plastics, etc.). We try to monitor pollution loads from several cities during rain events in drainage basin of (eutrophicated) Hracholusky Reservoir near Plzeň and we try to estimate especially phosphorus input in surface waters. We referred here about our first steps in 2018 [1]. In 2019 we documented situation in small city Kladruby.

2. Results

Kladruby (1600 inhabitants, new WWTP) is situated on a small stream Úhlavka. Overflowing waters are concentrated in one channel what enabled relatively easy monitoring. Three events were sampled (Tab. 1).

Results presented in Fig. 1 documented hard episodic loads of suspended solids (SS), fast degradable organic matter (BOD_5), phosphorus and also nitrogen, predominantly in form of $N\text{-}NH_4$ and organically bound N. Micropollutants and microbial contamination was not monitored. It is evident that: (1) Water of worst quality flows with highest flows of water i.e. despite the fact that individual episodes are short input of pollution could be considerable. (2) Concentration peaks were very high. In combination with dry Summer when water flows in recipient were very low (2019: 35-103 l/s) sewage water inflows were (sometimes considerably) higher than natural flow in the stream. It means that dramatic impact on water biota is very probable (data from Úhlavka are not available, yet). Úhlavka downstream Kladruby exhibit very good hydromorfology i.e. good environment for water biota, but episodic waves of organic pollution bring severe problems in oxygen regime – not only for flowing water, but for hyporheic habitat (under bottom of the stream), too. It could be detrimental for macrozoobentos and fish communities especially. (3) It is clear that standard scheme of monitoring (samples once per month) cannot be able to give us picture of impact of overflowing waste waters.

During our monitoring we noticed: (1) Increase of flows was very fast after beginning of each event (about 10 min) what means that buffering capacity of city surfaces, space in sewerage system and reserves in WWTP capacity were all very low => insufficient. (2) First overflowing water appeared already after ~2 mm of precipitation. It indicates clearly that the city (and we recognized the same situation in other cases e.g. Třeboň, Planá, too) has nearly zero capacity to absorb rain water i.e. zero rain water retention. (3) Considerable amounts of macroscopic “things” esp. wet wipes were observed regularly (also in all other localities we have studied), what means absence – and necessity – of basic pretreatment of overflowing waste waters. It seems very probable that main source of macroscopic plastics in surface waters is just input with overflows.

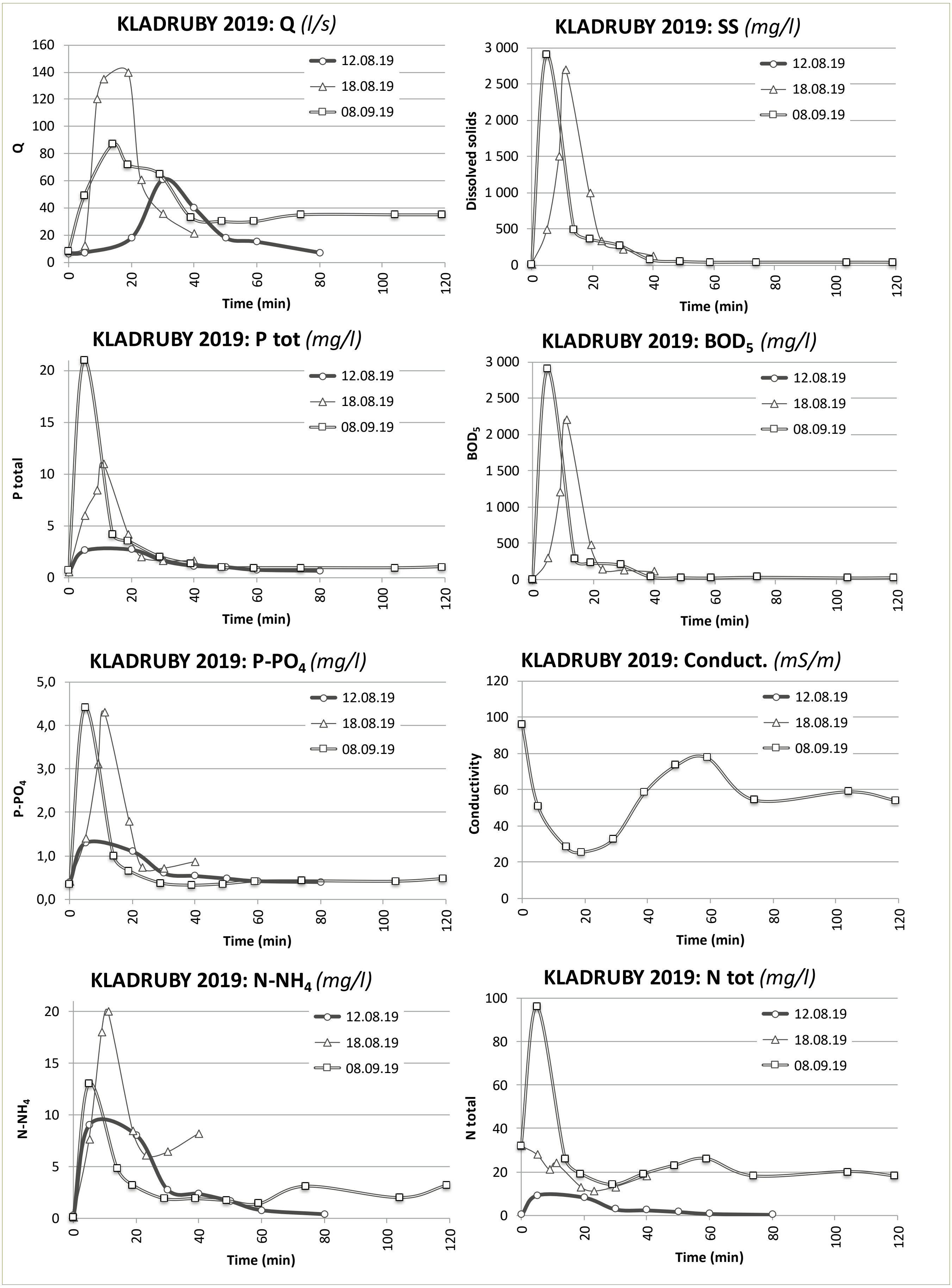

Fig. 1: *Overflows from Kladruby: Water quality during three rain events. All data are for overflowing waste water.*

Tab. 1: Kladruby: Characteristics of sampled rain events and results of mass balance calculation

KLADRUBY 2019		12.8	18.8	8.9
Rain	mm	5	6	10
Duration of the event	min	85	40	120
Intensity of rain	mm/1 hr	3,5	9,1	5,0
Total volume of water	m³	110,7	158,3	312,2
P load from overflow	g/event	116,0	780,0	847,0
P load from WWTP		40,5	18	71,9
P load from whole city		156,2	798,3	919,2
P input from the watershed above		19,6		157
P load from overflow vs. daily P load from the WWTP	%	17 – 35	120 – 240	100 – 200

Number of rainy days in Kladruby region during 2019 (mm/day) :	**>3,5**	**35**
	>5,0	**25**
	>10	**13**

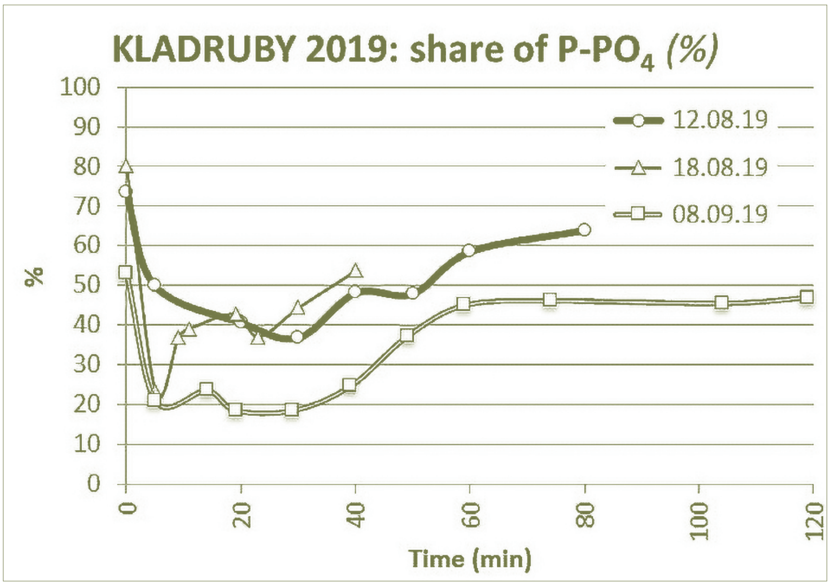

Fig. 2: *Overflows from Kladruby: Share of P-PO$_4$ on P total content in overflowing waste water*

Graph illustrating share of P-PO$_4$ on P total concentrations (Fig. 2) shows that % of P-PO$_4$ decreases in the beginning of each episode because maximum P was bound in organic flocs of material that was resuspended from sediments in pipes of sewerage. It means that pollution by overflowing waste waters in rivers cannot be detected, distinguished from impact of e.g. erosion and estimated its input simply after increased P-PO$_4$ concentrations. The issue is more complicated.

Mass balance calculations (Tab. 1) show that input of P with overflowing water highly exceeded input from the WWTP not only during the event, but – except the first case – also the daily P input (the range in Tab. 1 is given by variability of daily flow from the WWTP). Very roughly (only three events and no higher precipitation was documented) could be estimated that input of P during one year could reach about half of yearly P input from the WWTP.

3. Conclusions

Despite waste water overflows are in general considered to be quite “normal” and “legal” they represent very important input of risky compounds with impact on eutrophication and very probably also on ecological status of water bodies. Mitigation measures are well known (in cities green roofs, rain gardens, green faccades, retention reservoirs; on sewerage system accumulation volumes), but in practice little willingness to implement them could be seen. Also legislation is far behind actual needs. We think that monitoring of such episodic waves of pollution should be very useful contribution to the topic because currently is the problem overlooked and/or diregarded. Our common system of water quality monitoring needs re-thinking of whole the issue: to change accents and start to use special monitoring with remote controlled autosamplers etc.

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Fachbeiträge

Odborné příspěvky

Magdeburger Gewässerschutzseminar 2021

Magdeburský seminář o ochraně vod 2021

Klimatische Bedingungen und deren Auswirkung auf die Grundwasserneubildung

Klimatické podmínky a jejich vliv na doplňování zásob podzemních vod

Magdeburger Gewässerschutzseminar
MGS
2021
Magdeburský seminář o ochraně vod

ResiBil – Water resources balance in the Eastern part of the Bohemian – Saxon border area and evaluation of its long-term use

David Rozman, Zbyněk Hrkal, Pavel Eckhardt, Ondřej Nol

1. Introduction

The Bohemian Cretaceous sedimentary basin is one of the most significant sources of groundwater in Central Europe. Its significance increases especially during the period of climate change, which is manifested by long droughts affecting shallow aquifers. Cretaceous aquifer is therefore a strategic source of drinking water not only for the Czech Republic but also for neighbouring Germany.

The ResiBil transboundary project provides a foundation for a common strategy of the optimal use of groundwater resources. The project topic was addressed by an international expert team from T. G. Masaryk Water Research Institute, Czech Geological Survey and Saxon State Office for the Environment, Agriculture and Geology.

The results of the research are focused on three pilot sites, which cover the most significant groundwater exploitation sites in the area: Děčínský Sněžník, Hřensko/Kirnitzsch and Lückendorf (Fig 1).

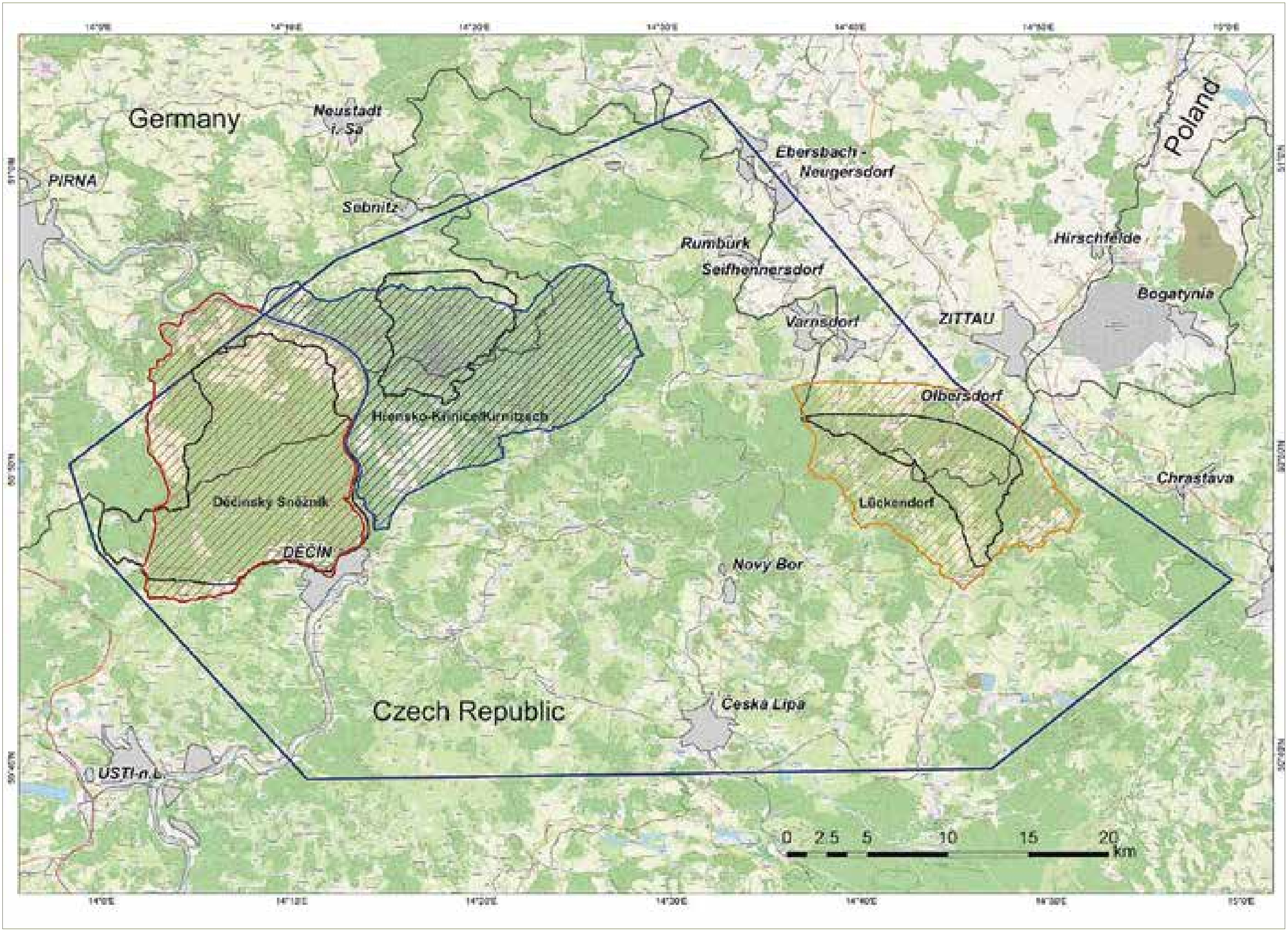

Fig. 1: Overview of the project area (blue line), pilot sites and model areas

The project evolved a system of consequential models, which improved the knowledge about the area. The results contribute to finding the answers to common questions about available amount of groundwater and future water management. The goal of the project is to support effective and sustainable exploitation of groundwater resources and their transboundary protection.

The first crucial output of the project was a transboundary 3D geological model, with a common interpretation of geological structures. The research team also performed additional hydrogeological investigation. The obtained results and findings were then used to construct numerical hydraulic models. The numerical models are based on long-term data sets of groundwater levels, surface flow rates, meteorological data and pumping rates. These tools enable the simulation of various scenarios of future climate changes and groundwater exploitation rates.

2. Hydrogeological investigation

Literature research and investment of archive boreholes revealed which parts of the pilot sites need better specification of the conceptual model and more input data for the numeric models. Field research was therefore focused on such areas, especially the area of Děčínský Sněžník.

Two new monitoring boreholes were drilled in a close vicinity of the state border in Sněžník and Maxičky. Both now boreholes were constructed to investigate the Turonian aquifer. The groundwater level was reached in depth over 60 m below surface. Continuous monitoring confirms small but consistent decrease of groundwater levels during last dry years (2017 – 2020). The geological and hydrogeological characteristics of the Turonian aquifer were recorded by geophysical well logging methods. Measurements form Maxičky borehole show slow downward current (0,002 l/s), while in borehole Sněžník, the current is much more intense, with vertical flow 1 l/s and recorded horizontal velocity 29,5 m/day. These results confirm significance of fractures, which cause heterogeneity of permeability of the sedimentary basin aquifer.

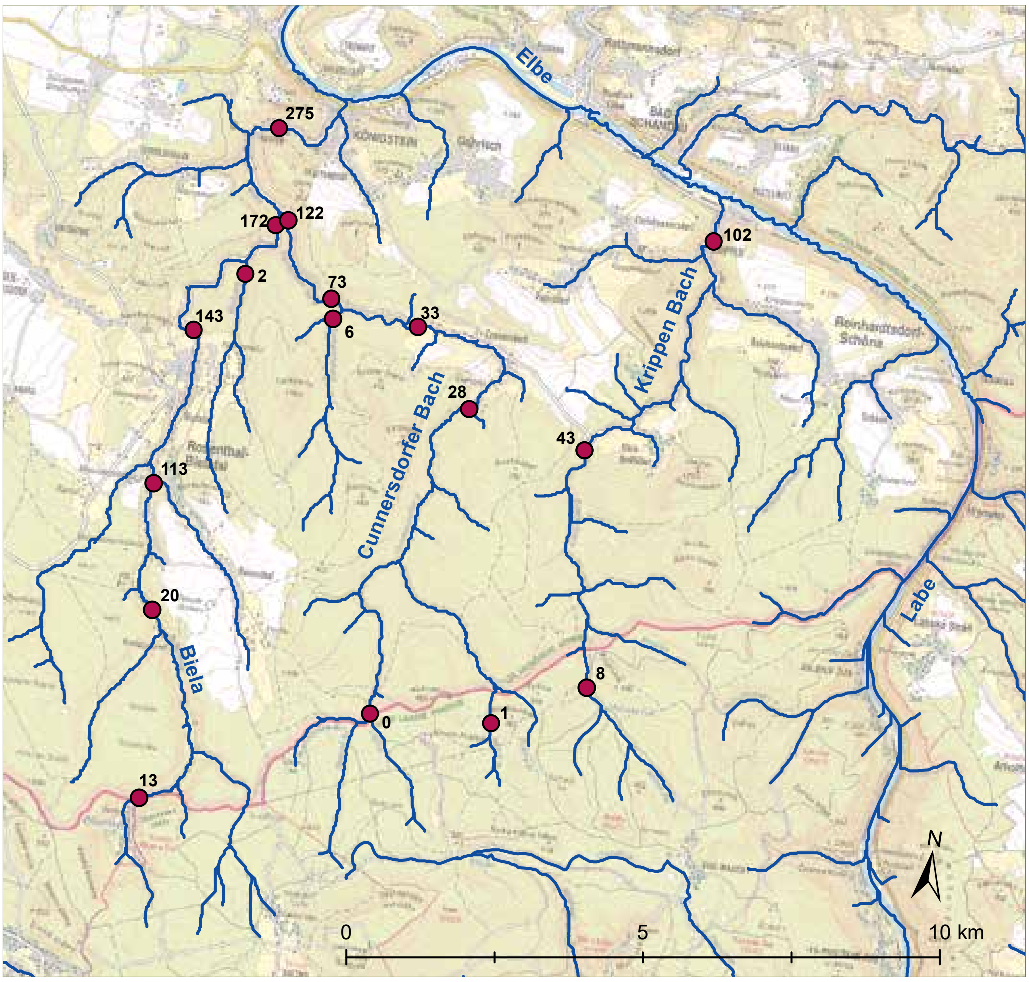

Fig. 2: Example of flow measurement in Děčínský Sněžník area

Hydrogeological conditions were further specified by measurements of surface water discharges. In general aquifers are connected to rivers and creeks in the area. If the groundwater level in the aquifer is higher than hydraulic level in a river, groundwater drains into the river. In the opposite case, the aquifer is recharged by surface water from the river. Drainage of the aquifer is baseflow and can be measured as discharge of the stream during periods of drought – with no surface runoff. By measuring baseflow at several profiles of the stream, we were able to identify main areas of drainage of the investigated aquifer, where increments of the discharge are most significant (Fig. 2). Another field investment activity was mapping of natural springs. By its location and discharge, springs provide important information about changes of the hydrogeological conditions and position of structures. In both areas Hřensko/Kirnitzsch and Děčínský Sněžník more than 150 springs were found and measured. In the area of Děčínský Sněžník, spring measurements enabled more reliable interpretation of the bottom of the Turonian aquifer and its transition to deep Cenomanian aquifer. In the area Hřensko/Kirnitzsch spring measurements were used for interpretation of the extent of lower and upper Turonian aquifers.

3. Numerical modeling

Infiltration of precipitation and groundwater recharge was evaluated by hydrological model BILAN, which simulates runoff compounds in a catchment scale. The input data for runoff models were time series of precipitation, temperature and surface area. The model was calibrated by available discharge time series.

The ultimate model, which enabled us a complex hydrogeological assessment, was hydraulic model MODFLOW. Construction of the model was a synthesis of geological and hydrogeological knowledge about the area. It included definition of geometry of the model layers, representing aquifers and aquicludes, hydraulic parameters and boundary conditions, which represent surface infiltration, interaction of groundwater with surface water and groundwater extraction. Hydraulic models were calibrated to match monitored groundwater levels in the area. Calibrated models were used to simulate groundwater flow, evaluation of available resources and the effect of variable groundwater extraction and recharge on groundwater regime.

To verify possible future unfavourable trends of groundwater quantitative status, we defined several stress scenarios with different intensity of groundwater extraction and decreasing trends of natural recharge, for the period until year 2050.

4. Results and conclusions

The constructed numerical models enable simplified simulation of natural process. According to the results, the total groundwater natural resources for the model area of Děčínský Sněžník are 724 l/s. This amount corresponds to 130 mm/year of recharge. Currently, the average amount of groundwater extraction in the model area reaches less than 10 % of this amount – 64,6 l/s. The resilience of the aquifers was tested by applying several stress scenarios. For example, figure 3 shows groundwater level drawdown in year 2050, after application of a scenario with current extraction rates (64,6 l/s) and a recharge rate, which starts on a current value, but decreases 3 mm every year. We can notice a decrease in groundwater level between 1 and 5 m for most of the model area and more than 5 m near the pumping sites.

In a similar way, figure 4 shows groundwater drawdown for model area Hřensko/Kirnitzsch in year 2050, again after application of a scenario with current extraction rates (104,5 l/s) and a 3 mm/year decreasing recharge rate. In case of model area Hřensko/Kirnitzsch we can quantify the total groundwater natural resources for the model area to 1481 l/s. This value corresponds to 250 mm/year of recharge. Current extraction rate represents 7 % of this amount. The highest extraction rates tested within stress scenarios were 115 % of currently permitted maximal rates, which means 120 l/s in case of Děčínský Sněžník area and 206 l/s in case of Hřensko/Kirnitzsch area.

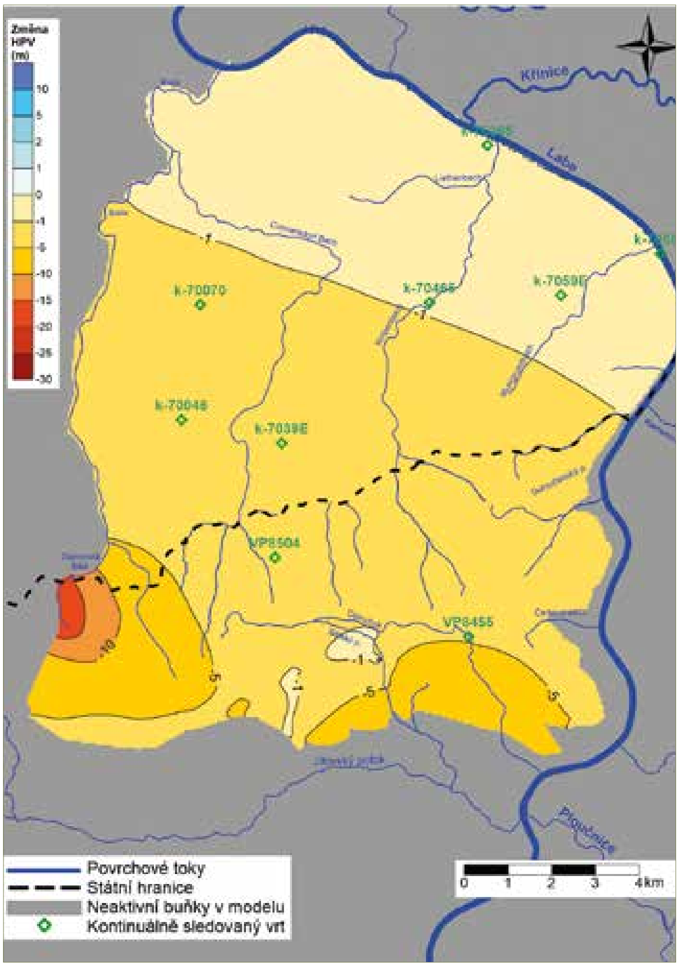

Fig. 3: *Děčinský Sněžník – groundwater level drawdown in year 2050 due to decreasing recharge rate*

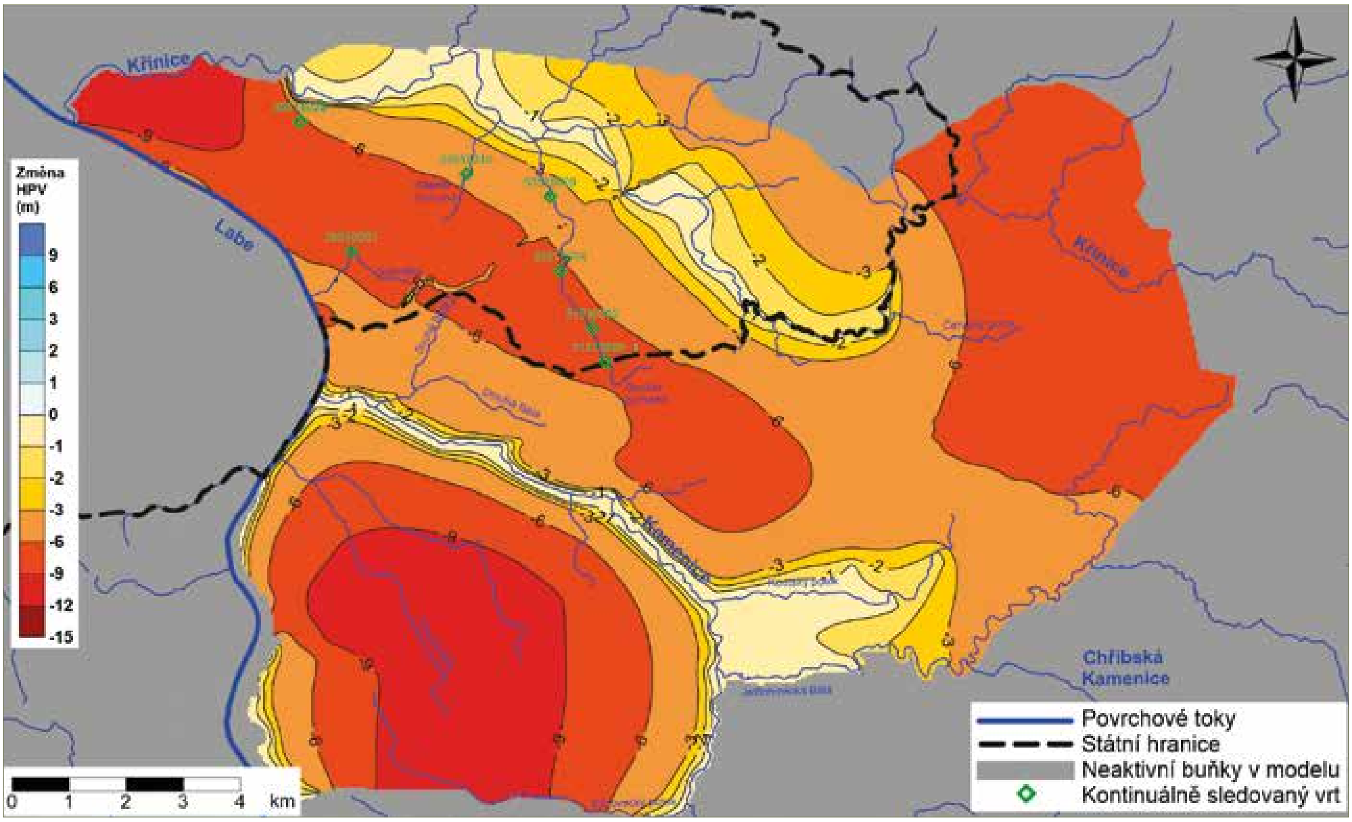

Fig. 4: *Hřensko/Kirnitzsch – groundwater level drawdown in year 2050 due to decreasing recharge rate*

The model stress tests demonstrate possible increase of groundwater extraction rates in the area, even under long-term unfavourable climatic conditions, however for the price of a certain drawdown of groundwater level and potential decrease of springs discharge rates. The results of the study confirm that changes of water regime and balance are in a various degree caused by both, climatic effect and anthropogenic influence, especially groundwater extraction. The results also confirm that groundwater exploitation in the study area currently has significant reserves.

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Change of groundwater recharge (GWN) in Saxony-Anhalt and the resulting effects on water usages

Martin Schneppmüller

1. Climatic and hydrogeological conditions

Saxony-Anhalt is located in the continental temperate climate zone. According to the information published by the German Weather Service (DWD) [1], [2], [3], this zone is characterized by relatively low precipitation and high evaporation and temperatures compared to the rest of the Federal Republic of Germany. The highest rainfall can be found in the Harz Mountains. The predominantly northern land area is, however, in the so-called Rain shadow of the Harz or in its area of influence and has significantly lower precipitation and thus low GWN. The comparison of precipitation and temperatures from 2018 to 2020 alone shows the strong differences between the entire Federal Republic of Germany and Saxony-Anhalt. The average annual precipitation for the whole of Germany is around 790 mm as a long-term mean (reference period 1961 – 1990, [1]). In Saxony-Anhalt, an average of around 352 mm fell annually in the entire federal state in 2018, around 485 mm in 2019 and around 500 mm in 2020 [1], [2], [3]. In comparison, the average rainfall was between 40 % and 63 %. Figure 1 illustrates these differences. The mean temperature of the reference period in Germany is approx. 8 °C [1]. In Saxony-Anhalt the mean annual temperature was measured at 10.9 °C in 2018, 10.9 °C in 2019 and 11 °C in 2020 [1], [2], [3]. This comparison over the past three years shows an example of the “unfavorable” climatic situation in Saxony-Anhalt and shows that relatively little precipitation is available for infiltration into the soil and that this is further reduced by evaporation.

From a hydrogeological point of view, Saxony-Anhalt can be divided into two areas on a very large scale. The northeastern part of Saxony-Anhalt is characterized by sandy, gravelly pore aquifers that are covered with relatively well-drained soils. Due to the Ice Age, accumulated layers appear. The southwestern part is predominantly characterized by solid rock aquifers (sandstone, limestone) and medium-permeable soils [4].

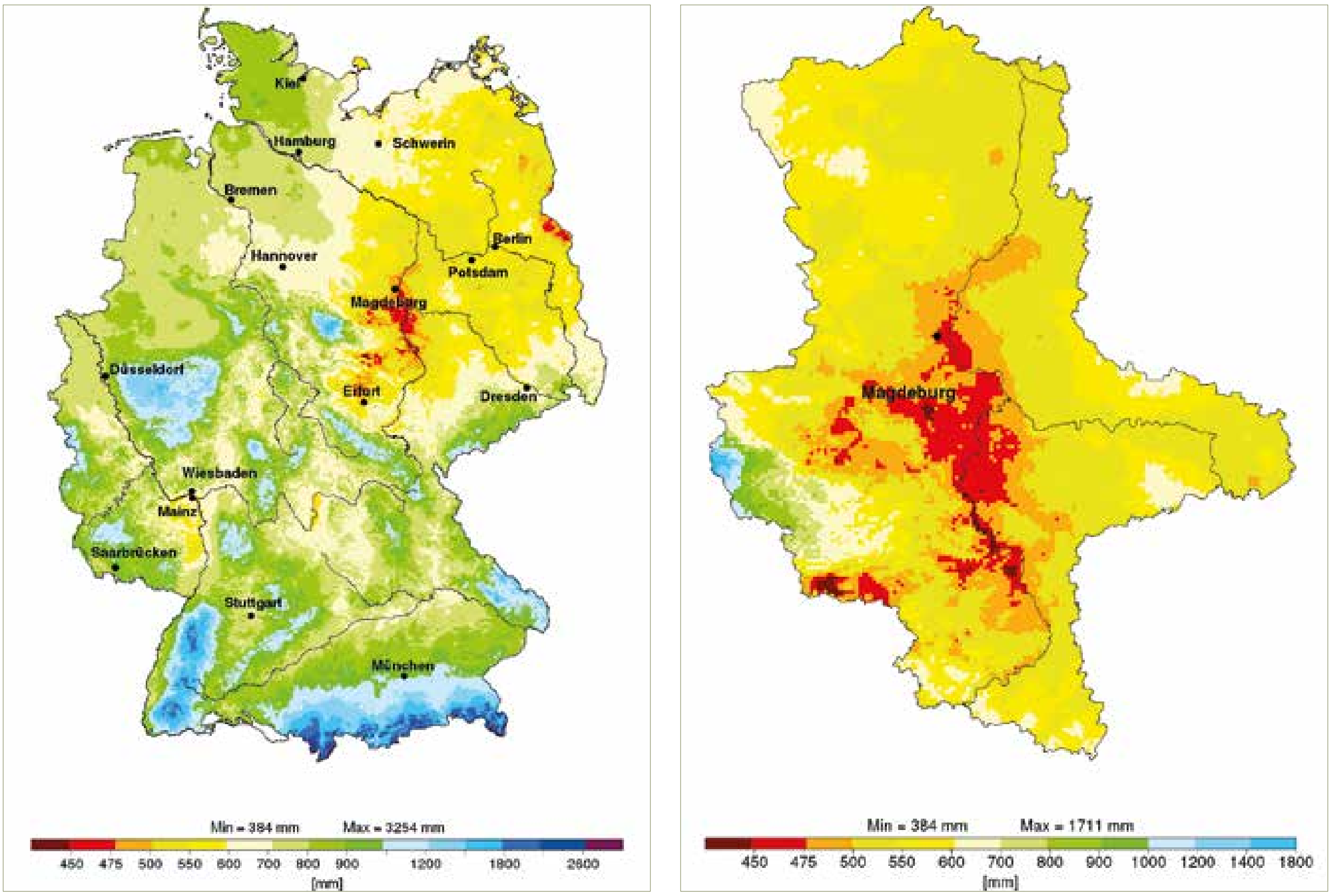

Fig. 1: Absolute mean annual precipitation in the reference period 1961 – 1990 (left Germany, right Saxony-Anhalt) [5]

2. Groundwater recharge in Saxony-Anhalt

To put it simply, groundwater recharge is the access of infiltrated water to groundwater [6] and the so-called In Central Europe, the groundwater base runoff mainly feeds the rivers. The groundwater recharge itself depends on various factors (e.g. precipitation, temperature, evaporation, soil properties, etc.). In Figure 2, the water balance is shown schematically to illustrate the new groundwater formation process. The driving force behind the formation of new groundwater is precipitation, which seeps away at different rates due to gravitational effects and, among other things, depending on the subsoil. The groundwater recharge can be calculated with different temporal and spatial resolutions using various model systems that take the influencing factors into account. Well-known model systems include mGROWA [7], MIKESHE [8], GWN-BW [9] and ArcEGMO [10].

In Saxony-Anhalt, over the past 25 years, the mean new groundwater formation has been calculated for a long period of time (usually 30 years) at different intervals on the basis of various model systems. When creating or transferring to other models, care was always taken to improve the data bases (e.g. soil data, precipitation) and to refine the areas under consideration (so-called elementary areas (EFL)). Up to 2001 1 km² grid cells (approx. 21,130 pieces, so-called MeTras) were used, for which the entire underground runoff (RU) was based on the method according to BAGROV, N.A. and GLUGLA, G. was calculated. From 2001 to 2013 the results (RU) from the modeling with the ABIMO ST system (discharge model based on BAGROV / GLUGLA and DIFGA [11], climate series 1961 – 1990) were used. Individual values were available for approx. 612,600 areas. After a transition period from 2013 to 2018, during which various adjustments were made to the model system, the model result from modeling with ArcEGMO / PSCN [12], [13] (climate series 1981 – 2010) is available. The results of the various runoff components are available here for approx. 1,400,000 million areas. The resolution of the model areas has been refined over the course of time from approx. 21,000 to approx. 1,400,000. Due to the improved spatial resolution, the theoretical model results also changed continuously and result in a reduction in the GWN compared to the 1990s, depending on the development of the weather conditions.

A comparison of the different results (Figure 3) shows how the new groundwater formation in Saxony-Anhalt has changed spatially and quantitatively (especially between ABIMO and ArcEGMO) over the years and also due to the improved model systems. The mean new groundwater formation in the entire federal state has decreased from (theoretically) approx. 102 mm/a to approx. 67 mm/a. According to current calculations (as of 2018) with the ArcEGMO modeling system, around 36 % of the EFL in the entire land area have less than 25 mm/a GWN. The GWN is the sum of the rapid intermediate groundwater runoff (RG1) and slow groundwater base runoff (RG2). The mean value (without weighting) over the area of Saxony-Anhalt for GWN (= RG1 + RG2) is currently around 67 mm/a. In a national comparison, Saxony-Anhalt is more than 50 % below the national average (135 mm/a [14]).

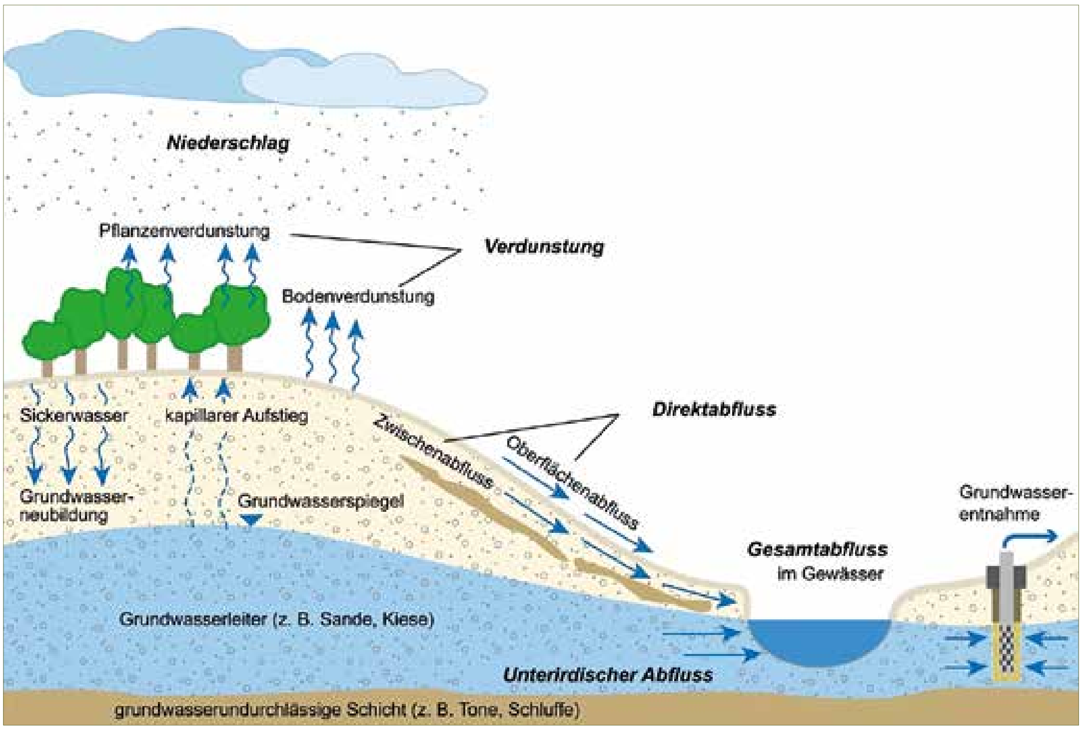

Fig. 2: *Schematic representation of the water balance (www.kliwa.de) [15]*

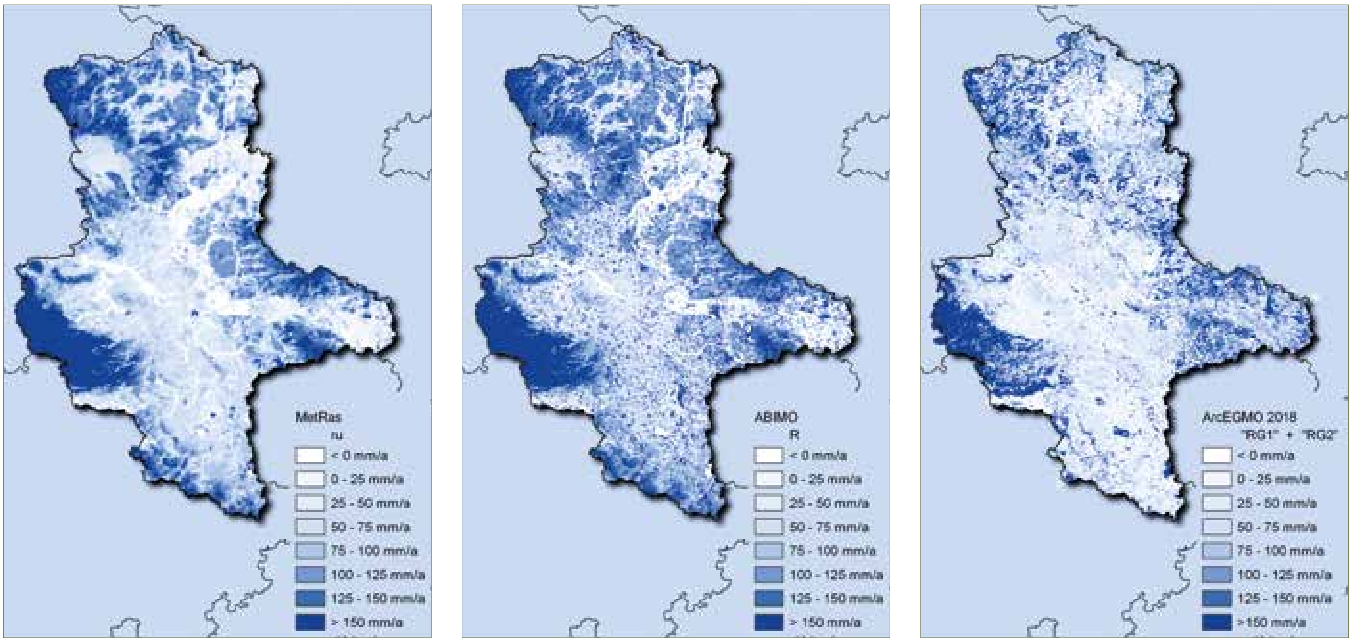

Fig. 3: *Groundwater recharge in Saxony-Anhalt (links: MeTras, mitte: ABIMO; rechts: ArcEGMO)*

3. Challenges

Due to the changing groundwater recharge (model calculations), which is partly reflected in falling groundwater levels, new challenges arise for water management and groundwater users. There are economic – ecological conflicts. In addition to the existing uses of groundwater and surface water in industry and the drinking water supply, due to the increasing number of dry years, the water demand is increasing, especially in agriculture, with a simultaneous decrease in water availability. A reduced base runoff in the waters, due to reduced groundwater recharge or increased use of groundwater, leads to damage to the ecosystem. In addition to the obvious effects in the body of water itself, the ecosystem adjacent to the body of water and dependent on the groundwater (e.g. alluvial forests) is also severely affected. In addition, a reduced runoff in the waters also limits the possibilities of discharging industrial and municipal wastewater. Falling groundwater levels also lead to a drop in the corresponding lake water level in the area of flooded lignite mining lakes. Due to the reduced counterpressure of the lake water or the reduced buoyancy within the embankments, landslides could occur above the bank areas but also below the water level. A reduced formation of groundwater also leads to a reduced and slowed dissolution of fertilizers. At the same time, due to the reduced input (precipitation), the seepage and flow times of the groundwater increase, which can lead to an accumulation of e.g. nitrate (increase in concentration). A reduction in the formation of new groundwater and the associated limited usable groundwater resource presents society with the challenge of acting sustainably for nature, people and the economy.

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The impact of drought on groundwater in the Czech part of the Elbe river basin in 2017 – 2020

Radek Vlnas, Anna Lamačová, Martin Zrzavecký

1. Introduction

In order to evaluate the effects of drought on the state of groundwater, 138 representative boreholes were selected in the Czech part of the Elbe river basin (see Fig. 1). These are shallow boreholes, which measure the upper groundwater aquifer, resp. upper horizon. The evaluation was related to the reference period 1981–2010. Monthly statistical characteristics were determined for individual boreholes, including minimum, maximum and percentile values 5 %, 15 %, 25 %, 75 %, 85 %, 95 %. This made it possible to characterize annual course of the particular borehole within the thirty-year reference period. The current values of the monthly medians from the period 4/2017–3/2020 were subsequently related to these characteristics and divided into 7 categories from extremely below-normal level (≤ 5 %) to extremely above-normal level (> 95 %), individual categories and their the corresponding colour scale is shown in Figure 1.

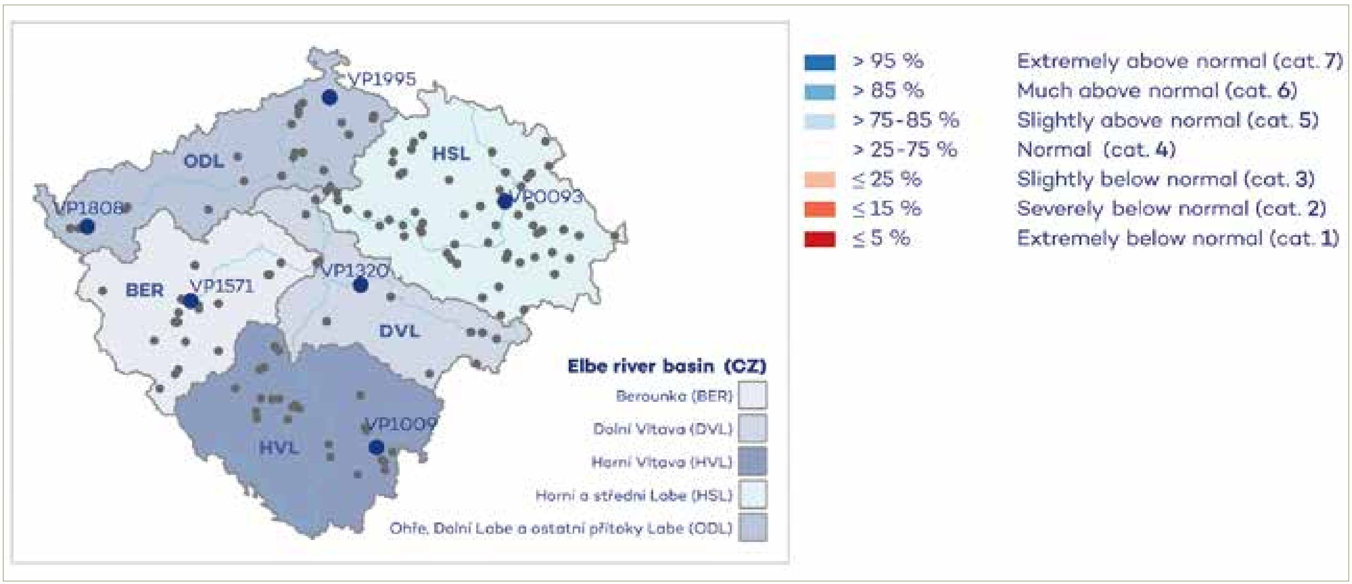

Fig. 1: *Left: position of monitoring boreholes and sub-basins in the Czech part of the Elbe basin. Right: a colour scale corresponding to seven categories of the groundwater level from extremely low (cat. 1) to extremely high (cat. 7).*

2. Water management year 2017

The air temperature in the water management year 2017 was above normal in the Elbe river basin in the Czech Republic. April was within the normal range with a negative deviation from median, below normal were September, February and March. In other months, the deviation from the normal was positive, June was much above normal across the entire territory of the Elbe river basin, in some basins also August and October.

In terms of precipitation, the year was normal. However, most of the months did not reach the precipitation median and the overall balance was improved by precipitation within the severely above-normal April and October. February was below normal, in the HSL and BER river basins it was severely below normal (around 20 % of normal precipitation) and in the ODL river basin even exceptionally below normal (only 13 %).

The main snowmelt took place in February 2017 already, when the snow water content was normal, in March it was already extremely below normal. At the end of 2017, snow water content was normal, but in lower altitudes even extremely below normal (up to 15 %).

Due to climatic conditions, the usual spring replenishment of groundwater storage did not take place. The groundwater level in April 2017 was almost below normal (25 % of the duration curve, hereinafter referred to as DC). In May, groundwater improved to normal due to severely above-average precipitation in April. High temperatures in June led to a rapid decrease of water levels to slightly to almost severely below normal during June and July

(15 – 17 % DC) – no single borehole was above normal, only 25 – 32 % of boreholes were within the normal range, the others were slightly to extremely below normal (18 – 24 % of boreholes extremely below normal). Cold September and severely above-average precipitation in October led to a significant rise in groundwater levels from October to January, but only within the normal range (48 – 64 % DC). As early as February, due to the absence of snow and precipitation, instead of groundwater storage replenishment, the water level dropped rapidly to a slightly below normal level in March (24 % DC).

3. Water management year 2018

The air temperature in the water management year 2018 was exceptionally above normal in the Elbe river basin in the Czech Republic. There was only positive deviation from normal within the months. April and May were exceptionally above normal, and August was exceptionally above normal in most river basins, while June, July, February and March were up to severely above normal.

In terms of precipitation, the year was slightly below normal. November was up to extremely below normal (27 % HSL), July and August were severely below normal throughout the territory, and April was also up to below normal (29 % HVL). None of the months from spring to autumn reached precipitation normal, especially in the north-eastern part of the river basin (HSL, DVL, ODL), the overall balance improved only at the end of the year (December to March). Only December was above normal precipitation (around 150 %) and in some basins January (160 % HVL, DVL, ODL), February and March were normal.

There was little snow in the spring 2018, in higher altitudes up to 50 % of normal, in lower altitudes only 20 to 30 %. Also at the end of the year there was little snow, water storage in the snow were only 40 – 60 % of normal. The usual spring replenishment of groundwater storage did not occur this year either. As a result of a combination of extremely above-average temperatures and often even severely below-normal precipitation, the groundwater level continued to decrease in 2018, so that it was severely below normal from April to December (6 – 19 % DC). In August, the groundwater level was even extremely below normal (4 % DC). From July to December, 40 – 55 % of the boreholes were extremely below normal, only 9 – 22 % of the boreholes were normal, and from April to December there were almost no above-normal boreholes. Above normal precipitation in December and the following normal months resulted in a significant increase of the groundwater level to almost normal by January (25 % DC) and a modest further rise in February and March within normal range (29 – 37 % DC).

4. Water management year 2019

The air temperature in the water management year 2019 was exceptionally above normal in the Elbe river basin in the Czech Republic. With the exception of the severely below-normal May, a positive deviation from normal was recorded in all months. Extremely above normal temperatures were in June and February (deviation from normal around + 5 °C in both months), much above normal were some basins in August and November.

In terms of precipitation, the year was slightly below normal. The only above-normal month was extremely above-normal February. The HSL river basin was severely below normal in June, July and December, and the HVL basin in April. The other months were normal or slightly below normal throughout the Elbe river basin.

In the spring of 2019, there was up to normal amount of snow in higher altitudes, but significantly below normal snow was in lower altitudes (only up to 20 % of normal). At the end of the year, there was almost no snow in the entire Elbe river basin.

Groundwater storage from melting snow was not replenished this year either, spring temperatures were again above normal and precipitation was below normal in April, therefore instead of the usual groundwater maximum, the water level dropped sharply to a very below-normal level (10 % DC). After that, the decline slowed down, but in July and August the groundwater level was again severely below normal (7 – 8 % DC). The severely below-normal situation then lasted until January with a slight improvement in November. From July to January, 25 – 44 % of the boreholes were extremely below normal, only 9 – 28 % of the boreholes were normal, and from April to January there were almost no above-normal boreholes at all. Winter precipitation was mostly rainy, or the snow melted soon, and February was extremely above normal in terms of both temperature and precipitation, which contributed to the improvement of groundwater in February and March to slightly below normal level (20 – 23 % DC).

5. Comparison with 2015

In terms of shallow boreholes, 2015 was rated as the third driest year since 1971. During the following years, drought continued to propagate, due to the absence of snow, especially in lower altitudes, there was no spring infiltration to groundwater subsidy and above-average temperatures in spring and summer increased evapotranspiration. In 2017, the normal precipitation was not enough to cover the deficit. The calendar year 2018 was rated as the driest in shallow boreholes since 1971. The driest period was recorded from August to the end of the year, with the water levels assessed as severely or extremely below normal. The areas most affected by drought were the HSL and DVL basins, to a lesser extent the HVL and BER basins. Over the years, the deficit had accumulated, the number of above-normal boreholes had been steadily declining, so that the year 2019 with only slightly below-normal precipitation eventually proved to be the second driest in groundwater since 1971.

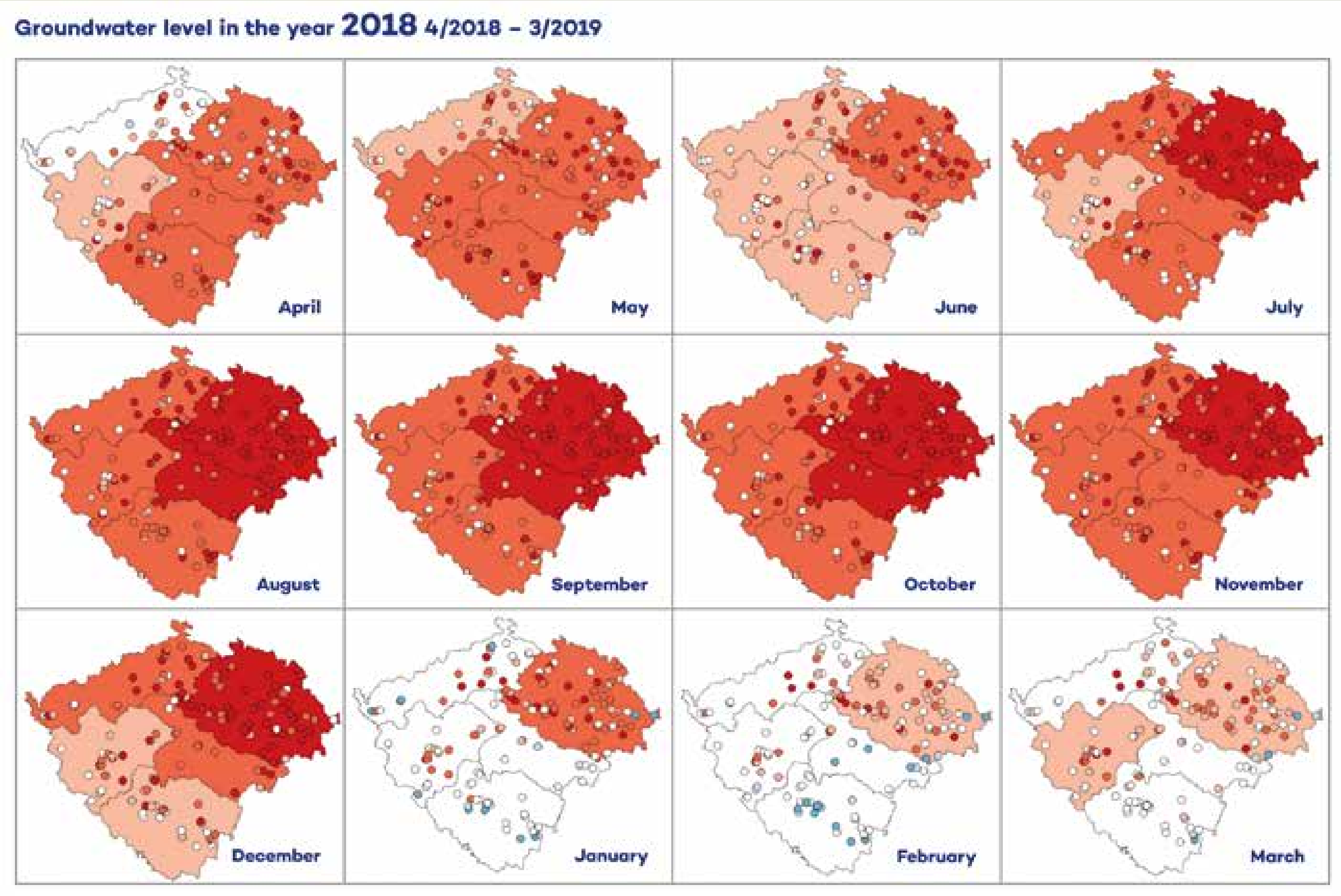

Fig. 2: Groundwater level in the water management year 2018 (colour scale is shown in Fig. 1).

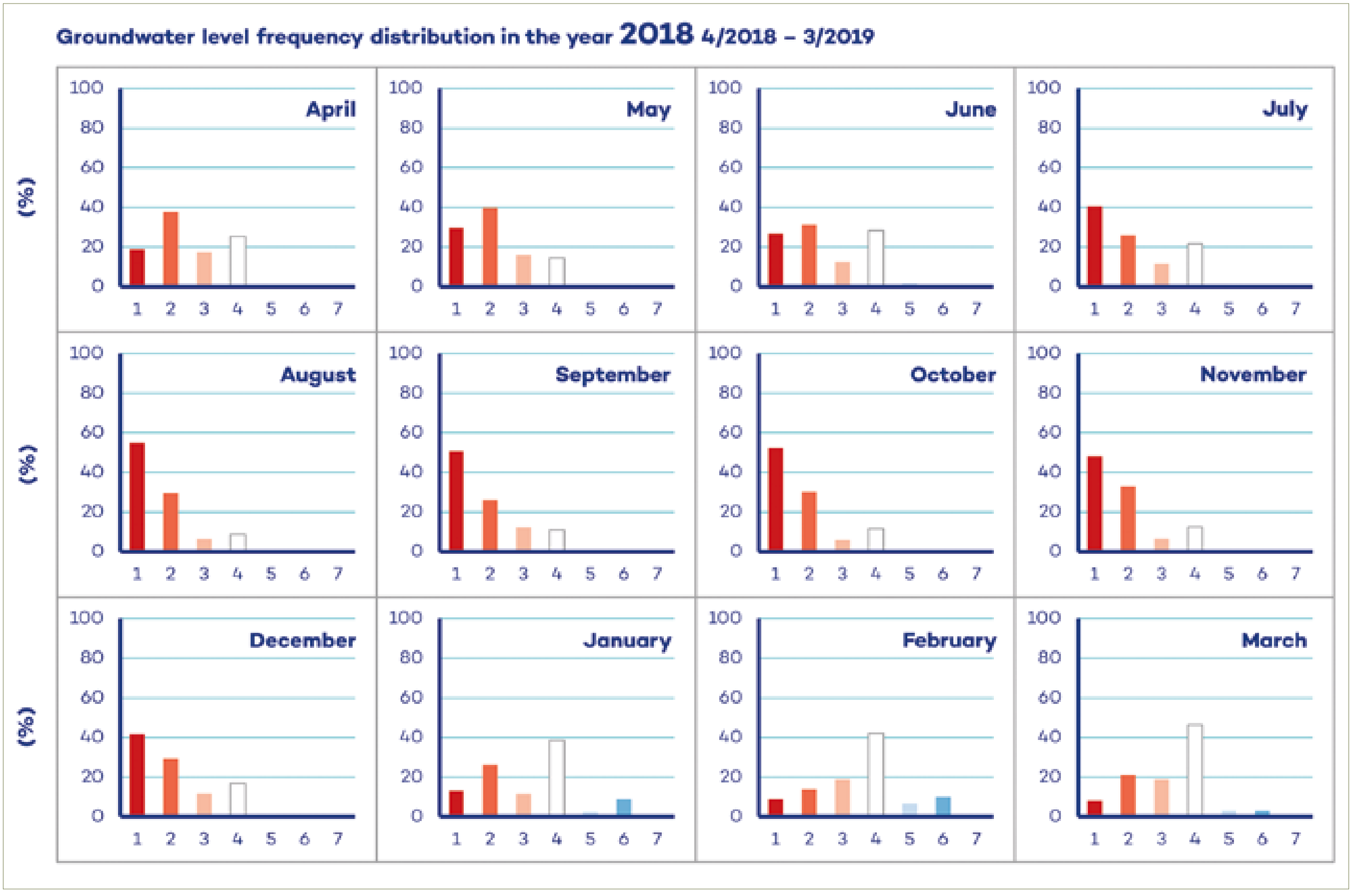

Fig. 3: *Frequency distribution of groundwater levels in the water management year 2018 (colour scale and categories description are shown in Fig. 1).*

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Fachbeiträge

Odborné příspěvky

Magdeburger Gewässerschutzseminar 2021
Magdeburský seminář o ochraně vod 2021

Veränderungen in der chemischen Gewässergüte
Změny chemické složky jakosti vody

Pesticides and their mixtures with other xenobiotics in groundwater – a current state in the Czech Republic

Vít Kodeš, Jindřich Freisleben, Miroslava Svátková

1. Introduction

Although groundwater is considered relatively safe water resource being naturally protected by soil and rock layers, xenobiotics also occur in groundwater contaminated by agriculture, industrial sites, landfills, leaky sewers etc. The national groundwater monitoring network is set up to avoid contaminated sites such as industrial areas, landfills etc. Despite such a setup, we nowadays find up to 176 organic micropolutants from 323 monitored synthetic compounds in various mixtures in groundwater.

2. Materials and methods

The data from the national groundwater quality network (Fig.1) operated by the Czech Hydrometeorological Institute (CHMI) in 2018-2020 period consisting of 700 monitoring sites were used for an assessment of occurrence of xenobiotics and their mixtures in groundwater. The samples are regularly taken twice a year (spring, autumn) and analysed using various analytical methods (mainly GC-MS/MS, LC-MS/MS). In total, 4144 samples were processed. The pollutants were divided into 10 groups i.e. PAHs (polycyclic aromatic hydrocarbons), VOCs (volatile organic compounds), pesticides, pharmaceuticals, alkyl phenols, benzotriazoles, chelating agents, PFCs (perfluorinated compounds), PCPs (personal care products) and "others" in order to demonstrate an impact of various point and diffuse pollution sources of diverse origin such as agriculture, industry, urban pollution, transportation etc. on groundwater.

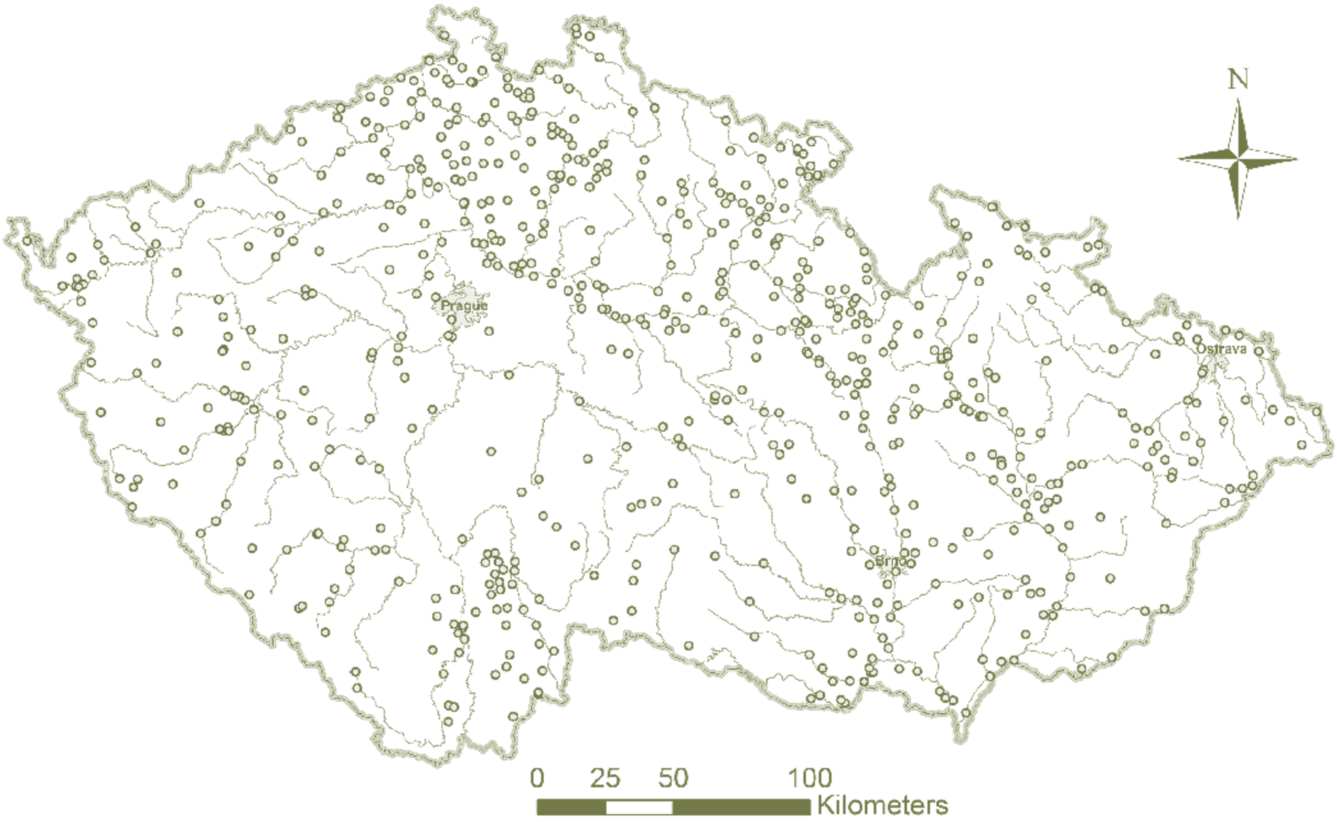

Fig. 1: Groundwater quality monitoring network

3. Results

The data from 2018 – 2020 period show that 22 % of samples were free of xenobiotic compounds, 15 % of samples contained just one compound, 10 % of samples contained two compounds, 3 to 10 compounds were detected in 40 % of samples and more than 11 up to 34 compounds were found in 13 % of samples (Fig. 2). At least two compounds occurred in 63 % of samples, thereof at least 2 compounds from 2 various groups of chemicals occurred in 47 % samples. Similarly, pollutants from two or more pollutant groups occurred in 46.5 % of samples (Fig. 3)

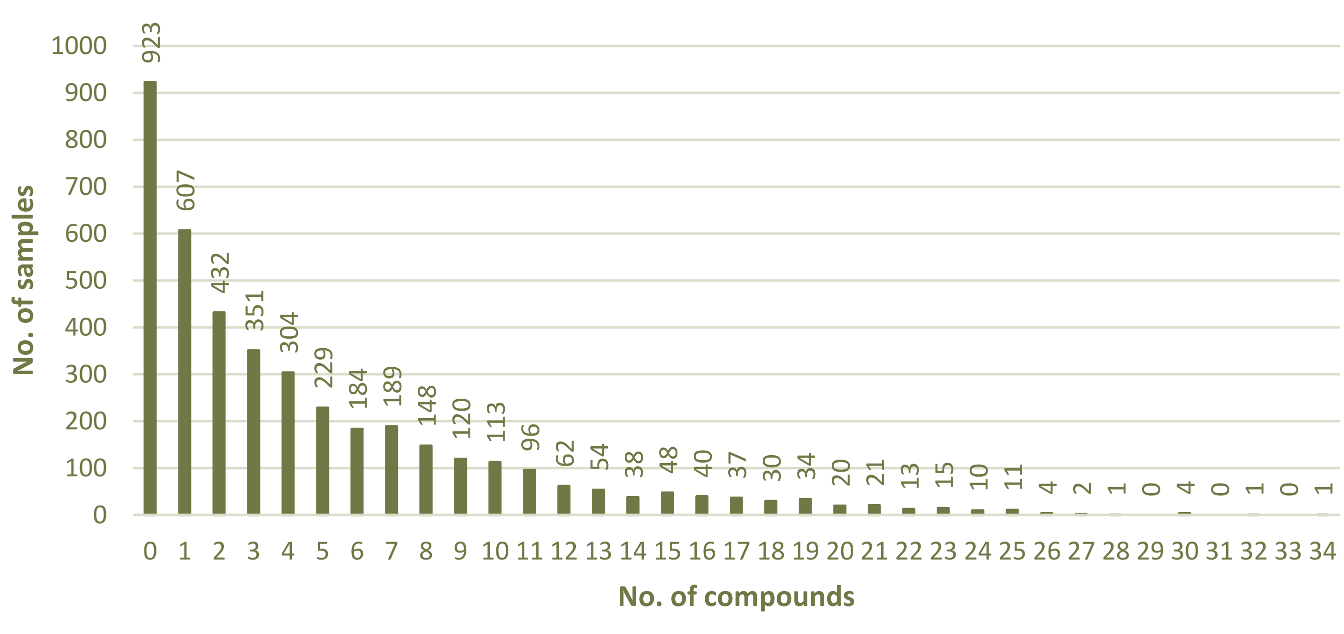

Fig. 2: *Number of individual pollutant findings in samples*

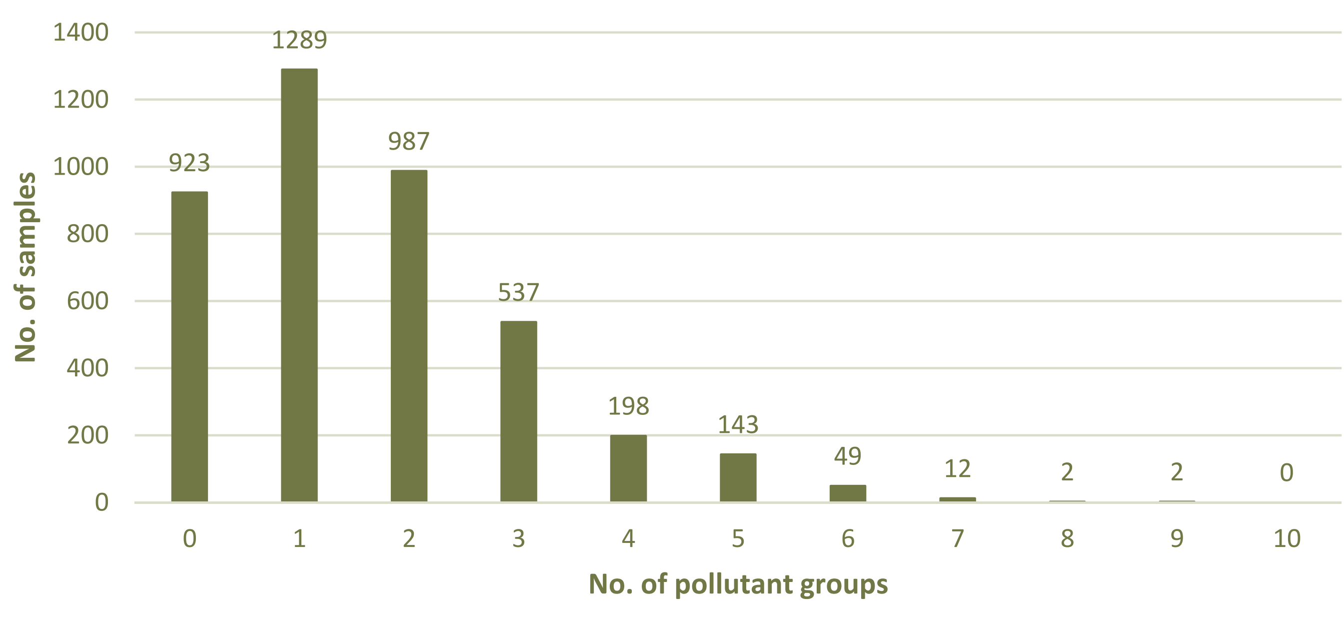

Fig. 3: *Number of findings of pollutant groups in samples*

Prevailing contaminants are pesticides (2094 positive samples) followed by PAHs (1914 samples) and VOCs (1020 samples). Also alkyl phenols (234 samples), pharmaceuticals (361 samples), chelating agents (655 samples), PCPs (169 samples) and benzotriazoles (239 samples) were detected in groundwater. Pesticides are regularly detected at 400 (57 %) monitoring sites; concentrations exceeded the groundwater threshold value for pesticides of 0.1 μg/l at 296 (42 %) of monitoring sites. The total concentration of xenobiotics in groundwater can exceed 100 and reach up to 443 µg/l, concentrations in majority of samples were up to 1 µg/l (Fig. 4). Percentage of positive samples and maximum concentration of the most frequently found pesticides is given in Fig.5. There are sites where very high concentrations or/and very high number of individual compounds from various groups of pollutants were found in mixtures. Examples of respective sites are provided in Table 1.

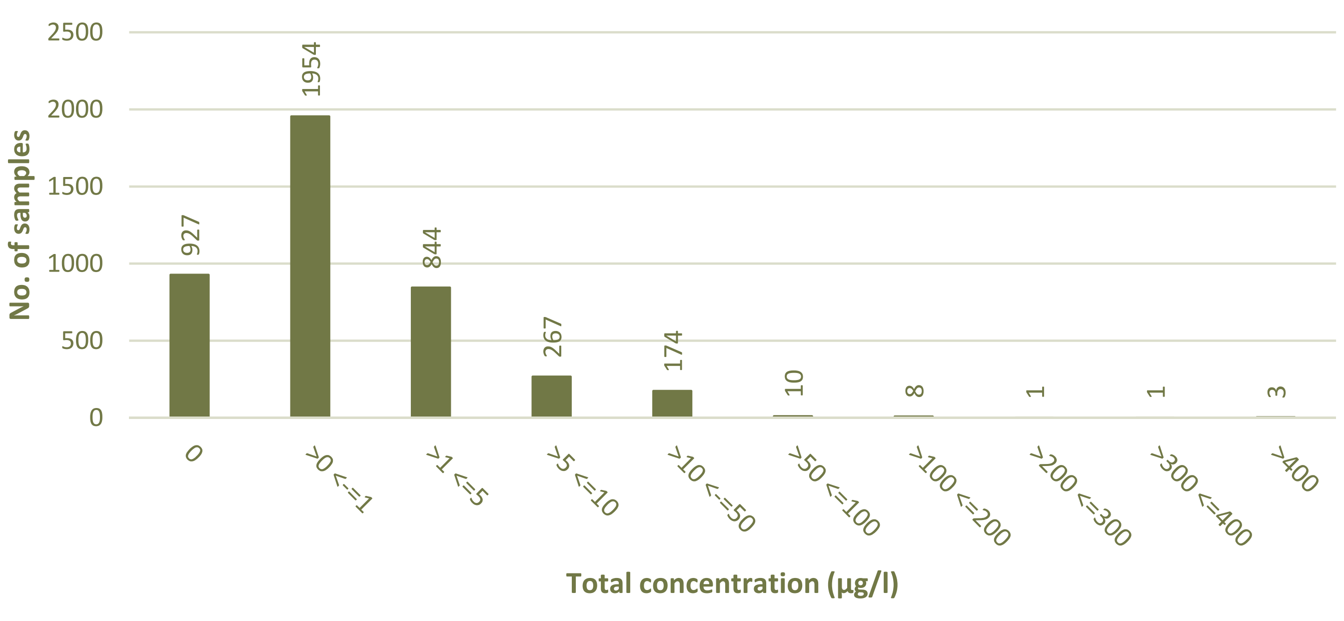

Fig. 4: *Frequency of total concentrations in samples*

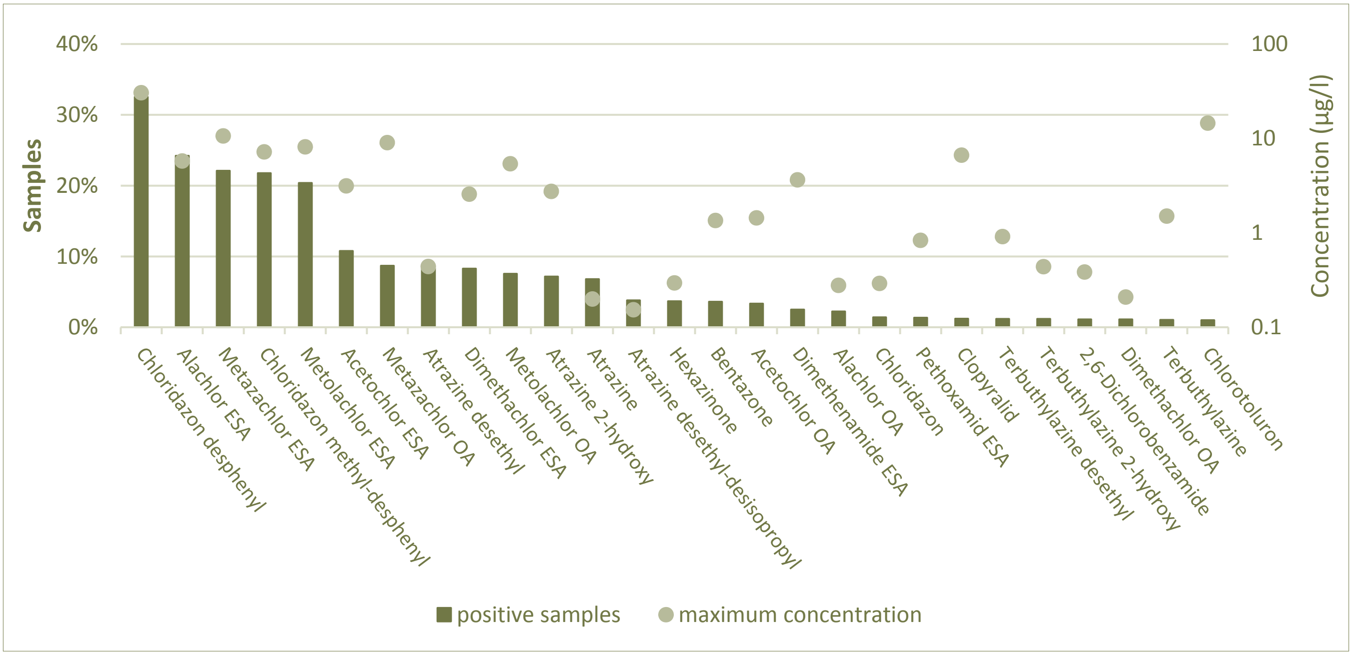

Fig. 5: *Findings and maximum concentrations of the most frequently occurring pesticides*

Tab. 1: *The national "record holder" sites*

Reason	Total concentration (µg/l)	Number of groups	Number of chemicals
High total concentration	443.39	4	10 – VOCs (6), pesticides (2), alkyl phenols (1), chelating agents (1)
High number of pollutants	28.9	4	34 – pesticides (29), PAHs(2), pharmaceuticals (2), chelating agents (1)
High number of pollutants and high number of pollutant groups	4.55	6	30 – PAHs (13), pesticides (10), pharmaceuticals (4), PCP (1), chelating agents (1), alkyl phenols (1)
High number of pollutant groups	7.606	9	25 – pesticides (8), pharmaceuticals (4), PAHs (4), VOCs (3), benzotriazoles (2), PCPs (1), alkyl phenols (1), chelating agents (1), others (1)

4. Conclusions

The most problematic pesticide compounds are preemergent herbicides applied on sugar beet, rape and maize, especially their metabolites such as chloridazon desphenyl, alachlor ESA, chloridazon desphenyl-methyl, metazachlor ESA, metolachlor ESA, acetochlor ESA, metazachlor OA, desethylatrazine, dimethachlor ESA and metolachlor OA, to name a few. Chloridazon desphenyl (its parent compound was used for sugar beet treatment until 2020) was found in more than 30 % of samples, its concentration can reach up to 30 µg/l. Alachlor ESA (its parent compound used for rape treatment was banned in the Czech Republic in 2008) is the second most frequently found pesticide in groundwater. A new metabolite of conazole fungicides (1,2,4-triazole) was analysed in selected samples from 53 sites known for pesticide contamination in 2020. This metabolite was found in a quite large number of respective sites (43 %), this makes 1,2,4-triazole a candidate for a frequently found pesticide in groundwater list in the Czech Republic, but it must be affirmed by further monitoring in future years. Together with pesticides, large number of other micropolutants often occur in groundwater, typically PAHs (phenanthrene, pyrene, fluoranthene, fluorene, naphthalene), chelating agents (EDTA), VOCs (toluene, tetrachloroethene), alkyl phenols (bisphenol A), pharmaceuticals (carbamazepine, gabapentin), benzotriazoles (1,2,3-benzotriazole, 5-methyl-1H-benzotriazole), some pollutants occur in high concentrations, typically VOCs , phthalates, pesticides, chelating agents, benzotriazoles, alkyl phenols and even pharmaceuticals. Monitoring results show that mixtures of various xenobiotics can be found in groundwater more often than one could expect. There is a very little knowledge on harmful effects of such mixtures and their impact on human health, thus the precautionary principle should be applied.

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Pollutants – from observation to regulation

Kerstin Röske, Sylvia Rohde

1. Introduction

The chemical status of surface water bodies is assessed according to EU-wide guidelines on priority substances (Directive 2008/105/EC, as amended by Directive 2013/39/EU). Article 8 of Directive 2013/39/EU states that the Commission establishes a Watch List (WL) of ten substances or groups of substances, for which Union-wide monitoring data is collected to support future prioritization processes. The analytical feasibility of the measurement is also tested. The first WL with the substances 17-alpha-Ethynyl Estradiol (EE2); 17-beta Estradiol (E2)/Estrone (E1); Diclofenac; 2,6-di-tert-butyl-4-Methylphenol; 2-Ethylhexyl-4-Methoxycinnamate; Macrolide antibiotics (Erythromycin, Clarithromycin, Azithromycin); Methiocarb; Neonicotinoids (Imidacloprid, Thiacloprid, Thiamethoxam, Clothianidin, Acetamiprid)); Oxadiazon and Triallate was established (EU COM 2015/4951) in 2015.

The monitoring of these substances is intended to provide high-quality data on their concentrations in the aquatic environment, which can support risk assessments to identify new priority substances. The WL is updated every two years. The updated WL was published 2018 (EU COM 2018/840). The substances Triallate, Oxadiazon, 2,6-ditert-butyl-4-Methylphenol, 2-Ethylhexyl-4-Methoxycinnamate and Diclofenac have been deleted from the list because it was stated that a risk assessment can be carried out without additional monitoring data. The insecticide Metaflumizon and the antibiotics Amoxicillin and Ciprofloxacin have been added to the WL.

The candidate substances for the third WL were selected according to three pillars; (i) the outcome of the last prioritization exercise, (ii) the outcome of the review of the 1st WL and recommendations for the 2nd WL and the (iii) literature search and/or other sources like information from Member States. Furthermore, the hazard properties, the availability of reliable safety thresholds as well as analytical methods for monitoring of the substances were taken into consideration. Three substances of the 1st WL should continue to be on the WL to ensure that enough high-quality monitoring data are collected for their risk assessment. The candidate substances are antibiotics (Sulfamethoxazole, Trimethoprim), other pharmaceuticals (Clotrimazole, Fluconazole, Miconazole, Venlafaxine and O-desmethylvenlafaxine), Plant Protection Products and biocides (Imazalil, Ipconazole, Metconazole, Penconazole, Prochloraz, Tetraconazole, Tebuconazole, Dimoxystrobin, Famoxadone) [1].

According to Article 8b the WL substances are monitored at 24 monitoring sites in Germany, six of them in the River Basin Community Elbe. The sampling sites are located in areas with inputs mainly from agriculture, municipal wastewater treatment plans or both. The substances are monitored over a period of one to four years with at least one measurement per year. To gain information about seasonal influences the substances should be measured four times in a year in equidistant intervals. With only a single measurement per year, it is difficult to estimate the exposure scenario of substances that have been little or not at all investigated so far.

At the moment, the list of priority substances is revised by the EU. For example, the inclusion of Diclofenac, Clarithromycin, 17-alpha-Ethynyl Estradiol (EE2); 17-beta Estradiol (E2) / Estrone (E1), Macrolide antibiotics (Erythromycin, Clarithromycin, Azithromycin) and Neonicotinoids in the list is examined.

The WLs are implemented in German law with the revised Surface Water Regulation (OGewV) in 2016.

In addition to the EU-wide list of priority substances for the assessment of the chemical status of surface water bodies the member states can define a list of river basin specific pollutants. In Germany, the strategy for proceeding with the selection of river basin-specific pollutants is described in Rakon VII (https://www.wasserblick.net/servlet/is/205333/). The identification and prioritization of river basin specific substances is carried out in a multi-stage process. Within a cycle of six years starting in 2015, the following steps and processes are foreseen: (i) Compilation of a substance data collection, (ii) Substance selection for a national WL, (iii) Monitoring of the substances on the national WL in a nationwide, representative monitoring network and evaluation of the results, (iv) Derivation of an environmental quality standards (EQS) proposal for prioritized river basin specific pollutants of the national WL and other available information, (v) Comparison of monitoring data (immission situation) with the EQS proposals, (vi) Proposal of river basin-specific pollutants for inclusion in the OGewV, (vii) accompanying, area-wide denser monitoring to expand the data basis and improve the argumentation.

The following substances are considered relevant for the national WL because the monitoring data exceed the EQS proposal: Ibuprofen, Bisphenol A, Carbamazepine, Barium (dissolved), Boron (dissolved) and Uranium (dissolved). In addition, Dimethenamid-P was included in the national WL.

2. Monitoring and Results

Substances of the WL are measured as part of the international coordinated Elbe measuring program (iKEMP) at important monitoring sites. Here, only selected sites in the river Elbe (data from Elbe Data Information System (FIS), https://www.fgg-elbe.de/elbe-datenportal-en.html) and results from the monitoring program of the Elbe river basin in Saxony will be presented. In Saxony, the WL substances are in the state investigation program and are regularly monitored at representative measuring points.

Figure 1 shows the annual average (AA) concentration of Diclofenac at four sites in the river Elbe. Despite the fact that Diclofenac was already on the first WL, no reduction over time is visible. Carbamazepin is on the national WL. The concentrations increase from Schmilka to Schnackenburg.

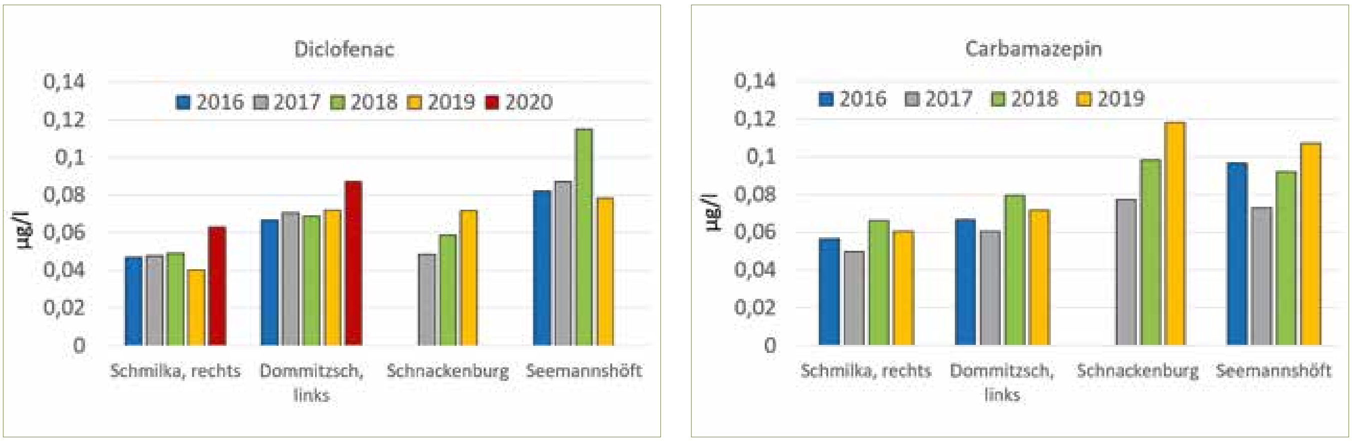

***Fig. 1:** Annual average concentration of Diclofenac and Carbamazepin at selected sites of the river Elbe*

Table 1 shows selected substances, the number of investigated sites in Saxony in the Elbe river basin, as well as the range of AA concentrations investigated between 2016 and 2020.

To compare the measured values, for example the AA quality standards (QS) found in the ETOX database (https://webetox.uba.de/webETOX/) were used. The most exceedances of AA-QS were detected for Diclofenac (AA-QS 50 ng/l). A large concentration range was found comparing the monitoring sites. Among the pharmaceuticals, the single values of Erythromycin, Clarithromycin and Azithromycin were in at least 90 % of the samples below the limit of detection. Less than 1 % of the AA concentration showed an exceedance of the AA-QS for Erythromycin (AA-QS 40 ng/l) and Clarithromycin (AA-QS 120 ng/l).

Despite the low limit of detection of the analyzed hormones over 80 % of the single values for Estradiol (E2) were even below that. The predicted no effect concentrations (PNEC) of 35 pg/l [2] for 17-alpha-Ethinylestradiol was most often exceeded, although the limit of detection was above the PNEC until the end of 2019. On the other hand, Estron (E1) (PNEC 3600 pg/l [2]) was nearly never exceeded. Because of the analytical difficulties, it could be of advantage to use effect based monitoring for this group of substances. Only a low number of AA concentrations of the analyzed pesticides, especially for Imidacloprid, exceeded the updated PNEC [2]. The AA concentrations of 2-Ethylhexyl 4-methoxycinnamaten and Butyl-Hydroxytoluol are complied with the PNECs [2] at all measuring points.

***Tab. 1:** Analyses of selected substances in the investigation program in Saxony between 2016 and 2020*

substance name	CAS Nr.	unit	Limit of detection (LoD) in Saxony	Number of investigated monitoring sites	Number of investigated samples	Number of investigated samples below LoD	Minimum to maximum range of annual average	maximum single value
Pharmaceuticals								
Azithromycin	83905-01-5	ng/l	25	546	4777	4561	<25–513	1500
Ciprofloxacin	85721-33-1	ng/l	20	546	4777	4691	<20–165	630
Clarithromycin	81103-11-9	ng/l	6	546	4777	3569	<6–150	420
Diclofenac	15307-86-5	ng/l	10	544	4616	1017	<10–4183	7000
Erythromycin	114-07-8	ng/l	6	546	4777	4294	<6–115	330
Hormones								
Estradiol (E2)	50-28-2	pg/l	200/100	31	376	315	<100–2255	6300
Estron (E1)	53-16-7	pg/l	100/50	31	375	18	128–3645	8300
Ethinylestradiol	57-63-6	pg/l	50/25	31	376	149	<25–1000	1200
Pestizids								
Oxadiazon	19666-30-9	ng/l	5	574	5344	5340	<5	9
Triallat	2303-17-5	ng/l	5	574	5343	5343	<5	<5
Acetamiprid	135410-20-7	ng/l	10/9	540	4427	4419	<9–17,5	65
Clothianidin	210880-92-5	ng/l	5	540	4427	4339	<5–15	53
Imidaclorpid	138261-41-3	ng/l	5	515	4002	3640	<5–112	390
Methiocarb	2032-65-7	ng/l	10/2	540	4427	4423	<2–2,1	34
Thiachlopid	111988-49-9	ng/l	9	540	4427	4399	<9–478	1900
Thiamethoxam	153719-23-4	ng/l	5	540	4427	4375	<5–16	62
Chemicals								
2-Ethylhexyl 4-methoxycinnamate	5466-77-3	ng/l	25	574	5344	5303	<25–114	420
Butyl-Hydroxytoluol	128-37-0	ng/l	10	574	5344	5111	<10–90,5	330

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Water balance and hydrochemistry of a mine waste dump landscape at Schlema-Alberoda site (Wismut)

Annia Greif, Andrea Schramm

1. Introduction

The rehabilitation of uranium ore mining legacies in East Germany has been taking place for more than 30 years. The physical remediation work on mines, waste rock dumps (WRDs), tailings ponds, operating areas and ore-processing sites by the Wismut GmbH is now largely completed. Meanwhile, some of the remediated objects entered the aftercare phase while monitoring for proofing success of remediation measures continues. In addition, the treatment of mine decant and seepage water from waste rock dumps will remain a long-term task. The remediation site Schlema-Alberoda is characterised by a high density of WRDs deposited in vicinity to settlements. In total, 20 dumps of the former SDAG Wismut containing about 44 million m^3, were remediated as part of the remediation program of the Wismut GmbH. Most of the dumps consist of coarse waste rock material. The site also includes a tailings pond at Borbachtal (Fig.1). The general aim of remediation is to ensure safe long-term storage of mining residues by minimizing possible impacts on the environment through air- and water-related pathways. To this end, most dumps have been left at their respective location and covered with a two-layer system consisting of 0.8 m of mineral subsoil and 0.2 m of humous topsoil. In addition, a drainage system was constructed for capturing surface and seepage water.

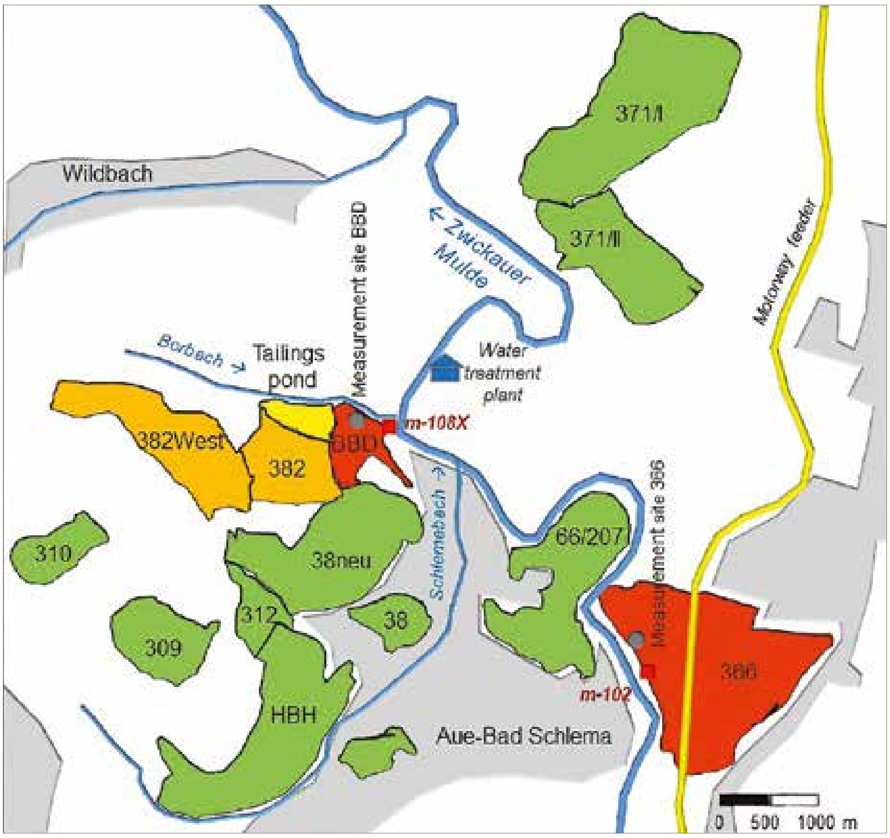

Fig.1: *Site overview of waste rock dump landscape at Schlema-Alberoda site: WRD 366 and Borbachdamm (BBD) red, WRDs along valley Borbachtal orange, tailings pond yellow, seepage water measuring points red*

Parallel to the physical remediation work, since 1999 field measurements have been conducted to quantify the effect of remediation on the water balance and the dynamics of water storage in soil. This includes in-situ measurements with soil probes and lysimeters helping to describe the system soil-plant-atmosphere in detail. Measurement results of two representative dumps covered with different vegetation (grassland, trees/shrubs) are used to calibrate a water balance model.

Interfered by meteorological conditions, the interaction between infiltrating water and waste rock material is reflected in the recharge rate as well as in the chemical composition of seepage water of dumps and affected groundwater. Main contaminants are arsenic and uranium accompanied by other trace elements like nickel, copper and selenium as well as sulphate. The results of the long-term observation at the Schlema-Alberoda site indicate two different scenarios:

a) decreasing concentrations of contaminants with increasing flow rates of seepage and
b) increasing concentrations of contaminants with increasing flow rates of seepage (that´s the exception).

The contaminated seepage water of the different dump objects reaches either the receiving waters directly or it is injected in a controlled manner into the mine and treated in the water treatment plant (WTP) Schlema-Alberoda.

2. Site characteristics and monitoring concept

The case examples are the two WRDs Borbachdamm (BBD) and 366. Both are located near the town of Aue-Bad Schlema (Fig.1, Tab. 1). The remediation of the dump objects lasted from 1996 to 2008. The design of the cover system (thickness 1 m) was optimised by considering site-specific boundary conditions and remediation objectives. The primary objective of the cover system was the reduction of radon emission. Secondary, cover and vegetation should increase evapotranspiration (ETR) as the main component of water balance. Minor aims were the control of cover percolation and thus oxygen ingress.

***Tab. 1:** Characteristics of WRD objects at Schlema-Alberoda site*

	WRD Borbachdamm	WRD 366
Volume	1.2 million m³	7.5 million m³
Footprint	6 ha	43 ha
Cover Completion	1999/2000	2004
Period of water balance measurements	1999 – 2020	2004 – 2020
Bordering remediation objects	WRD 382 and tailings pond	-
Seepage water measuring points	m-108X since 1997	m-102 since 2004
Emission-Immission	Borbach → Zwickauer Mulde (ZM)	<9 m³/h: into the mine → WTP → ZM >9 m³/h: Eisenbrückenbach → ZM

With a view to damming the valley location for the storage of uranium ore processing residues during the active mine period, the WRD Borbachdamm was piled up by a very steep slope. During remediation this steep slope was flattened to 40 %. The mineral soil (0.8 m) consists of sandy-loamy silt. The overlying 0.2 m thick organic vegetation layer consists of a substrate produced by the composting of residual organic materials.
Conical in shape, the prominent landscape feature of WRD 366 is one of the largest dump objects at the Schlema-Alberoda site. Design of the cover is similar to that placed on the WRD Borbachdamm. Both WRDs were seeded with grass after cover completion. Today a lush vegetation of trees, shrubs and grass has established on both dumps. Immediately after remediation work, different types of soil probes were installed at depths of 0.4 m and 0.8 m within the mineral soil to investigate soil water dynamics. Complementary to the soil probes, various lysimeters are operated in immediate vicinity to monitor cover percolation. Flow rates are determined by regular volumetric metering of collection vessels. The lysimeter construction permits quantification of lateral flow (RH) within the cover as well as the cover percolation rate (RU). Additionally water balance models were established for each measurement site using time series of local meteorological data. The Swedish model "Coup Model" [1] was calibrated on the basis of depth-related soil probe data and finally the model based water balance was checked against flow measurements by lysimeters.

As part of the remediation a drainage system was built at the bottom of each dump. The seepage water measuring points m-102 and m-108X as well as selected (groundwater) observation wells are monitored regularly as part of the environmental monitoring program.

3. Water balance

The establishment of a complete annual water balance of both measurement sites is the final result of the hydrological monitoring. By now the measurement results of 16 and 21 years, respectively, provide a detailed description of time and vegetation dependent changes within the water balance. At the measurement site Borbachdamm the total flow (RH+RU) amounts to 42 % of annual mean precipitation, ascertained by lysimeter (2001 – 2019). At the measurement site at WRD 366 the average value of percolation, measured by slope lysimeters amounts to about 30 % of precipitation (2004 – 2019). The annual model-based water balance was established to quantify actual ETR and to compare measured percolation data with model results. Fig. 2 illustrates the changes of water balance as a function of vegetation development.

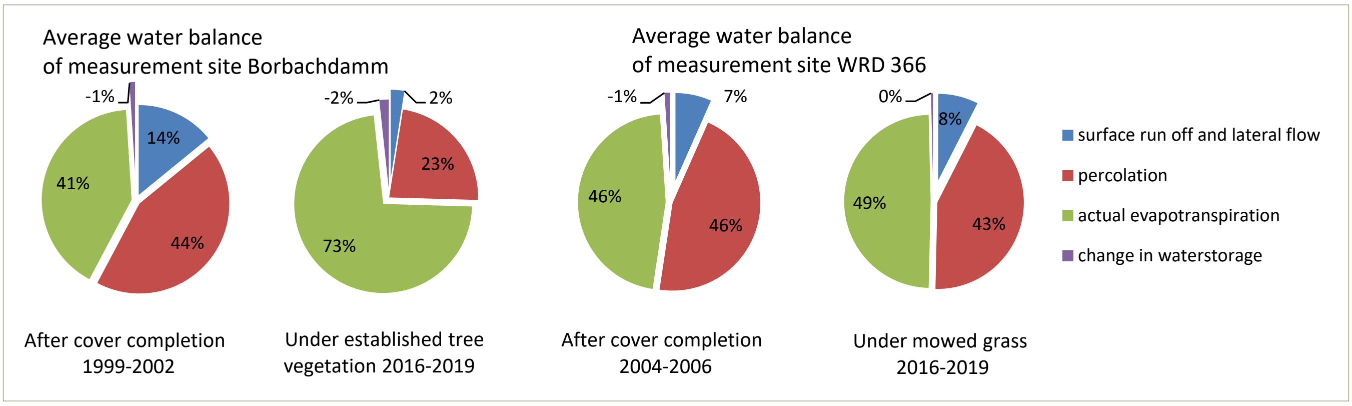

Fig. 2: Changes of water balance as a function of vegetation development

After cover completion with a bare dump surface initially a grass-herbs-vegetation developed. During the first years this led to an increase of water consumption. Later trees established by natural succession or were planted. With plant and root growth an increase of water consumption was detected. Finally the roots extended to the whole thickness of the mineral soil for using the stored water. However, the evapotranspiration of a frequently mowed grass cover without trees is limited (Fig. 2). Regional grass reference evapotranspiration (ET0), is in the order of about 550 mm/a. It takes about five to six years following completion of cover placement and initial vegetation to reach this evaporation performance. With the advanced development of trees, real ETR amounts up to 135 % of ET0. Consequently, vegetation verifiably performs its function of reducing percolation rates. With the development of trees the percolation decreased from about 500 mm/year to a value of about 250 mm/year. Due to the lower ETR under regularly mowed grass the percolation of such plots is higher (about 350 to 400 mm/year). The development of water balance is reflected in the decreasing trend of seepage discharge quantity of both dump objects (Fig. 3).

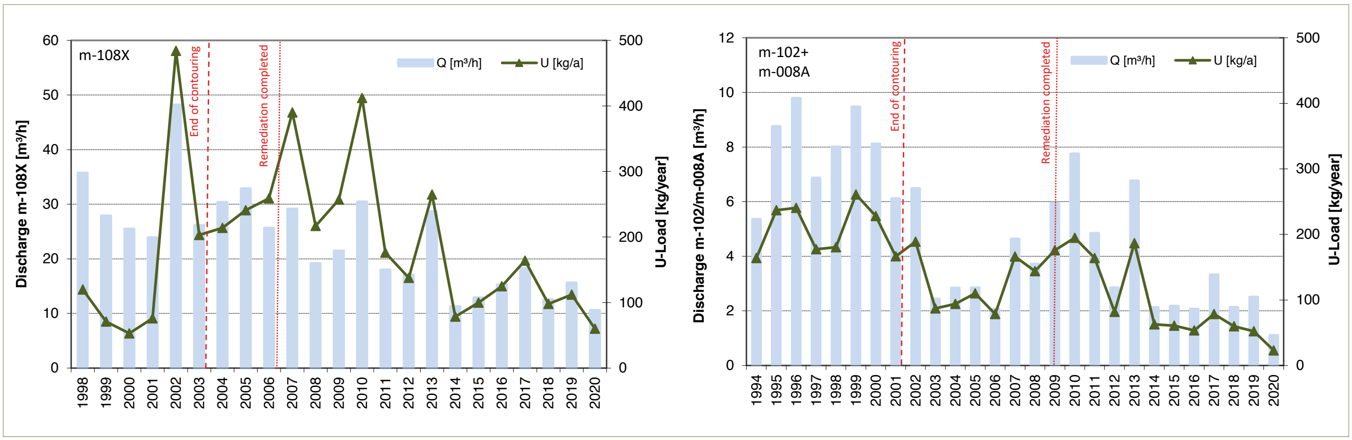

Fig. 3: Discharge quantity and uranium load of central discharge points

4. Hydrochemistry

The remediation of the dumps often results in a temporary increase of contaminant concentrations in seepage water particularly during contouring. After remediation, these contents decrease principally. This decrease of main contaminant concentrations (uranium, arsenic) applies to both sites (at BBD since 2011, at 366 since 2006), although this trend has slowed in the aftercare period and is currently stagnating. However, a wide variation in the concentrations complicates statements on the trend development additionally (Fig. 4 left).

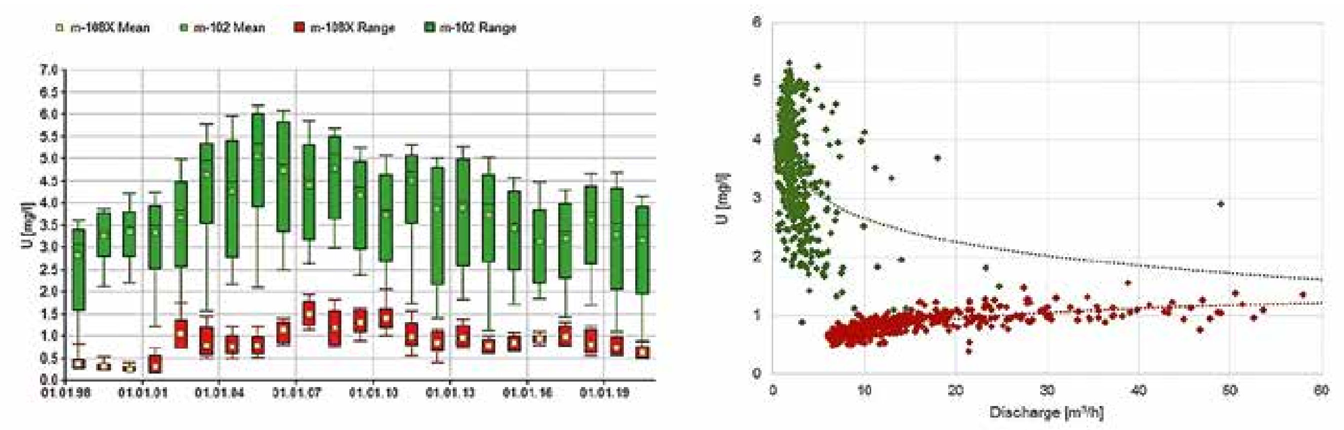

Fig. 4: *Range of the annual uranium concentrations (left) and relation between discharge and uranium concentration 2011 – 2020 (right) in the seepage water of central discharge points m-108X (BBD) and m-102 (366)*

At the WRDs usually exist a negative correlation between the seepage water discharge and the element concentrations (Fig. 4 right) like case WRD 366. The WRD 366 has a limited catchment area. The WRD Borbachdamm on the contrary is a part of several remediation objects along the Borbach valley (Fig. 1 orange and yellow areas) and particularly influenced by the release processes within the tailings pond. As a result, here the concentrations increase with increasing seepage water discharge.

While primarily governed by the remediation progress it also appears that both, water balance and release of contaminants, are significantly impacted by special meteorological situations with low water discharges prevailing since summer 2013 (Fig. 3). However, in general, a decreasing trend of discharged pollutant loads has been observed after the finish of remediation.

5. Relevance of the emission for the Schlema-Alberoda site

Compared with the total emission at the Schlema-Alberoda site, the two discussed discharges are only of minor importance. In the low-flow period from 2014 to 2020 the amount of water at both discharge points reached a maximum of 1 % of the total amount of contaminated mining water reaching the river system. The uranium load at the discharge point m-108X makes up 9 % of the real emissions at the site, at the discharge point m-102 the proportion is < 1 % due to predominant injection into the mine (Tab. 1). The main part of emission at the Schlema-Alberoda site comes from the treated flooding water of the uranium mine.

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Fachbeiträge **Odborné příspěvky**

Magdeburger Gewässerschutzseminar 2021
Magdeburský seminář o ochraně vod 2021

Einfluss von Braunkohlebergbau auf die Oberflächengewässer
Vliv těžby hnědého uhlí na povrchové vody

Ochre pollution of watercourses in the Lusatian lignite mining area: Causes, extent and solutions.

Wilfried Uhlmann, Sven Radigk

1. Introduction

The groundwater recovery in the remediation areas in the Lusatian lignite mining district is accompanied by a mining-induced iron input from the groundwater into the watercourses. This leads to a massive ochre pollution and possibly acidification. The ochre pollution impairs the ecology and the usage of the watercourses. The effects of ochre pollution on the Spremberg reservoir and on the southern polder of the wetland Spreewald, which had triggered an enormous media response a decade ago, were particularly spectacular.

2. Causes

In [1] and [2], seven sources of acidification and ochre pollution of watercourses in Lusatia were identified (Fig. 1). The ochre pollution of watercourses and agricultural drainage systems was already known to be typical of Lusatia outside lignite mining (1). The cause is the near-surface drainage and aeration of hydromorphic, organogenic, anaerobic and pyrite-containing soils. In addition to the post-mining lakes (5), the large-scale inner dumps (3) and outer dumps (4) of the opencast mines remain as eternal witnesses of lignite mining. The aeration of the geological strata during opencast mining is the operational cause of pyrite weathering and iron mobilisation. Originally, the idea was that in the future a discharge of contaminants from the inner dumps and outer dumps of the opencast lignite mines via the groundwater pathway into the watercourses was to be expected. In the inner and outer dumps, pyrite-rich tertiary sediments have been deposited. Due to the distance to the watercourses, there would have been sufficient warning time and scope for action. One of the surprising findings of the ochre pollution of streams in Lusatia at the end of the 2000s is that significant iron loads are mobilised from Pleistocene aquifers (2) and from Holocene marshes (6), which were affected by the lowering of groundwater levels outside the opencast mines. In the unaerated peat horizon, the marshes sometimes contained higher pyrite contents than the Tertiary overburden sediments of the lignite seam. Iron input started almost spontaneously with the groundwater connection to the watercourses on the last metre of ascent.

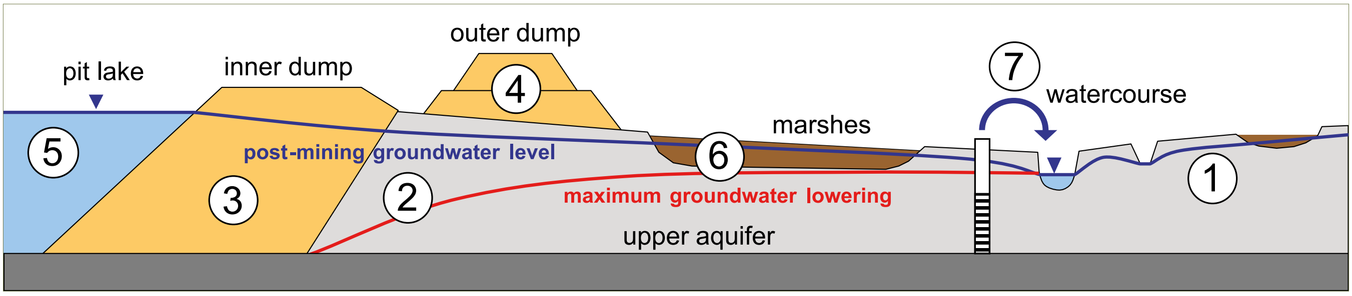
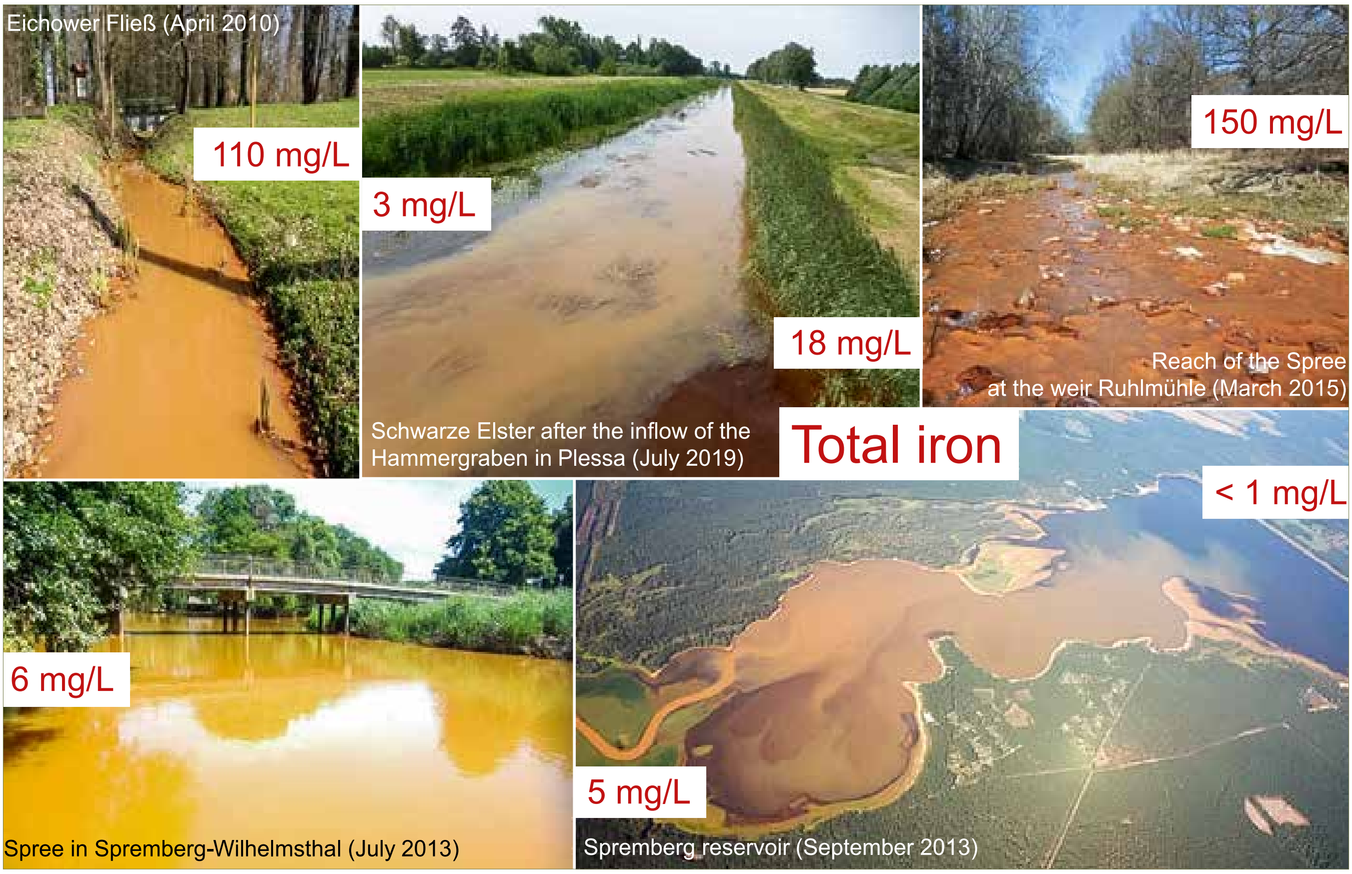


Fig. 1: Sources of ochre pollution in Lusatia mining district [2]

In the course of juvenile genesis, predominantly acidic and iron-rich mining lakes are formed in Lusatia (5), which could be considered iron sources if connected to the watercourses. This danger is averted by external flooding and inlake neutralisation. The discharge from the post-mining lakes is no longer a relevant source of iron in the LMBV's remediation areas. The support of the local water balance from wells (7), which is required by mining law, has become largely dispensable in the course of the groundwater recovery in the LMBV's rehabilitation mining area. With a few exceptions, they are no longer relevant as a source of acidification and ochre pollution of watercourses. In the area of the extraction mining industry, the supporting water discharges are being retrofitted with water treatment plants.

3. Extent

The iron enters the watercourses with an anoxic groundwater basically only as dissolved divalent iron. In this form, it is almost invisible even in high concentrations. The divalent iron oxidizes in the watercourse to trivalent iron and hydrolyzes by reacting with water to iron(III)hydroxide. In the unfavourable case, the hydrolysis leads to acidification. The iron hydroxide is visible by a strong turbidity and by an ocher-brown coloration (Fig. 2) and settles as sludge in the water body. The kinetic oxidation reaction of the iron depends on the environmental conditions such as water temperature and pH. Due to the specific reaction process, the iron load can lead to very different hydrochemical phenomena in the watercourses (Fig. 2). The iron load in watercourses ranges up to 150 mg/L. Depending on the type of water body, the Surface Water Protection Ordinance provides threshold values for iron of 0.7 or 1.8 mg/L as an annual average.



Eichower Fließ (April 2010)

Schwarze Elster after the inflow of the Hammergraben in Plessa (July 2019)

Reach of the Spree at the weir Ruhlmühle (March 2015)

Spree in Spremberg-Wilhelmsthal (July 2013)

Spremberg reservoir (September 2013)

Fig. 2: *Concentrations and habitus of iron-loaded watercourses in the Lusatian lignite mining area.*

In the Lusatian lignite mining area, three areas are distinguished with striking iron pollution of the watercourses and with a different cause-effect structure:

(1) The southern remediation area is affected by diffuse iron inputs from the Pleistocene Spreewitz Channel – a glacial geological structure with pyrite-bearing and well permeable sands. The iron input occurs over 8 respectively 4 kilometers long sections into the rivers Spree and Kleine Spree (Fig. 3). The iron is transported in the Spree to the Bühlow pre-reservoir and the Spremberg reservoir. By then, the iron is completely oxidized and naturally separated due to the low flow velocity and the long residence time.

(2) From the northern remediation area iron is carried into the southern polder of the Spreewald from 2nd order watercourses, e. g. the Greifenhainer Fließ. The iron largely originates from numerous marshes that have been rewetted after groundwater recovery.

(3) Iron is discharged from the Lauchhammer remediation areas into the Schwarze Elster via the watercourse Hammergraben. The iron load originates mainly from the inner dumps and the open pit lakes of numerous, partly very old open pit lignite mines.

As of 2020, more than 200 kilometers of 1st and 2nd order watercourses and a total of more than 480 kilometers of watercourses in the three remediation subareas of the Lusatian lignite mining region are evidently affected by ochre pollution. This is unique in Germany.

4. Solutions

According to current knowledge, ochre pollution of watercourses is expected to last for a very long time. The responsibility of the LMBV, the technical stakeholders and the approval authorities is to plan, implement and operate low-maintenance, energy- and raw material-efficient measures to avert iron pollution. Because of the unique nature of ochre pollution, new solutions must be found to address it. This primarily concerns treatment of the iron sources. In the course of the legally agreed coal phase-out in Germany, the extraction mining industry is faced with comparable challenges.

After the responsibility of the LMBV for this specific type of mining consequences was legally established in 2013, the LMBV is planning and implementing numerous measures to mitigate iron pollution of the watercourses. The concepts differ in the focus areas of ochre pollution depending on the local constellation of iron inputs and loads, [3] and [4]:

(1) A phased plan was developed for the southern remediation area [3] (Fig. 3, left). It initially provided for the safe retention of iron in the Spremberg reservoir by means of adapted management and the prevention of its further transport into the Spreewald. In a second step, temporary water treatment was put into operation at the Bühlow pre-reservoir in 2014, including liming, flocculation and systematic desludging (Fig. 3, left). This has improved the condition of the Spremberg reservoir. The above measures will provide the necessary time for the planning and implementation of a permanent solution. This involves the interception of the iron-contaminated groundwater close to the river Spree and Kleine Spree by means of wells, infiltration trenches and/or ditches. The captured groundwater is fed to a central water treatment plant, where it is treated and discharged back into the Spree (Fig. 3, right). Modular container-based water treatment plants (MWBA) were installed at iron loading hotspots from 2018 to 2020 as an interim solution to provide timely relief to the rivers Spree and Kleine Spree. In the future, as a particularly sustainable solution, a sealing wall on the northern bank of the Lohsa reservoir will mitigate the source strength of the iron load [3], [6].

(2) Due to the immediate threat of ochre pollution to the biosphere reserve and the tourist attraction Spreewald, in a short time end-of-pipe solutions in the form of natural or hybrid water treatment plants on the iron-polluted second-order watercourses were put into operation in the northern remediation area [3]. In the medium term, the end-of-pipe solutions are to be replaced by source treatments in the catchment areas [6].

(3) To protect the Schwarze Elster from ochre pollution and acidification, an end-of-pipe solution at Hammergraben is favored. The Plessa water treatment plant is under construction and is scheduled to start regular operation in 2023. The end-of-pipe solution implies that iron contamination of the watercourse in the Hammergraben catchment area, which is heavily disturbed by mining, will be maintained for a long time. Source treatment in the Lauchhammer remediation area was considered disproportionate [6].

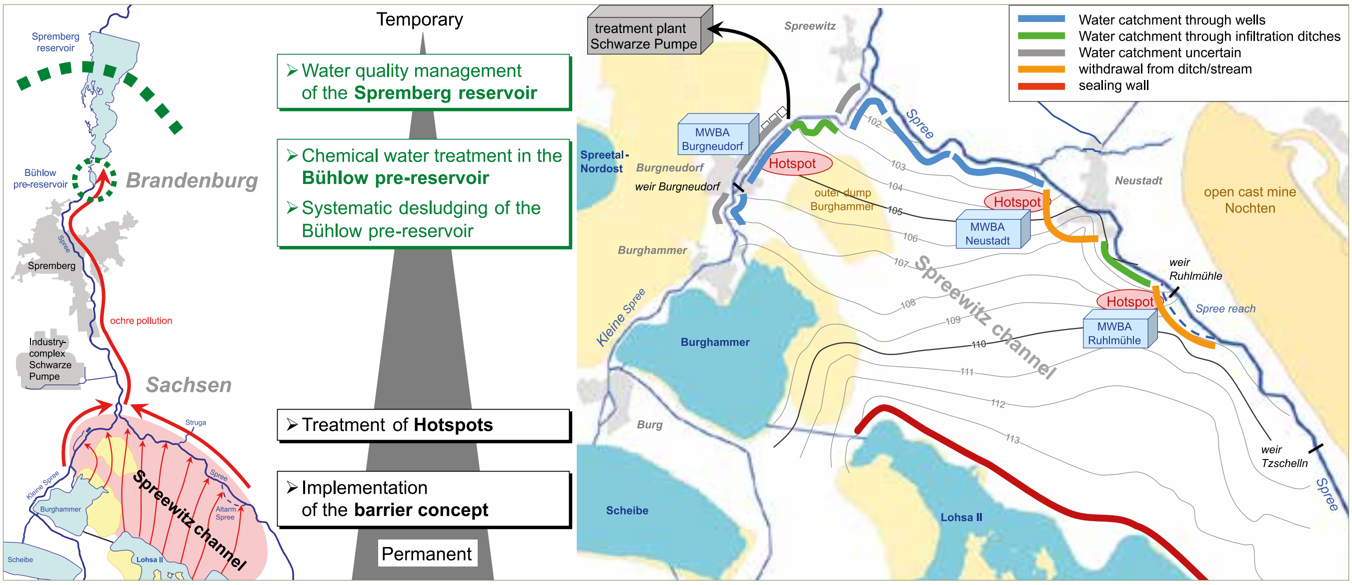


Fig. 3: Concept for the mitigation of iron pollution in the southern remediation area of the LMBV [2], [4], [5].

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Flooding lignite surface mines after the end of their operation – the experience and future

Václav Svejkovský

There are four lignite surface mines in the Ústí nad Labem region – ČSA, Vršany, Libouš and Bílina. Their operation will be terminated within several decades. According to the summarizing rehabilitation and reclamation plans, the so-called hydric reclamation, i.e. flooding the deepest residual pits of these mines is to be carried out. Therefore, four new lakes are to be created in the Chomutov and Most regions – see Fig. 1. According to the summarizing rehabilitation and reclamation plans, these parameters are to be sustainable without the need of pumping water, i.e. without large permanent costs to maintain levels in the future lakes.

Fig. 1: *Map with the future lakes*

Since 2010, the Chabařovice and Most residual post-mining pits have been flooded in the Ústí nad Labem region, thus creating two lakes – Milada and Most. Most Lake has no permanent inflow from a watercourse. Also this lake was supposed to have no need of water pumping after completing the hydric reclamation. Nonetheless, the reality shows that at present, Most Lake is not able to exist without water pumping. Every year, water from the Ohře River must be fed in the amount of approximately 1 million m^3. Without the pumping, water in the lake would permanently drop. It became evident that contrary to the expectations, the surface evaporation is larger and the water inflows from the lake basin are lower than expected.

Water management experts pointed out this fact when dealing with the potential administration and use of the future lakes. Therefore, by Regulation No. 421 of 17 June 2019 [1], the Government of the Czech Republic ordered the Minister of Agriculture in collaboration with the Trade and Industry Minister to process a complete update of the water management balances in 2020 regarding the completed and scheduled hydric reclamations of residual post-mining pits and to assess feasibility of interconnecting the water management system of already completed and scheduled hydric reclamations of residual pits after complete termination of lignite mining in the Ústí nad Labem region. Based on the results, the Trade and Industry Ministry in collaboration with the Ministry of Agriculture and Ministry of the Environment was to process a proposal of a technically most effective method of the future operation and administration of flooding residual post-mining pits in the Ústí nad Labem region. These tasks were to find a sustainable concept of flooding the residual pits with water and propose a method of the future lake administration.

The Povodí Ohře national enterprise was entrusted with ensuring tasks relating to the residual pit water management balance and a feasibility assessment of the flooded residual pit water management. It provided a Study of a Comprehensive Water Management Residual Pit Flooding Balance after complete termination of lignite mining in the Ústí nad Labem region – Stage Report No. 1 [2] and a Study of a Complete Water Management Residual Pit Flooding Balance after complete termination of lignite mining in the Ústí nad Labem region – Stage Report No. 2 [3]. The studies were produced by the Faculty of Civil Engineering of the Czech Technical University in Prague. Both studies were based on assessment of hydrological quantities that affect the first flooding and the subsequent operation of the flooded residual pits. They also assessed the impacts of the mean climatic change scenario on the hydrological quantities and the need of water for its strategic users in the course of the flooding and the subsequent operation of the lakes. The results were discussed within an interdepartmental group consisting of the Ministry of Agriculture and the Trade and Industry Ministry representatives.

The Stage Report No. 1 [2] was concerned with filling each of the residual pits with water and its operation separately. It was proved that the future lakes cannot be operated without the use of water from the neighbouring watercourses. The impact of a climatic change on the lake operation is significant. The use of the Ohře River was considered for the initial residual pit filling. This water source proved to be sufficient. When flooding the residual pits, the needs of the other water users would be provided.

The stage No. 2 [3] assessed interconnection of the future lakes into a water management system. It assessed 4 options agreed in the working group. The assessment used data on hydroecological water inflow from the residual pits' own basins. The data came from an Analysis and Assessment of Interconnected Water Management Options of the completed hydric reclamations (*Vodohospodářský rozvoj a výstavba*, 2020). The Stage Report No. 2 arrived at the following findings:

Libouš Lake cannot be operated as a lake on the Hutná stream. The optimum option is its interconnection with the Nechranice na Ohři Dam, which will improve flows in the Ohře River by 24 %. The lake level would fluctuate depending on the Nechranice reservoir level.

ČSA Lake – with regard to the slope instability, the lake cannot be operated with level on the altitudes of 230 – 233 MASL. The lake is sustainable with level on the altitude of 180 MASL. There will be no water outflow provided. On the contrary, it will provide the other water sources with its needs.

Vršany Lake – a sustainable operating level has not been found within the researched options. The location cannot be operated as a lake. It has been recommended to preserve the location.

Bílina Lake – level on the altitude of 200 MASL is sustainable. The lake storage volume of 21.88 million m^3 has been found.

Most Lake has currently no sustainable level without the need of water pumping. Interconnection of Bílina Lake and Most Lake would ensure a sustainable level in Most Lake on the altitude of 199 MASL.

Stage Report No. 2 [3] pointed out risks connected with the use of water from the Bílina River for the flooding. Water feed from the Bílina River would significantly limit flows downstream the Bílina where only a minimal residual flow would run when flooding the residual pits. This fact may also negatively affect water quality downstream the Bílina. These risk must be considered.

The following analyses and studies were made in 2020 outside the scope of tasks assigned by the Government of the Czech Republic in addition to both Stage Reports:

- Technical and economic study of new pumped-storage power plants (PVE) in areas of present and past lignite mines (Energotis, 04/2020),
- Analysis and assessment of options for an interconnected water management system in completed hydric reclamations (VRV, 05/2020),
- Analysis of a feasibility assessment of solar power park construction in the scheduled hydric reclamations and in the reclaimed areas (Deloitte Advisory/VRV/ENACO, 05/2020),
- The use of spontaneous succession as an effective tool of the ČSA mine ecological renewal (AOPK ČR/ČZU, 12/2020).

Based on an assignment from a Cabinet Resolution, the Trade and Industry Ministry in collaboration with the Ministry of Agriculture with application of the above-mentioned water management and other materials made a Report on Outputs from Processed Analyses assessing feasibility of an interconnected water management system of completed and scheduled hydric reclamations and its power potential in the Ústí nad Labem region [5]. This report comments on water management risks connected in particular with the minimum residual flow in the Bílina River and water quality in this watercourse. Moreover, the impacts of level fluctuations in the future lakes on the summarizing plans of rehabilitations and reclamations and thus the economy of the reclamations have not be assessed so far. Because of these and other facts, the government assigned tasks to the Minister of Agriculture, the Trade and Industry Minister and the Minister of the Environment by the Cabinet Resolution No. 344 of 6 April 2021 [4] that will lead to a decision on the future form of the residual pits and thus the form of the future landscape in an important part of north-west Bohemia.

These tasks include processing of the following water management studies:

- assessment of the impacts of feeding and operating the residual pits on the Bílina River – issues connected with wastewater treatment in the entire Bílina basin with a proposal of improving the water quality, water quality assessment in the future lakes considering the feeding and operating and the minimum residual flow downstream the Bílina River with regard to the condition of the water bodies
- verification of the water management concept in the ČSA and Vršany residual pits – finding an option of a sustainable water level without the need to pump water for operation of the flooded residual pits including potential application of spontaneous succession,
- technical and economic study of interconnecting Libouš Lake with the Nechranice Dam including the lake bypass.

These water management studies should confirm interconnectivity of the future Libouš Lake with the Nechranice na Ohří Dam and clarify proposal of the water levels in the future lakes with regard to the impact on the long-lasting important water consumers downstream the Bílina River when considering climatic changes and needs of water for other users.

The water management assessment is fundamental for the future potential flooding of the residual pits and thus the method of their reclaiming. Nonetheless, based on the Cabinet Resolution No. 344 [4], the option of power production and potentialities of spontaneous restoration of the location will be assessed. The impact of the water management concept on the summarizing plans of rehabilitations and reclamations including the impact on the financial demands of these plans and enumeration of the impacts on the national budget will also be assessed. Potentialities of the reclamation and power-production funding will be verified.

All of these activities will be carried out by June 2022. Based on these materials, the options will be verified according to the selected criteria in the second half of 2022. The criteria will include a water management balance, technical feasibility, financial demands, geotechnical aspect (slope stability in the Ore Mountains, landslide areas, abrasion, water level fluctuation in power-production – pumped-storage power plant), urbanism, the environment, property settlement, social aspects (development of the region, recreation) and other benefits of the project (hyrotechnical and solar power plants). Subsequently, the government should make a decision on the residual pit flooding option, i.e. the overall approach to the surface post-mining residual pit reclamation in the Ústí nad Labem region.

Literature:

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[3] Study on the complex water management balance of the residual pit flooding after complete termination of lignite mining in the Ústí nad Labem region – Stage Report No. 2 (ČVUT, 11/2020)

[4] Cabinet Resolution No. 344 of 6 April 2021

[5] Report on outputs from processed analyses assessing feasibility of an interconnected water management system in completed and scheduled hydric reclamations and their power-producing potentials in the Ústí nad Labem region

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Restoration of the Spree River near Cottbus – a symbiosis of water management, mining and nature conservation

Christoph Gerstgraser

1. Inducement

In the federal state of Brandenburg, on the outskirts of the city of Cottbus, lignite was mined in the opencast mine "Cottbus-Nord" until the end of 2015. The pond group "Lakoma", which consisted of 22 ponds, was located within the approved mining area. The ponds were used for carp-breeding, especially young fish. As a result of the pond farming, which has been practiced for centuries, a high level of biotope and biological diversity developed in and around the ponds. A total of 1320 species were found in the area and 68 protected biotopes were designated.

In December 2003, the Lakoma ponds with an area of 130 ha were reported as Flora-Fauna-Habitat-area (FFH) to the European Commission. Since the hermit beetle (*Osmoderma eremita*), a priority species, was potentially affected, the European Commission had to be included in the plan approval procedure at the end of 2004 [1].

In November 2006, the European Commission informed in writing that the compensation concept would preserve the overall coherence of the Natura 2000 network. With the closure of the Lakoma ponds, the complete elimination of an FFH-area was approved for the first time in Germany [2].

As the largest nature conservation compensation measure for the drainage of the FFH-protected pond system by the lignite mining north of Cottbus, the Spree and its floodplains were restored along 11 km and within an area of 400 ha. This represents the largest river renaturation project in Brandenburg.

2. Renaturation of the Spree flood plain

The Spree River is an important and sensitive aquatic lifeline connecting Berlin with Brandenburg. Like many other medium-scale rivers in Europe, the Spree catchment was subjected to transformations from a natural into a cultural landscape over the past centuries – with strong impact on the river itself.

Today, almost the entire river course of the Spree has been straightened and regulated. Riparian areas and forests were cut-off by dykes and drained, discharge is controlled by the outflow from barrages. Additional stress on the aquatic ecosystem is exerted by the lignite mining activities in Lusatia that affect large parts of the Spree. Here, the groundwater level is lowered to enable open mining and the pumped and chemically altered groundwater is discharged directly into the river network. Due to these severe pressures, biodiversity has been dramatically declined, which probably best shows in fish: Only two species cover 75 % of the fish population of the Spree.

Besides improvements in water management, the priority of the renaturation scheme was laid upon creating new areas for habitats and species according to the EU Habitat Directive. Implemented measures were:

- Re-establishment of longitudinal connectivity by modifications and reconstructions of rock ramps
- Structural improvements by installation of groynes, bifurcations and side-arms
- Reconnection of oxbows and relocation of the Spree main flow
- Lateral dyke relocations up to 3 km to create inundation areas and wetlands
- Increase in width to depth variance by widening the river banks above mean water level
- Initialization of site-specific riparian forests and bank vegetation
- Improvements in lateral connectivity between the river and its dyked hinterland by creating and connecting a 6 km long side arm
- Improvements in water balance by decommissioning existing drainage systems
- Forest conversions and creation of forested wetlands in the dyke hinterland
- Provision of habitats for amphibians in the dyke hinterland

The Spree is significantly upgraded through the creation of ecological continuity, combined with structural improvements through the installation of islands and dead wood, lateral dyke relocations and the creation of side arms.

The networking of the Spree with the dyke hinterland and the closure of existing drainage systems lead to a sustainable improvement in the water balance of the drained floodplain.

Fig. 1: *Measures to improve the structural diversity in the Spree. Left – Installation of wooden groynes, right – construction of a river island*

All farmland and intensively used grassland areas in the floodplain have been extensified. Large areas are grazed throughout the year with aurochs (Heck cattle) and water buffalo. Existing, non-native forest stands were converted and reforested with trees appropriate to the location. In addition, all forest areas within the renaturation area were provided for forestry use. The renaturation of the Spree and its floodplain benefits a large number of animal and plant species and promotes biodiversity in the region. The construction works were implemented between 2006 and 2015.

Fig. 2: *The dyke was relocated up to 3 km, 45 ha of new floodplain and a new water network were created*

Fig. 3: *Left – 2006 the Spreeaue before renaturation, right – 2008 after renaturation. (photos: LEAG)*

In addition to the renaturation of the Spreeaue, targeted measures for special species and habitat types according to the Habitats Directive had to be implemented. Among others, the Spreeauen ponds were created as a partial measure which consist of eight ponds with a water surface of 21 ha. In particular, the ponds serve to secure the Natura 2000 network for otters (Lutra lutra), fire-bellied toad (Bombina bombina) and habitat type 3130 and 3150 according to Habitats Directive Annex I.

Extensive landscaping measures were carried out to structure the pond system and to enhance the surrounding area. In the ponds, reed rhizomes and pond bottom from the impact area were placed in the ponds for rapid development of pond vegetation. Along the ponds groups of trees and bushes were planted and large areas of swamp forest and reed beds were created in the surrounding area. The ponds are managed with carp similar to the Lakoma ponds.

Amphibians of the affected area were also relocated to the Spreeauen ponds. For this purpose, amphibian larvae were caught in the Lakoma ponds in the summer of 2007 and 2008. From September 2007 to June 2010, old and young animals were relocated over several weeks in spring and autumn. A total of 180,000 larvae and animals, thereof 76,220 red-bellied toads (Bombina bombina), were caught in the Lakoma ponds [3]. Of these, almost 150,000 amphibians were moved into the Spreeauen ponds and over 30,000 amphibian larvae were handed over to the Brandenburg State Environment Agency for resettlement.

Fig. 4: *The Spreeauen ponds. Left – before construction: arable and grassland, right – the pond area six years after completion*

With the renaturation of the Spreeaue, a new, impressive landscape was created in a short time. Thus the renaturation of the Spreeaue is an important component in securing the Natura 2000 network. In addition, a large number of other animal and plant species benefit from the renaturation. The ecological networking in the region is enhanced and a place of quiet relaxation is created for the residents.

3. Monitoring

The control of the effect of the compensation measures was carried out by a complex monitoring program with the involvement of various experts. Up to 16 different, extensive reports were submitted to the authorities each year. The monitoring included studies of flora and fauna as well as abiotic factors. The success control extends over five years after completion of the individual compensation measures.

The monitoring confirmed that all compensation goals were achieved and that the Natura 2000 network was maintained. In addition, the data also show that for individual FFH-relevant species such as the fire-bellied toad (Bombina bombina) there has been a significant increase in populations as a result of the compensation measures. All in all, the existing monitoring data allow unique conclusions to be drawn about the effect and development of the renaturation of a floodplain [4].

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Posterpräsentationen

Posterová sdělení

Magdeburger Gewässerschutzseminar 2021

Magdeburský seminář o ochraně vod 2021

Magdeburger Gewässerschutzseminar
MGS
2021
Magdeburský seminář o ochraně vod

Impact of the river stone field on the composition of fauna and flora – biological monitoring of the experimental stone field on the lower part of the elbe

Eduard Bouše[1]*, Miroslav Barankiewicz[1], P. Vlašánek[1], Jirí Musil[1]

Abstract

The river stone fields are among the most common revitalization structure, mainly used for concetrating current in the flow. Furthemore, they increase the heterogeneity of the environment, the sheltering capacity of the stream, and the amount of the natural washed alluvial areas. The aim of this project is to assess the ecological benefits of individual types of river stone fields, to determine their impact on fauna and flora in their surroundings, and to compare them with the natural river beach.

Biological monitoring has been carried out since 2009 and includes monitoring of vegetation, malacofauna, ichtyofauna, entomofauna, and macrozoobenthos. In total, three types of river stone field were established. The first type is the **flow-through** stone field, which is most suitable for rheophilous fish species, and for the malacofauna. **Beach** types of stone fields are of similar character es the original river banks. They possess the highest diversity of plants, ripiculous species of beetles, and macrozoobenthos. Fish that are not so demanding in terms of flow velocity also show high diversity at these localities. The **lagoon** type of stone fields expresses higher species diversity, especially in fish older than 1+. In comparison with other stone fields, phytophilic fish species are more often fished there, and more hygrophilous plant species occur more frequently.

From the ecological point of view, natural river beaches are most similar to the beach type of river stone fields. Our results show that river stone fields have a positive effect on both abundance and species composition of fauna and flora. They properly extend the range of microhabitats and may partially replace the original gravel beaches, which had to give in the requirements of navigation.

Key words:
river stone field, natural river beach, ecological condition, ichtyofauna

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Periodic increase of microbial pollution in the Švihov drinking water reservoir

Jakub Dobiáš, Dana Baudišová, Karel Kolář

1. Summary

The Švihov water reservoir on the Želivka river is the largest source of drinking water in the Central Europe. Due to this importance, Vltava River Basin, state enterprise in the cooperation with the water treatment company provide intensive regular monitoring of the water quality [3]. Since autumn 2016 there has been an annual increase of bacterial pollution, which is detected with the standard methods as a coliform origin (ČSN EN ISO 9308-1, ČSN EN ISO 9308-2 a ČSN 75 7837). The increase starts usually in September – August and lasts 1 – 2 months (Fig. 1). The causes of annual occurrence may be associated with diurnal mixing (Fig. 2), end of the vegetation period of phytoplankton (Fig. 3) and macroscopic submerged vegetation [1,2,4,5,6,8,9] and less likely agriculture, hydrological conditions and waterfowl occurrence [7,8]. It will be further investigated.

Detailed analysis of the bacterial community by the MALDI-TOF method (matrix-assisted laser desorption/ionization) showed (Tab. 1), that commonly used methods differ one from the other in the selectivity and they might overestimate results of coliform bacteria pollution. Selected bacterial colonies were further identified by the MALDI-TOF method as bacteria of the genera Aeromonas, Plesiomonas and Enterobacter (lactose non-fermentative strain). These are not typical pathogenic fecal coliform bacteria strains. They are commonly found in the aquatic environment and they can multiply under appropriate conditions [1,2,4].

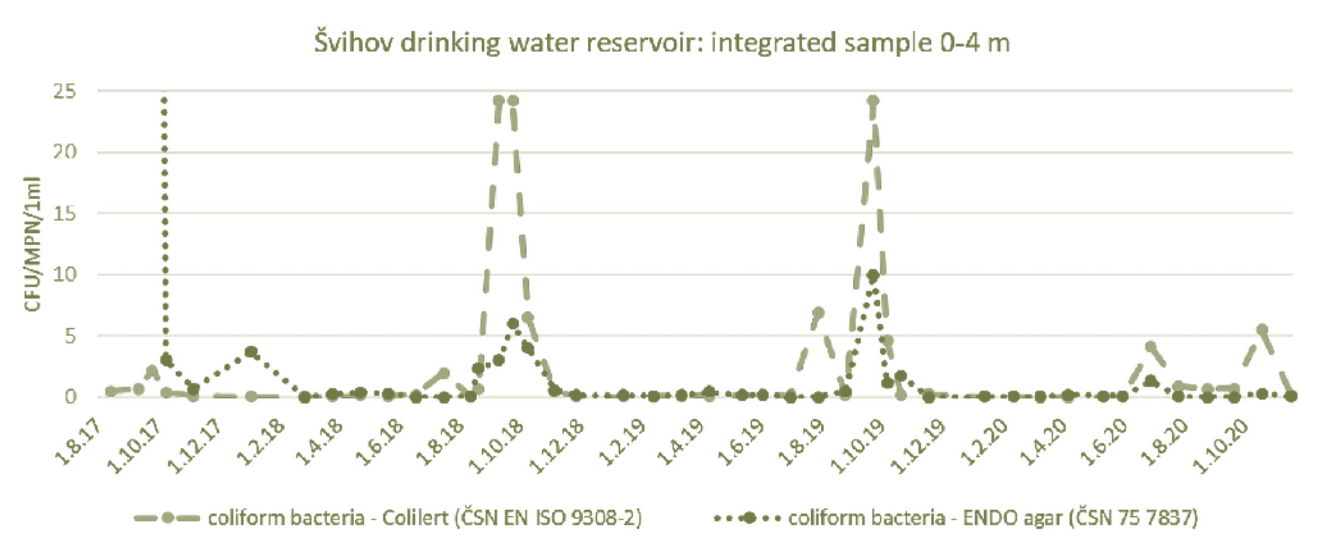

Fig. 1: *Coliform origin bacterial pollution detected by the current methods, dam location.*

Tab. 1: *MALDI Biotyper Classification Results.*

Organism (best match)	Score Value
Enterobacter bugandensis	2.18
Aeromonas veronii	2.25
Plesiomonas shigelloides	2.3
Enterobacter cloacae	1.82

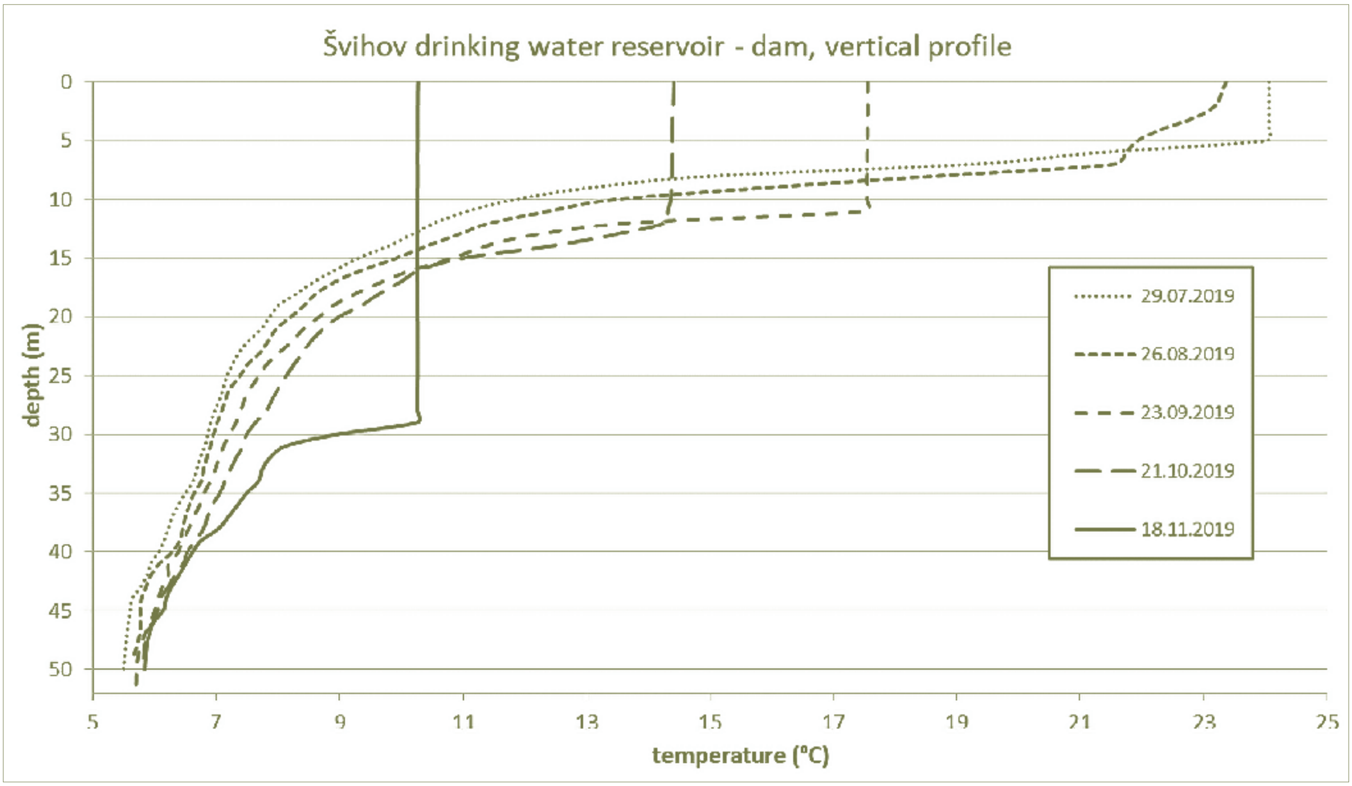

Fig. 2: *Temperature stratification development at the end of the vegetation season.*

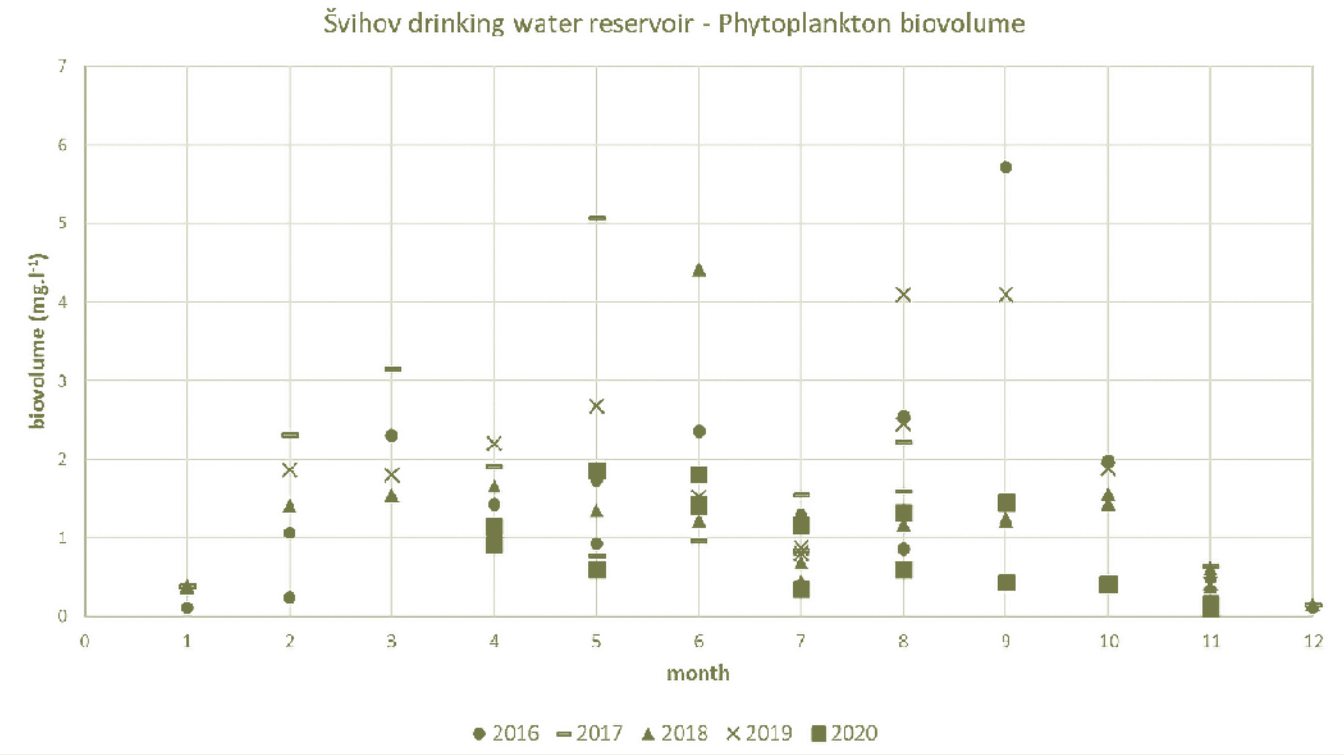

Fig. 3: *Phytoplankton biovolume development in years 2016–2020, dam location.*

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Short and Long-term trends of Selected Organic Micropollutants in the Czech Part of the Elbe river Basin

Martin Ferenčík

1. Intoduction

Variability of organic micropollutants' concentrations is a function of many various factors (seasonal application of pesticides, changes in the list of approved pesticides and illegal applications, pharmaceuticals' usage patterns, influence of rain precipitation and snow melting, extremes in hydrological conditions (droughts, floods), operation of wastewater treatment plants, industrial or traffic accidents, illegal waste water discharge, dumpsite leakage, etc.

Another decisive factors are sampling methods (spot water samples versus integral passive water samples, sediments versus monthly collected suspended matter samples), selection of sampling sites, random or purpose sampling time, sampling frequency, etc. Despite of these shortcomings operational monitoring based on monthly spot water sampling provides information on the occurrences and trends, but the interpretation must take into account above mentioned factors and phenomena.

2. Accidental and short-term micropollutants' Contamination Events

An example of a huge and rare accident caused by insecticides used in conventional agriculture is the event at Doubravka brook from March 2014 described in the article [1]. Discharge of high concentration pesticide mixture Dursban containing chlorpyrifos and cypermethrin (at a ratio of 10:1, respectively) caused death of over 10,000 individuals of the critically endangered noble crayfish Astacus astacus, macrozoobenthos, and fish (brown trout Salmo trutta and stone loach Barbatula barbatula) over 6 km downstream from the confluence of the brook with drainage channel from a local agricultural company. Extreme concentrations of chlorpyrifos in dried sediment samples up to 13 mg/kg were determined due to high sorption of insecticides to sediment containing organic carbon.

Besides these very rare poisonous accidents, there are much more frequently short-term (hours) high concentration pesticide events (immediate rainfall-runoff events) that happen after the pesticide application followed by rainfall

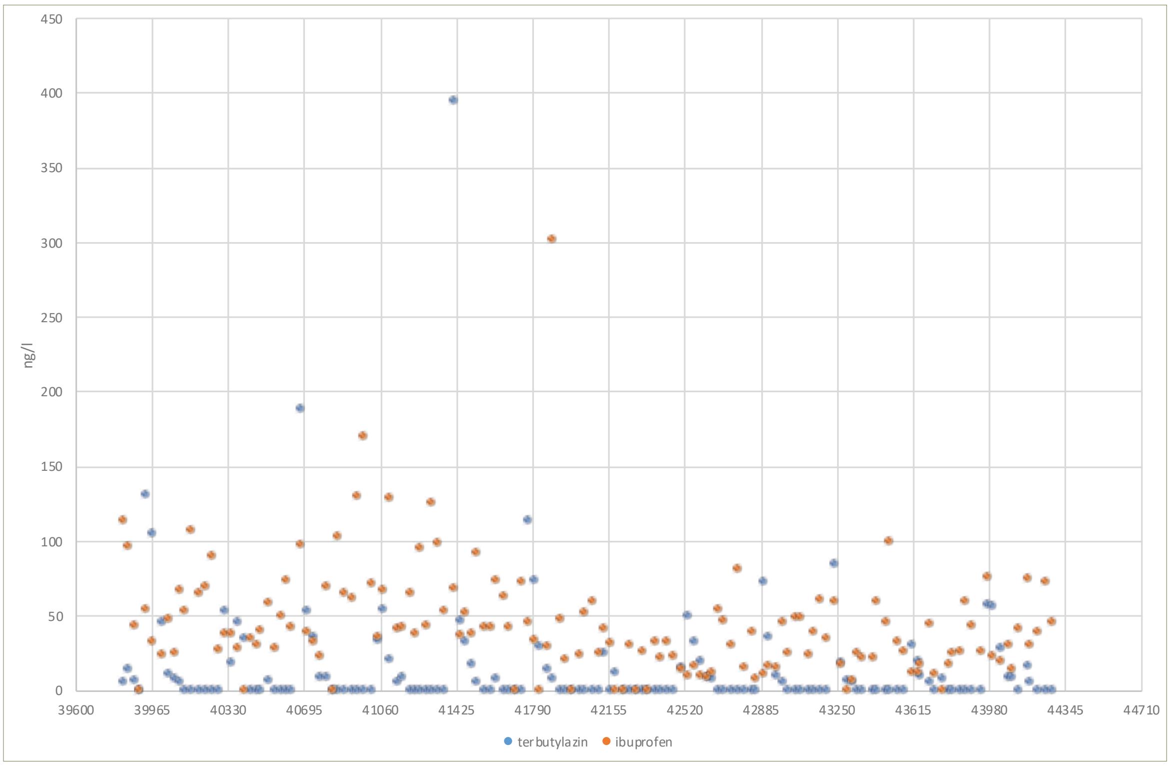

Fig. 1: *Metabolites of chloroacetanilide herbicides in raw water from drinking water reservoir Vrchlice*

precipitation. These high pesticide concentrations (micrograms per liter) are only rarely recorded by regular monitoring using spot monthly water samples, although they occur probably regularly.

There are also accidents caused by leakage of petroleum hydrocarbons and industrial chemicals (in traffic accidents, industrial accidents, flushing of retention reservoirs and waste-water treatment plants during severe storms, etc.).

3. Long-term trends in micropollutants' concentrations in surface waters

Long-term trends can be illustrated on the example of persistent metabolite of herbicide Alachlor (alachlor ESA), which usage was terminated in 2006, and compared with still used herbicide metolachlor (metabolite metolachlor ESA) on samples of raw water from drinking water reservoir Vrchlice (Figure 1) [2]. While concentrations of alachlor ESA are steadily decreasing, concentrations of metolachlor ESA are more or less stable.

Figure 2 illustrates differences in uccurrences of common pharmaceuticals (ibuprofen) and wide used herbicide terbuthylazine. While human pharmaceuticals are present throughout the year [3], terbuthylazine is used in spring on maize and is present usually in summer.

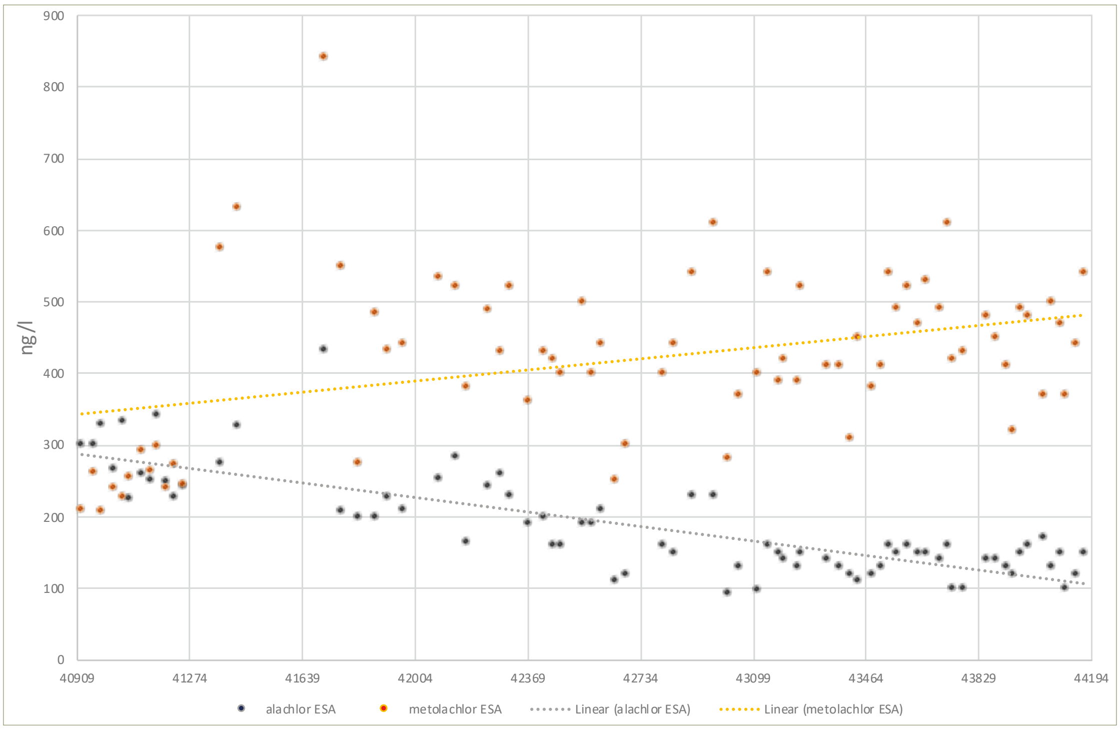

Fig. 2: *Occurrences of herbicide Terbuthylazine and human pharmaceutical Ibuprofen in Orlice River Nepasice*

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The influence of the City of Prague on pollution of Vltava and Czech Elbe

Josef K. Fuksa, Lenka Smetanová

The City if Prague is a substantial source of pollution of the Vltava River, cca. 43 km upstream the confluence with the Elbe. It is a typical communal source with over 1,2 million people connected mostly to a central WWTP, discharging approx. 3,5 m^3/sec. downstream the city. The main source of drinking water is the Švihov reservoir situated in the river basin upstream. Big industrial sources of pollution are absent in the basin and Vltava upstream the city is substantially influenced by big reservoirs (Slapy and Orlík, with approx. 40 and 50 days of retention time, respectively). Reservoirs are artificially improving the discharge during dry months, and control the thermal cycle of river even in the city approx. 50 km downstream (no ice in winter, cold water in summer).

Influence of the City on the Vltava quality and comparison with the Upper Elbe:

Long-term development (1970 – 2018) of the water quality of the Vltava shows that during last more than 10 years the City of Prague (it's WWTP) contributes only by a medium increase of phosphorus and of the ammonia nitrogen, input of B.O.D. and C.O.D. being negligible. Discharged ammonia quickly disappears as nitrified to the nitrate in well-oxygenated river and on the level of nitrate, dominant form of nitrogen in river, the nitrogen increase is also negligible. Most of organic carbon (C.O.D., B.O.D.) comes from the primary production in the river basin and shows some seasonal cycles at present. During dry seasons, the discharge (supported by discharging from the Orlík reservoir) never drops under 45 m^3/sec, so the WTTP discharge represents max 8 % of total discharge in the recipient river (about 2 % during long-term mean discharge).

At the confluence Vltava and Elbe have similar mean discharge, but other characteristics of their basins differ substantially (see Table 1). In case of Elbe the pollution sources are relatively small (and containing industrial sources) and reservoirs as tools for discharge control are missing.

Value	Vltava	Elbe at confluence	Elbe at Hrensko/Schmilka
Basin area [km^2]	28 090	13 695	50 176
Mean discharge [m^3/s]	150	148	319
Population [thousands]	3 331	1 603	6 118

Water quality of Elbe differs from that of Vltava slightly, according to stepwise abatement of industrial pollution and upgrading of many WWTPs. In addition, a different geology of the basin (higher Ca, K) could play a role. In general, at the confluence Vltava shows a lower level of pollution than the upper Elbe. The passage of 100 km of to state border, to profile Hrensko/Schmilka, does not cause substantial changes of water quality during last 20 years.

Budgets of material transport

Standard comparing of concentrations does not well reflect real transport of pollution downstream. Having monthly data of concentrations and relevant data of Qd, we can calculate 12 daily budgets for any year. Naturally, at the level of transport calculations, changes of discharge are a substantial factor controlling the budget values, concentration values being relatively conservative. A budget of yearly means of transport [tonnes per year] shows the Fig 2.

Conclusions:

Quality of water in Czech Elbe both at the confluence with Vltava and at the profile Hrensko(/Schmilka is stable and good. At the level of concentrations, it corresponds to the quality in the German Elbe downstream, as reported in the MKOL/IKSE Water Quality Report for 2010. Therefore, big reservoirs at Vltava could partially control the transport even at the Hrensko. The pollution status reported is valid only for "classical" indicators of pollution. Specific pollutants as PPCPs behave in a quite different mode, both when discharged and as to their behaviour in the river.

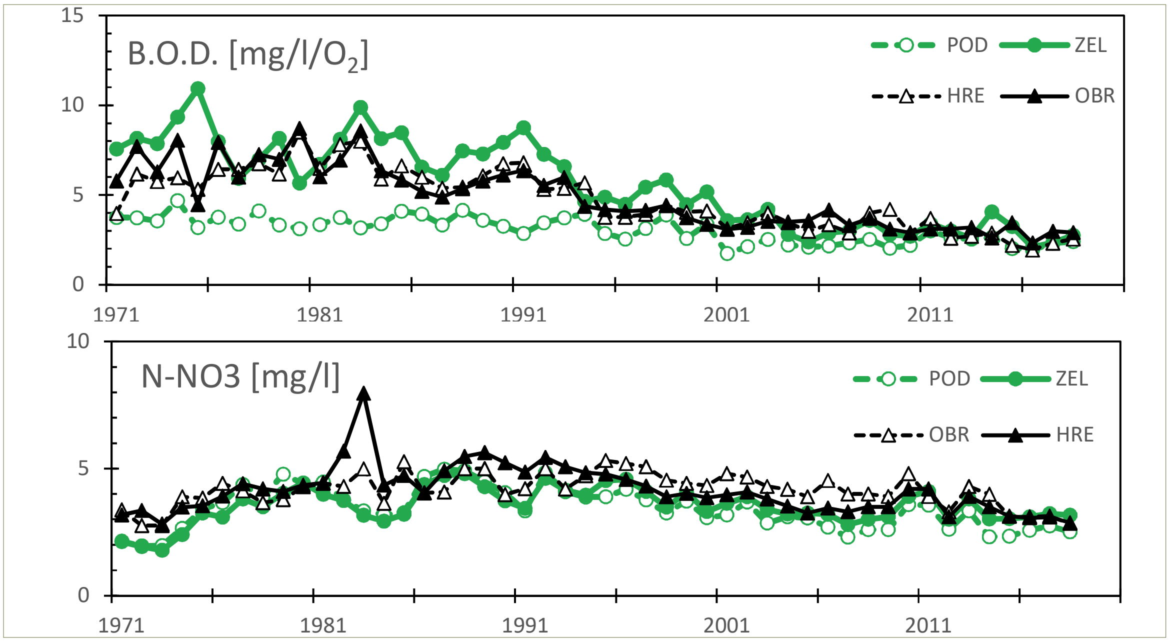

Fig 1: Annual means of B.O.D. and N-NO3 in Vltava upstream (POD) and downstream (ZEL) Prague and in Elbe upstream the confluence (OBR) and at the state border (HRE).

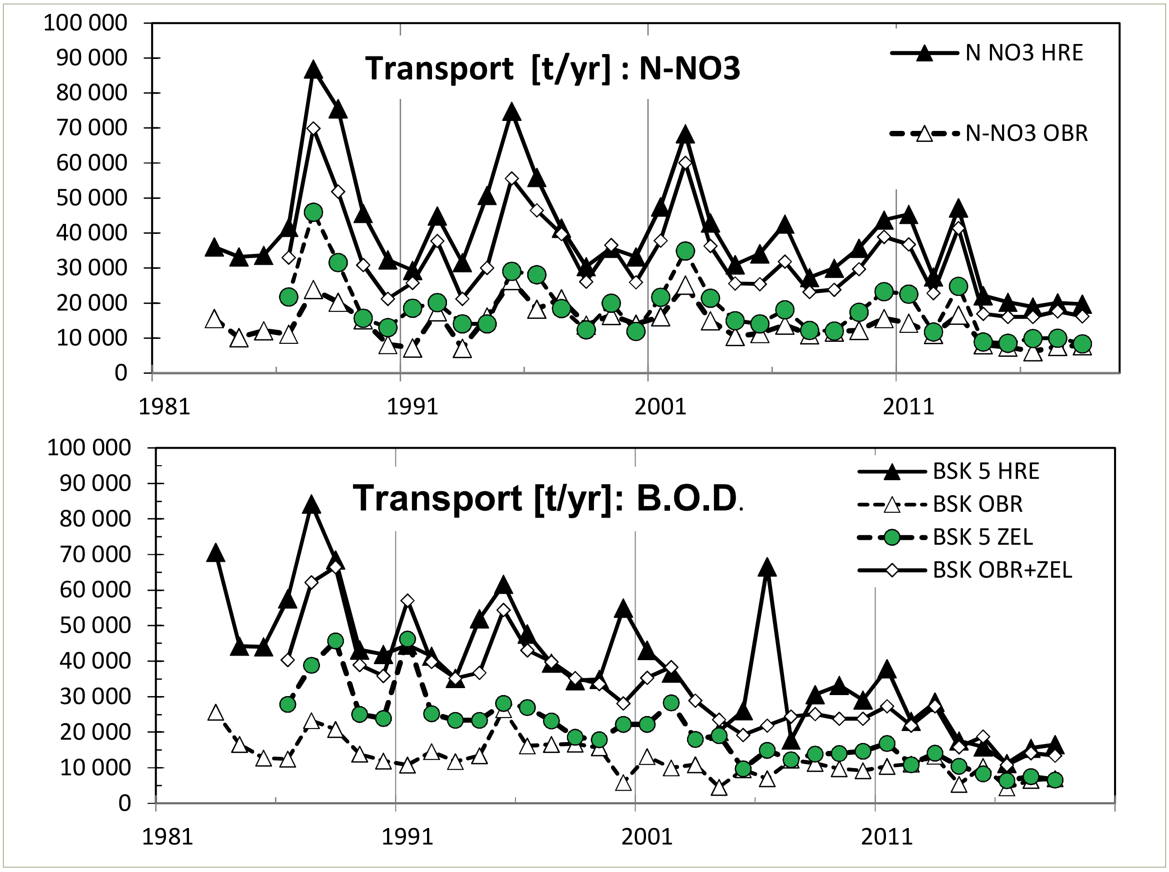

Fig. 2: Annual budgets of transport of B.O.D. and N-NO3 [tonnes/yr] from the confluence of Vltava (ZEL) and Elbe (OBR) to the state border (HRE). (OBR+ZEL) represents a summarised transport downstream the confluence. Columns show the change between the confluence and state border.

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Water quality during the 2018/2019 Elbe low flow events

Gerd Hübner, Daniel Schwandt

1. Introduction

In summer and autumn 2018 and 2019, severe low flow events of the River Elbe occurred. During both events, the *"Monitoring Programme for Hydrological Extreme Events of the River Elbe"* (MPE) of the River Basin Community Elbe [1] was conducted. This programme was carried out by the federal states of Saxony, Saxony-Anhalt, Brandenburg and Lower Saxony, and coordinated by the Federal Institute of Hydrology (BfG). It provided water quality data of the Elbe and its tributaries Saale, Mulde, and Havel. Here, we present an overview of noteworthy aspects of the Elbe water quality during the 2018/2019 low flows.

2. Study area and methods

The study area and sampling sites are shown in Fig. 1. According to the discharge of the Elbe and the sampling dates of the MPE, the duration of the low flow periods was set to 16.7. – 10.12.2018 and 15.7. – 30.9.2019, respectively. Sampling took place approximately every fortnight with ten samples taken during the 2018 and six samples taken during the 2019 low flow. Results of continuous measuring stations of the Elbe are also included in the analyses. The underlying data are presented in [2] [3].

Fig. 1: *Study area with sampling sites of the MPE and reference gauges during the 2018 / 2019 Elbe low flows*

3. Results

The low flow event in 2019 was much shorter than that in 2018, but similarly strong developed. During both low flow periods, a large proportion of the Elbe runoff at Schmilka originated from Czech reservoirs. This additional water supply improved the water quality of the Elbe in Saxony. Both low flow events were accompanied by notably high water temperatures (especially in 2018), whereas oxygen concentrations remained above critical levels. Electric conductivity and the concentration of major ions increased, which is typical for low flow events. Some of the measured concentration peaks of calcium, potassium, sodium and chloride (Fig. 2, left) have not been observed within the last 20 – 25 years.

The concentrations of chlorophyll-a, TOC and total suspended matter were higher in 2019 compared to 2018 and showed an inverse trend to the concentration of ortho-P. Elevated concentrations of ortho-P compared to the hydrological reference year 2012 were measured at some sites of the Elbe in September and in 2018 also later on. During both low flow periods, the concentration of nickel (Fig. 3) and arsenic increased in filtered and unfiltered samples at some measuring sites. The pharmaceutical substances carbamazepine (Fig. 2, right) and sulfamethoxazol showed elevated concentrations. Further information is given in [4][5].

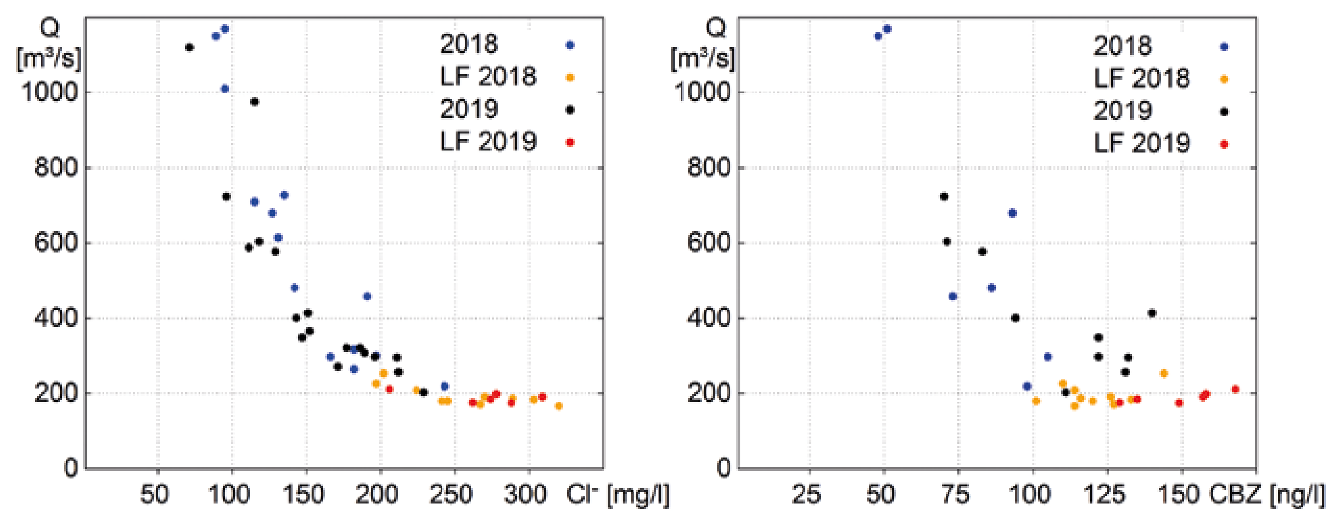

Fig. 2: Concentration of chloride (left) and carbamazepine (CBZ) (right) of the Elbe at Schnackenburg in relation to discharge (Q) during the low flow (LF) events in 2018 / 2019 and on further sampling dates of these years

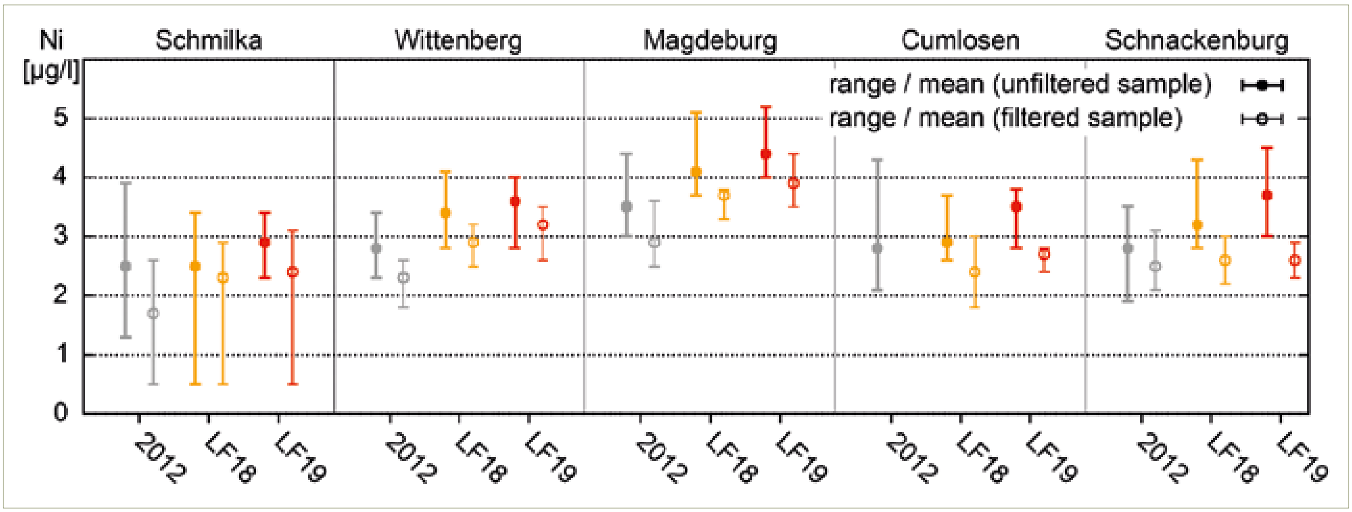

Fig. 3: Nickel concentration of the Elbe in the hydrological reference year 2012 and during low flows in 2018 (LF18) and 2019 (LF19)

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Tritium in the Vltava and Elbe Rivers – monitoring and modelling

Eva Juranová, Barbora Sedlářová, Diana Marešová

1. Introduction

Tritium is a radioactive isotope of hydrogen, commonly present in the environment in low concentrations. Besides natural processes, it can be generated by human activities e.g. operation of nuclear power plants. This is also the case of the Temelín Nuclear Power Plant, which releases its tritiated wastewater into the Vltava River [1]. As a result, tritium is elevated above its natural level along the Vltava River reach and the following reach of the Elbe River. The tritium concentrations in the Czech territory are well measurable, clearly distinguishable from the natural tritium levels, but still they are far below the legal threshold values for surface and even for drinking water according to the Czech government decree 401/2015 Coll. and Council Directive 2013/51/Euratom.

2. Measured tritium concentrations in the Vltava and Elbe Rivers – Czech Republic

The surface water samples for tritium monitoring were collected at 6 sites at the Vltava and Elbe Rivers, downstream of the Temelín Nuclear Power Plant waste water release (influenced sites) and, in addition, at two reference sites not affected by the tritiated waste water release. Surface water has been sampled regularly with frequency from twice a week to once a month since 2001 [2], when the Temelín Nuclear Power Plant was put into operation. The tritium concentrations were determined using the standard liquid scintillation method according to the ČSN EN ISO 9698. In this article, data of the period 2006 – 2017 are evaluated, as it is displayed in the tab. 1. Based on these monitoring results, it can be generally stated that the tritium concentration at the influenced sites is significantly higher than at the reference sites. Concerning the influenced sites, the tritium concentration decreases along the river reach with the distance from the source, as the river swells and tritium is diluted in higher amount of water with a very low tritium concentration.

Based on the measured tritium data and the annual average flow rates, the annual tritium activities for the studied sites were calculated as products of average tritium concentrations and annual average flow rates at the same site and year. Comparing of the tritium amounts among the studied sites leads to the conclusion that it is very stable as it travels along the river reach, the influences of radioactive decay, evaporation, sorption or other can be neglected. This fact was used for estimation of the tritium concentration at sites at the German part of the Elbe River.

Tab. 1 *Tritium concentrations at the Vltava and Elbe monitoring sites, measured in 2006 – 2019.*

River	Site	Site-type	Distance from source [km]	Tritium concentration [Bq/l]			
				Average	Min	Max	STD
Vltava	Hluboká	Reference	-	1,2	< 0,51	2,3	0,29
Elbe	Lysá n. L.	Reference	-	1,1	< 0,37	3,9	0,41
Vltava	Kořensko	Influenced	0	62	< 0,49	2900	260
Vltava	Solenice	Influenced	56	21	3,5	64	11
Vltava	Štěchovice	Influenced	118	20	< 0,86	51	8,9
Vltava	Podolí	Influenced	144	13	< 0,82	36	5,9
Vltava	Zelčín	Influenced	196	12	< 1,0	36	5,5
Elbe	Hřensko	Influenced	309	6,6	< 0,65	21	3,4

3. Modelling of the tritium concentration in the Elbe River – Germany

The estimation of the tritium concentration at the German part of the Elbe River, the annual amounts of tritium, calculated from the data measured at the Czech part of the river reach were used. The concentration estimation was calculated as a ratio of the tritium amount and the annual average flow rate at the Wittenberg site at the German part of the Elbe River [3]. The calculated concentration estimations were compared with the data measured at the Wittenberg site by the German Federal Institute of Hydrology (BfG) [4]. As it is shown in the fig. 1, the modelled (estimated) tritium concentrations in the German Wittenberg site correspond well to the data really measured at the site by BfG.

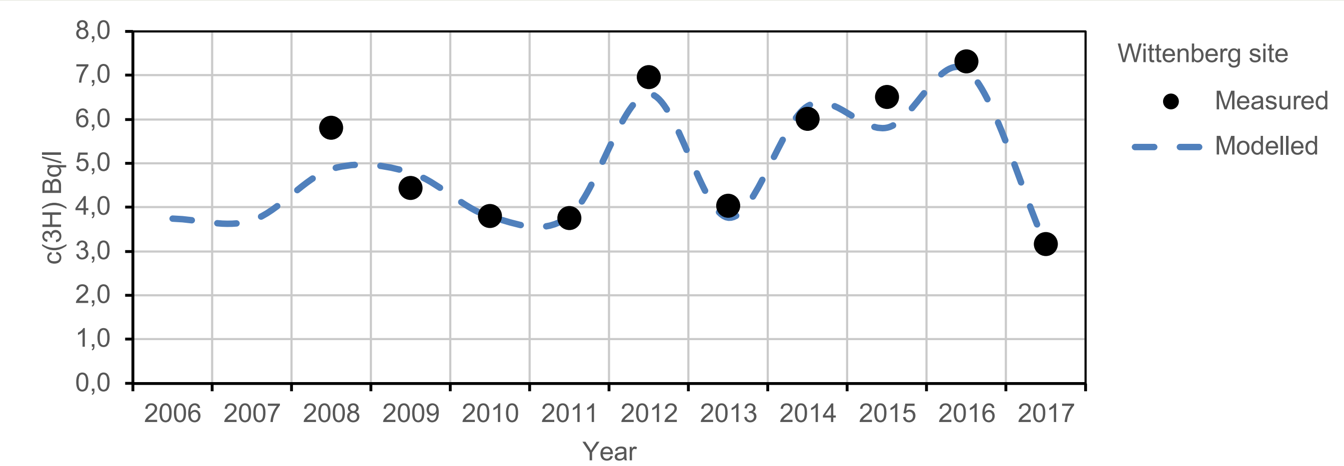

Fig. 1 *Annual average tritium concentrations – estimated (modelled) and measured at the Elbe River, Wittenberg site for the period 2006–2017.*

4. Conclusion

Tritium concentrations elevated above the reference level, are measurable along all the river reach, affected by the releases of the tritiated waste waters from the Temelín Nuclear power Plant. These concentrations fulfil all the legislation requirements, so the risk for human health is insignificant, but it can be used for modelling purposes, as it was shown at the estimation of the tritium concentrations at the Wittenberg site at the German part of the Elbe River.

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TRITIUM IN THE VLTAVA AND ELBE RIVERS – MONITORING AND MODELLING

Eva Juranová, Barbora Sedlářová, Diana Marešová

Introduction

Tritium is a radioactive isotope of hydrogen, present in the environment in low concentrations. Besides natural processes, it can be generated by human activities e.g. operation of nuclear power plants. This is also the case of the Temelín Nuclear Power Plant (see fig. 1), which releases its tritiated wastewater into the Vltava River. As a result, tritium is elevated above its natural level along the Vltava River reach and the following reach of the Elbe River. The tritium concentrations in the Czech territory are well measurable, clearly distinguishable from the natural tritium levels, but still they are far below the legal threshold values.

Fig. 1 Temelín Nuclear Power Plant

Tritium measured in the Czech Republic

The surface water samples for tritium monitoring were collected at 6 sites at the Vltava and Elbe Rivers, downstream of the Temelín Nuclear Power Plant waste water release (influenced sites) and, in addition, at two reference sites. The tritium concentrations were determined using the standard liquid scintillation method according to the ČSN EN ISO 9698. Measured tritium concentration is displayed in the tab. 1.

Based on the measured tritium data and the annual average flow rates, the annual tritium activities for the Czech studied sites were calculated.

Tab. 1 Measured data on tritium concentration at monitored sites in the Czech Republic.

River	Site	Site-type	Distance from source [km]	Average tritium concentration (2006-2017) [Bq/l]
Vltava	Hluboká	Reference	-	1,2
Elbe	Lysá n. L.	Reference	-	1,1
Vltava	Kořensko	Influenced	0	62
Vltava	Solenice	Influenced	56	21
Vltava	Štěchovice	Influenced	118	20
Vltava	Podolí	Influenced	144	13
Vltava	Zelčín	Influenced	196	12
Elbe	Hřensko	Influenced	309	6,6

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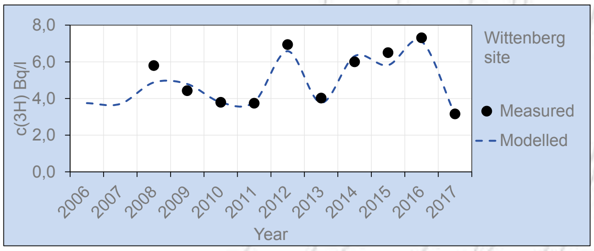
Fig. 2. Map of tritium monitoring sites

Tritium modelled in Germany

The data measured at the Czech part of the river reach were used for estimation of the tritium concentration at the German part of the Elbe River. The concentration estimation was calculated as a ratio of the tritium annual amount and the annual average flow rate at the Wittenberg site at the German part of the Elbe River. The calculated concentration estimations were compared with the data measured at the Wittenberg site by the German Federal Institute of Hydrology (BfG). As it is shown in the fig. 3, the modelled (estimated) tritium concentrations in the German Wittenberg site correspond well to the data really measured at the site by BfG.

Fig. 3 Fluctuation of tritium concentrations in selected sites



Conclusions

As a result of the releases of the tritiated waste waters from the Temelín Nuclear power Plant, tritium concentrations are well measurable along the Vltava and Elbe rivers. These concentrations fulfil all the legislation requirements, so the risk for human health is insignificant. On the other hand, measured data on tritium can be used for modelling purposes, as it was shown at the estimation of the tritium concentrations at the Wittenberg site at the German part of the Elbe River.

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Organic micro-contaminants in the Uhlava River basin – an example of anthropogenic influence on water supply for municipal waterworks in Pilsen

Milan Koželuh, Lumír Kule, Václav Tajč, Eliška Tůmová

1. Introduction

The Uhlava River and its tributaries provide water for more than 200 thousand people as main supply for treatment of drinking water. Contamination comes from the surface run-off, or it is carried from Wastewater treatment plants (WWTP). River basin is mostly agricultural with a high proportion of industrial crops (oilseed rape and maize). Applications of plant protection products (herbicides) comes the main danger for surface water. Herbicides are applied every spring and autumn, and their penetration into the aquatic environment depends on hydrological conditions (amount and intensity of rainfall), on a compliance protective zones and on the each landscape profile. The important source of pharmaceuticals and personal care products (PPCP´s) is district town Klatovy (22300 inhabitants, many municipal and industry activities). The most of treated wastewaters flow into the recipient Drnovy potok a few kilometers before confluence with Uhlava River.

2. Monitoring scheme

Targeted monitoring of organic micro-contaminants is carried out continuously and with great care. Uhlava River is exposing to a permanent danger of unexpected and latent micro-contaminants entry. Consequently, the waterworks technologies can be damaged and especially quality of drinking water in Pilsen agglomeration can be endangered. Monitoring of weekly cumulated samples is an efficient instrument, how to get full integrated information about quality of surface-water in the drawing site of the Waterworks in Pilsen. In addition, the balance analysis of micro-contaminants from the Uhlava River basin were calculated (Fig. 1).

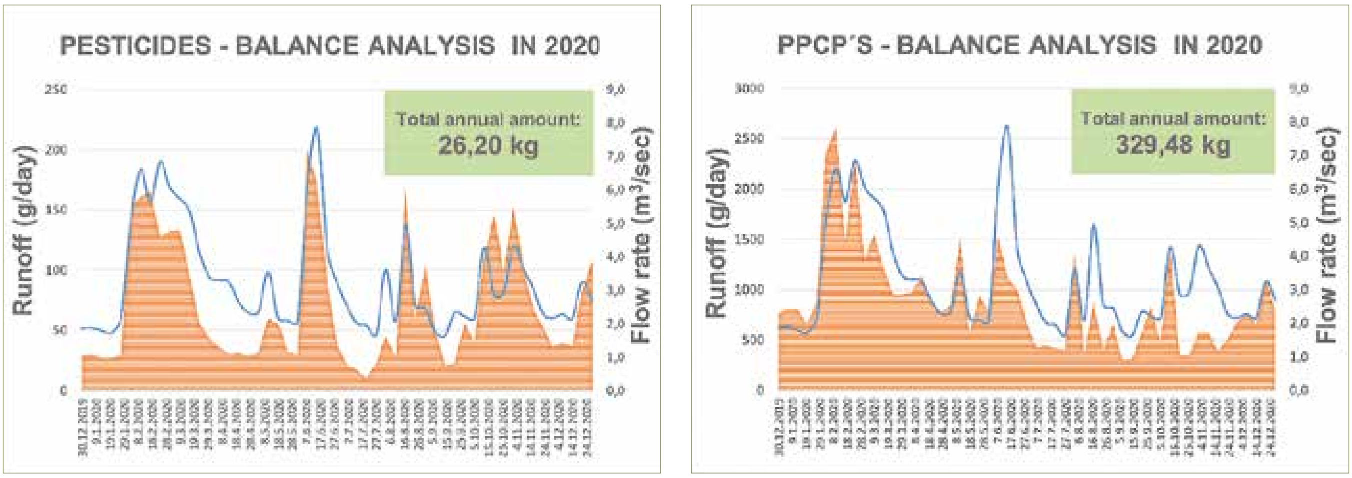

Fig. 1: *Uhlava Plzen Doudlevce – Balance analysis of Pesticides and Pharmaceuticals and Personal Care Products (PPCP´s) in 2020*

3. Enviromental accident in October 2019

The hazardous accident – leakage of about one hundred liters of concentrated fungicidal wood preservative from a private woodworking factory Holz-Schiller in October 2019 was the real test of cooperation between Povodi Vltavy state enterprise, Municipal Waterworks, Regional and Municipal Authorities and Emergency Service. The main aims were (i) to prevent contamination of drinking water in Pilsen, (ii) the raw-water source substitution for a limited period, and (iii) a dilution of extremely high concentrations of pollutants by increasing of water outflow from Nyrsko and Hracholusky reservoirs. Thereupon, safety concentrations (bellow 100 ng/l) of the main marker propiconazole in the downstream basins (Berounka River and Vltava River) were measured several hours after culmination. A balance analysis of propiconazole at the accident culmination was processed (Fig. 2).

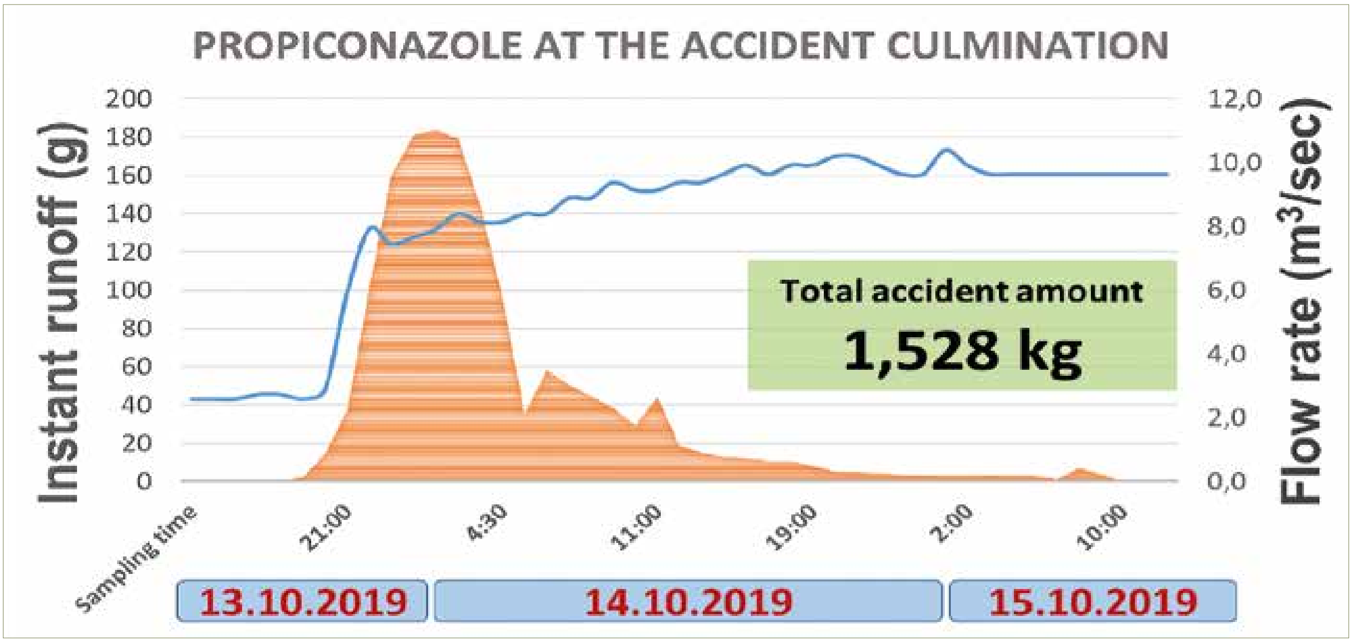

Fig. 2: *Uhlava Plzen Doudlevce – Balance analysis of propiconazole at the accident in October 2019*

4. Post-accident monitoring in 2020

Monthly the source of the contamination in two sites was monitored– (i) the leaking water of the Holz Schiller factory area and (ii) the recipient Drnovy stream under this factory. The results show a gradual decrease in concentration of both compounds during 2020 (Fig.3). The leaking water from Holz-Schiller factory can be considered a permanent risk of contamination threatening a significant source of raw water. Therefore, the monthly monitoring also continues in 2021.

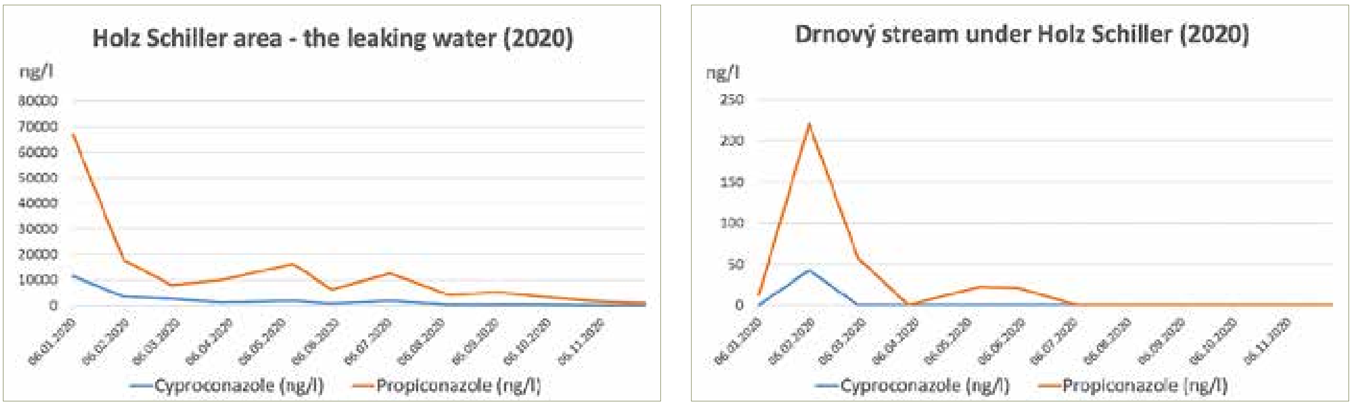

Fig. 3: *The accident site – post-accident monitoring of propiconazole and cyproconazole in 2020*

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Determination of water quality in Mastník Bay of the Slapy Reservoir

Luboš Mrkva, Bohumír Janský, Miroslav Šobr

1. Introduction

Two important goals of water resources management are to restrict pollution sources and to prevent worsening of surface water quality. Eutrophication has become the primary problem facing most surface water bodies worldwide [2]. According to research results, water management is an area that could be highly affected by climate change, especially in relation to water temperature and discharge [6].

Small watercourses in rural areas often show many unsecured water pollution sources. The problem of diffuse sources of water pollution such as rural settlements and agriculture remains unsolved [7]. The consequences show that the most significant risk for river eutrophication is posed by point rather than diffuse phosphorus sources, even in rural areas with high phosphorus losses in agriculture [3]. Classification of lakes based on various methods and indices have been made by various workers. The classical and most commonly used method, based on the productivity of the water body, is the biomass related trophic state index (TSI) developed by Carlson (1977) [1].

The Mastník Bay at Slapy Reservoir was selected as the object of this study. The objectives of this study were to describe the trophic state and water quality of Mastník Bay and ascertain its effect on the Slapy Reservoir. Thus, nutrients and oxygen concentrations, water temperature and biomass in Mastník Bay was investigated over three growing seasons (2016 – 2018).

2. Material and methods

The Mastník catchment area is located in the centre of Czechia. The Mastník stream flows into the Slapy Reservoir at approximately river kilometre 103 of the Vltava River. About 70 % of the Mastník catchment area is part of the Agriculture Soil Fund, reflecting the predominantly agricultural character of the catchment [4]. Mastník Bay is 4.7 km long and about 230 m wide near its mouth to the main part of the reservoir. The volume of the bay is approximately 6 million m^3, depending on the water level of the reservoir.

Sampling in the field took place from May to October (growing season) from 2016 to 2018. A total of 160 water samples were collected from six locations selected in Mastník Bay.The authors' dataset was extended with data provided by the Vltava River Basin Authority (SOE).

Monitored water quality parameters in Mastník Bay were evaluated based on concentrations along longitudinal and vertical profiles. Emphasis was placed on ascertaining change in concentrations of nutrients and chlorophyll – α over time, enabling comparisons between the monitored years. In this study, also two trophic indexes were used: Carlson's Trophic State Index (CTSI) and Trophic Level Index (TLI).

By comparison of datasets from the Slapy Reservoir locations, the possible effect of the Mastník stream on water quality in the Slapy was evaluated.

3. Results

In the summer months, high levels of phytoplankton activity are clearly visible in Mastník Bay. Measurements of chlorophyll – α concentrations were used to estimate the total phytoplankton biomass. Chlorophyll concentration changes during the growing seasons of 2016 and 2018 along Mastnik Bay can be displayed by sorting measured values of chlorophyll concentration into 5 categories. The results show that the upper part of the bay had much higher concentrations than elsewhere in the bay. Chlorophyll concentrations in the upper part of the bay exceeded 100 $\mu g \cdot l^{-1}$ and at some location were above 500 $\mu g \cdot l^{-1}$, as seen during July and August 2016. In 2018, lower values were observed at the same station. A maximum Chl – α concentration of 280 $\mu g \cdot l^{-1}$ was reached in August. During the growing seasons in 2016 and 2018 the pattern of areal distribution was similar, showing decreasing concentrations in the direction of the reservoir.

The numerical trophic index values for Mastník Bay clearly show the hypertrophic conditions of the bay. Hypertrophic refers to high levels of biological productivity characterized by frequent and severe algal blooms and low water transparency. The average CTSI value for the bay was 65.66, indicating that the bay is at a hypertrophic level and ranged between 53.6 (eutrophic) to 79.13 (hypertrophic). The average TLI value was 6.04 and varied from 5.2 (supertrophic) to 6.96 (hypertrophic).

Eutrophication problems in the summer months are more intense in the bay than in the reservoir. Based on data from 2015 and 2016 for profiles located on free water surface in the Slapy Reservoir, the difference in concentrations of parameters during the observed period is marginal. The data confirm the negligible effect of the Mastník stream and dominance of internal water quality development in the bay. By the wide mouth of Mastník Bay, water masses mix only minimally due to low velocities. In summer months, under mean hydrological conditions, the Slapy reservoir water mass behaves as a “dam”, which retains the hypertrophic waters of the Mastník stream in its bay.

4. Conclusion

High water residence times in the Mastnik Bay favour algal growth, especially during the growing season. Based on trophic indices, the bay can be classified as hypertrophic while the Slapy Reservoir itself is eutrophic. Total phosphorus concentrations in the bay are still high, even though the supply of phosphorus from the Mastník catchment area is decreasing. An increase of eutrophication and thus chlorophyll concentration can also be associated with increasing surface water temperatures and stronger thermal stratification, or by releasing TP from the sediment. However, the effect of the Mastník catchment on the concentration of the monitored substances of the main water body of the reservoir could not been proven. Rising air temperatures and changes in precipitation may result in deterioration of surface water quality despite all measures and investments made so far. It is necessary to continue devoting attention to this issue [5].

Acknowledgements

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Changes in Ecological and Chemical Status of Surface Water Bodies in the Czech Part of Elbe River Basin District

Hana Prchalová, Petr Vyskoč, Tomáš Mičaník

1. Introduction

As a part of the Third River Basin Management Plan, it was necessary to carry out an assessment of the ecological and chemical status of surface water bodies. This assessment is an important basis for the elaboration of all levels of river basin management plans and is used to prepare Programme of Measures to achieve good water status. The assessment is performed for each water body of the 'river' and 'lake' categories. Czechia assess surface water body status each three years and the period 2016 – 2018 was used for the Third River Basin Management Plan. The evaluation was carried out in accordance with the requirements of European [1] and national legislation according to the updated methodological procedures.

2. Methodology and monitoring changes

Compared to the second planning cycle (from the evaluation in 2010 – 2012), the number of surface water bodies changed only slightly; however, a significant change occurred in the re-definition of heavily affected bodies of the 'river' category in 2019. Total of 49 water bodies previously designated as 'natural' have now been defined as 'heavily affected'; in contrast, 40 previously 'heavily affected' water bodies have now been defined as 'natural'. Chemical status assessment includes several methodological changes – evaluation of the bioavailable form of dissolved metals of nickel and lead and new priority and hazardous substaces. However, a fundamental change compared to the previous method of evaluation was the approach to situations where none of the chemical status pollutants was monitored in the given representative profile. Due to precaution, the status of such a body was marked as 'unknown' (formerly 'good'). Several methodologies were updated for ecological status – the stricter limits of nutrients and oxygen conditions and new assessment of fish quality elements are the most important changes. And the new assessment of hydromorphology was added in the ecological status/potential.

3. Comparison of status assessment results

The simple comparison of status assessment results is not favourable – the proportion of water bodies in good or better ecological status/potential decreases from 15 % in the 2nd cycle to 3,5 % in the 3rd cycle and from 69 % to 29,5 % in the chemical status. However, the real reasons for the 'deterioration' were not higher concentrations of pollutants or worse conditions of biological quality elements, but methodological changes or higher number of monitored water bodies and enlargement of monitored pollutants. For example, the proportion of water bodies in good or better ecological status/potential for macrozoobenthos and phytobenthos was similar between the 2nd and 3rd cycle – and slightly better in the 3rd cycle, and results for fish were significantly better due to the distinct change in methodology. On the other hand, results for general physico-chemical quality elements were much worse in the 3rd cycle due to the stricter limits of good status/potential.

And the higher number of surface water bodies failing to achieve good chemical status was caused by extended number of monitored water bodies and pollutants. For this reason Water Research Institute prepared interactive maps, tables and graphs for the results of each pollutant, indicator and/or quality element. The maps show the results on water body level and tables and graphs provide statistics on the sub-unit, river basin district or the whole country level [2].

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Changes in the ecological status of water bodies and communities of water invertebrates in the dry seasons

Jan Špaček, Pavel Hájek

Abstract

The Povodi Labe, state enterprise, monitors and evaluates the ecological status of water bodies in the administered area. Low flow rates and higher temperatures in the last few years have had an impact on the status of water bodies. These factors affect the structure of aquatic communities. Mainly due to changes in temperature and oxygen regime, changes in transport of nutrients and pollutants. Long-term flow reduction or flow drying affects the status of the communities so. Changes in the status of water bodies vary according to the size of the stream, the area, the altitude and the degree of anthropic influence. Examples of these changes are given on selected water bodies. These significant changes are presented on the assessment of ecological status and on significant changes in communities of organisms.

Introduction

Low flows and drying of some streams are commonly present in monitoring of ecological status. This was also the case in earlier times. The impact of low flows on aquatic communities was presented, for example, at the Magdeburg Seminar in Teplice in 2010 [3]. In recent years, however, these situations have increased extremely. This has of course also had an impact on the ecological status assessment for the second planning period. It can be assumed that the effects of the dry and warm years will become apparent in the third planning period. An overview of the assessment is given in the table (Table 1.) Drying up of streams has a number of negative effects on communities of organisms and has become the subject of intensive research and assessment in recent years [1, 2, 4, 5].

Tab. 1: *Povodi Labe water bodies ecological status assessment.*

	Ecological status of WB							
	High	**Good**	**Moderate**	**Poor**	**Bad**	**not classified**	**number of dried**	**number of WB**
2010–2015	1	30	67	52	10	54	7	214
2016–2018	1	24	105	81	13	3	37	227
2019–2020							5	

Results

During the years 2010–2015 we encountered 7 water bodies where single or repeated drying occurred. During the years 2016–2018, a total of 37 water bodies dried up in at least one sampling period. The majority were dried up in the autumn period. Results of assessment of ecological status from these years are in the table (Table 1). There has been no assessment of ecological status in the years 2019–2020. In 2019 and 2020, we encountered 5 cases of stream drying (Table 1). In addition to the commonly known impacts, we observed some others.

At some sites, reduced flows resulted in temporary reductions in nutrient and pollutant concentrations. This was due to the overall lack of water in the landscape. Pollutants did not reach the main receiving water and were deposited in dry channels.

Another phenomenon was the intensive overgrowth of dry riverbeds in some places with mud and terrestrial vegetation. This often completely changed the character of the stream. The plants in the stream caused faster sediment deposition and changes in flow. As a result, oxygen consumption was faster.

In addition to the direct effect of drying on organism communities, we also observed changes in streams with reduced flows. The effect of temperature changes over several seasons resulted in the disappearance of some organisms or changes in their life cycle. This phenomenon was particularly evident in low-impact streams at higher elevations. This phenomenon was particularly evident in stenothermic organisms, such as stoneflies (Plecoptera). An example was the unusual occurrence of *Capnia bifrons*. This species starts its development when the water temperature drops in autumn, usually in mid-November. Adult emergence occurs no later than March. In 2017, there was a significant acceleration of development at some sites. Already in mid-November, larvae of the last instars were present at sites in unusually high numbers.

Conclusion

The dry and warm season of recent years has presented us with unusual situations. For example, the question is how to evaluate a dry stream in terms of its ecological status. Is it a bad condition if it is a natural drying phenomenon? We have seen streams drying up in good ecological condition, with minimal anthropic influence. Other findings included changes in species and community behaviour in response to extreme situations. We will continue to monitor the changes brought about by the dry season in the coming years. Whether the dry season continues or the climate returns to normal.

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Redynamization of the Spree River – Watercourse renaturation and flood protection at the biosphere reserve „Oberlausitzer Heide- und Teichlandschaft“

Daniel Steinmüller

North of the town of Bautzen, the Spree river flows through the biosphere reserve „Oberlausitzer Heide- und Teichlandschaft“. Until the beginning of the 20th century, the river in the planning area was charac-terised by a natural, meandering course. Between 1927 and 1931 the river Spree was extensively strai-ghtened and expanded. The expressed objective was to improve flood protection and reduce the fre-quent flooding of communities and farmland. This regulation led to increased flow velocity and, conse-quently, a deepening of the riverbed. For this reason, weirs and bottom sills were built. The floodplain forests and meadows were only rarely flooded, but this is absolutely necessary for their long-term preservation. The village of Halbendorf continued to be flooded regularly during floods.

Fig. 1: *General plan of the measures*

In 2013, planning began for a redynamization of the Spree River. Construction from 2018 to 2019 has returned the river to some of its original condition. Several partial measures were implemented on an approximately 5-kilometer long section of the Spree River, leading to an improvement of the river structure, the restoration of ecological continuity and, consequently, the enhancement of habitats of protected species. While the uninhabited parts of the floodplain are better connected with the Spree due to a more frequent and thus typical flooding, flood protection for the pro-tection target HQ(100) is simultaneously established for the village Halbendorf, which is located in the middle of the planning area. With the implementation of the planned measures, the length of the Spree has been extended by approximately 1.9 kilometers and the structural diversity in this section has been increased. Thus, a vitalization of the watercourse in the existing profile is achieved, which also initiates a self-dynamic watercourse development.

The redynamization was implemented in four phases:

Re-integration of existing river oxbows in the main or in the tributary channel

Two oxbow sections of the river were re-integrated into the main channel of the Spree. The respective straightened course of the river remains as a flood basin. Three river oxbows are traversed from a HQ(2).

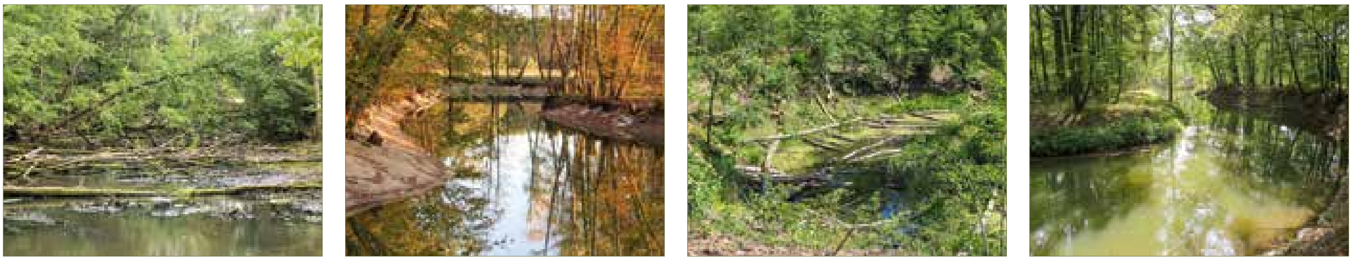

Fig. 2: *Reconnection of river oxbows: from left to right » river oxbow Kaupe before – after; river oxbow Lömischau before – after*

Creation of ecological continuity

The non-functional weir at Lömischau was completely dismantled and the river bed restored to a near-natural condition.

Fig. 3: *Complete dismantling of the weir Lömischau, left 01/2018 before and right 12/2018 after demolition*

Fig. 4: *Arable swale Lömischau filled during floods*

Restoration of the cross-link between the Spree River and the floodplain

By removing embankments as well as channels and depressions that extended well into the banks of the Spree, the floodplain can be flooded more frequently again. In addition, an arable area has been transformed back into a floodplain meadow.

Improvement of flood protection

A 500-meter-long flood protection structure was built on the left bank of the Spree in Halbendorf. This consists of a sheet pile wall, which was covered with soil and planted with vegetation. The sheet pile wall is only visible as a free-standing wall for 150 meters. In order to increase the discharge through a road bridge, the foreland on the right bank of the Spree was removed over a length of around 250 meters.

Fig. 5: *Flood protection in Halbendorf, left free-standing sheet pile wall, center covered sheet pile wall, right new flood protection mill Halbendorf*

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Measures for water retention in landscape in the Czech Republic

Miriam Dzuráková, Kamila Osičková, Pavla Štěpánková

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

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

All collected measures follow basic goals:
- supporting infiltration of water into the soil,
- limitation of concentrated surface runoff,
- decreasing of water velocity to avoid soil erosion,
- increasing of water retention of the landscape.

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

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

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Changes in Radiological Indicators in Surface Water and Sediments in the Elbe River Basin

Pavel Stierand, Libor Mikl

1. Introduction

The Czech Hydrometeorological Institute (CHMI) performs long-term monitoring of radiological indicators in sediments and evaluates radiological indicators in surface waters [1], [4]. The aim of the study was to compare quantity of uranium and radium radiological contamination in Stráž pod Ralskem region during and after the termination of uranium mining in this area. The Ploučnice River flows through this mining territory and then merges with the Elbe River in Děčín near the Hřensko border crossing (upper Elbe river basin, Czech Republic), where activities of radiological indicators are also being monitored and documented.

2. Result

Radiological indicators have been monitored since 1960 in surface waters and since 2000 in sediments. The development of total alpha and beta volume activity, uranium concentration and radium activity is described for specific profiles near the uranium mining site, especially in the vicinity of the Stráž pod Ralskem deposit, where uranium extraction has already been terminated [3].The detected uranium contents in water initially collected at weekly intervals are statistically evaluated for each year of monitoring (maximum, median, upper and lower quartile). An example of a change in the uranium content of surface water on the Mimoň – Ploučnice profile is shown in the figure (Fig. 1).The activity of radio 226 isotope in surface waters on the profile of Březina, before the mouth of the River Ploučnice into the Elbe River is shown (Fig. 2). A comparison of the activity of isotopes in sediments on the profile of Březina before the mouth of the Ploučnice river to the Elbe river and on the profile of Decin – Elbe below this estuary is given in the table (Tab. 1).

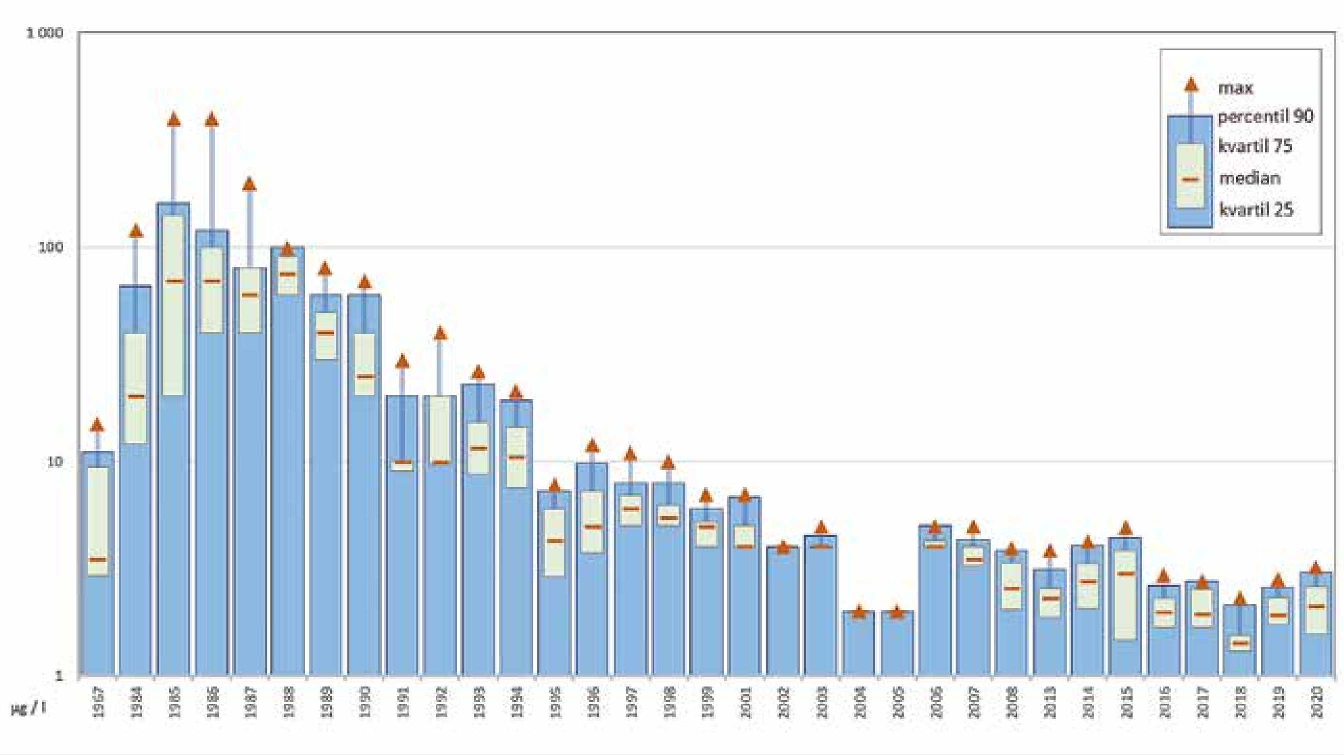

Fig. 1: *Uranium concentration on the Mimoň – Ploučnice profile for the period (1967-) 1984 – 2020*

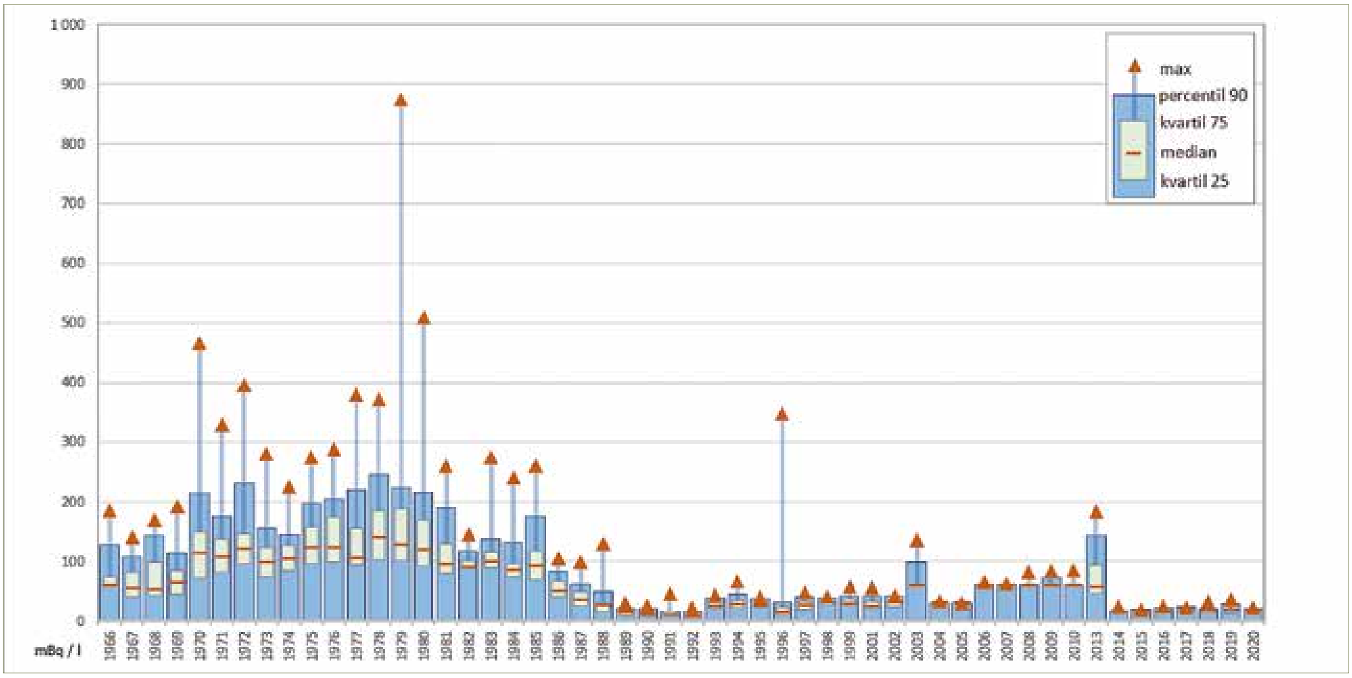

Fig. 2: *Ra-226 Activity on the Březiny – Ploučnice profile for the period 1966–2020*

Tab. 1: *Radiozotope activities in sediments*

Profile	Period	Pointer	Uranium	U 238	U 238	Cs 137	Ra 226	Ra 228	Th 228	Pb 210
		Unit	mg · kg⁻¹	Bq · kg⁻¹	Bq · kg⁻¹	Bq · kg⁻¹	Bq · kg⁻¹	Bq · kg⁻¹	Bq · kg⁻¹	Bq · kg⁻¹
Ploučnice – Březiny	2007–2020	Max		7.08	167	10.6	199	75.6	91.9	193
		Median		3.9	39.5	5.09	108.2	39.9	38.1	41.8
Labe – Děčín	1999–2017	Max	6.7			6.9	49	47.2	37.5	
		Median	3.1			3.2	36.6	23.5	18.5	

3. Conclusion

Maximum uranium concentrations are documented before 1990. A significant decrease in radiological activity was observed in the 1990s.The concentration of uranium in surface waters in the late 1980s reached approximately 200 μg / l, according to the updated ČSN 75 7221 [2], the classification in Class V corresponds to very heavily contaminated water. After the end of uranium mining at the Stráž pod Ralskem deposit, uranium concentrations decreased by 2 orders of magnitude, and surface water on the profile Mimoň – Ploučnice in the last 5 years is classified in Class I non-contaminated water. The decrease in the activity of radio 226 isotope is not so pronounced, surface water on the profile Březina – Ploučnice is still classified in Class II, i.e. slightly contaminated water, on the profile Horka – Ploučnice surface waters are classified into III or IV pollution class.

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Effects of climate change on runoff seasonality in headwater areas of the Ore Mountains

Vojtěch Vlach, Milada Matoušková, Ondřej Ledvinka, Marie Bejčková

1. Introduction

After a very intense period of extreme regional floods between 1997 and 2013, Central Europe experienced an abnormal, persistent period of hydrological drought from 2015 to 2020 [1]. Even regions with higher annual precipitation amounts, such as the Ore Mountains, experienced a very dry period from the long-term perspective of instrumental period. The main aim of this study was to evaluate the frequency, seasonality, and intensity of hydrological drought in selected headwaters of the Ore Mountains. Direct impacts of a changing climate on the runoff regime were studied in the region, whose rivers are a crucial source for north-western Czechia and Saxony. Outputs of this study can help identify the manifestations and causes of the changing runoff regime in the headwaters of Central European rivers. Drought characteristics were evaluated using several indices along with the comparative analysis of drought occurrence in the 1967 – 2018 study period.

2. Study area & data

The Ore Mountains are located alongside the state border between Saxony and north-western Bohemia. Three headwater catchments (Fig. 1) of the Ore Mountains have been included in this study: Zwota (Svatava), Rolava, and Natzschung (Načetínský potok). The study areas experiences relatively evenly distributed annual precipitation ranging from 800 to 1100 mm, annual average air temperatures vary between 3.5 and 7.0 °C. The study catchments were chosen because of two factors: (a) the length of the available time series linked to runoff (at least 50 years) and (b) the absence of large dams and weirs that, otherwise, would significantly affect the runoff regime in the gauging profiles. Environmental and climatic conditions in the catchments are rather similar. The study region as a whole underwent very significant land cover changes in the past. Recently, bark-beetle infestations have become the biggest problem regarding the environmental and land cover stability. Time series of mean daily discharges, monthly air temperature, precipitation and snow depth for the 1967 – 2018 period were obtained from the Czech Hydrometeorological Institute (CHMI), the Saxon State Office for the Environment, Agriculture and Geology (LfULG) and Deutscher Wetterdienst (DWD).

3. Methods

Indices of hydrological drought used in this study were selected based on several criteria, such as availability of suitable data and the comparability with studies of a similar focus. The analysis included the evaluation of discharges in the “cold” (November to April) and “warm” (May to October) half years. From the daily runoff series, the following characteristics describing water deficits were calculated: (a) annual, seasonal, and monthly number of days with daily discharge under the Q_{355} quantile corresponding to the probability of exceedance equal to 97.19 %. The Q_{355} quantile was calculated for the whole study period (1967 – 2018) as well as for individual months separately [2]; (b) annual, seasonal, and monthly deficit volume (magnitude) based on the Q_{355} threshold method; (c) the intensity of drought (deficit volume divided by duration); (d) annual 1-day low flow ($Q_{minA)}$, the Julian day of its occurrence, and monthly 1-day low flow (Q_{minM}); (e) Low Flow Index (LFI): the ratio of Q_{minA} to Q_a; (f) Base Flow Index (BFI): the ratio of the volume corresponding to base flow to the total discharge volume. Four of the indicators (Q_{355}, Q_{minA}, Q_{minM}, BFI) were retrieved by the Indicators of Hydrologic Alteration (IHA7.1) software [3]. The original form and also the seasonal version of the Mann– Kendall nonparametric test (MK test) were used to detect trends and to examine their statistical significance in both hydrological and climatic time series at the significance level $\alpha = 0.05$ [4]. All methods used in this study are presented also in the full text of this research [5].

4. Results

Initial results related to the quantile Q_{355} pointed to a difference of the CHA gauge (Fig. 1), mainly in the almost unique occurrence of dry days with at CHA in the 1970s. In contrast, the driest years at the KLI and ROT profiles (e.g., 2018, 2003, or 2015) were concentrated in the second half of the study period. It is also necessary to stress the extremity of the summer season of 2018 which exceeded maxima of drought duration and deficit volumes within the period of instrumental records at KLI (since 1961) and ROT (since 1929). During that year, the two profiles recorded 96 (KLI) and 111 (ROT) dry days, both of which were almost uninterrupted episodes spanning from July to October. The longest drought at the CHA station occurred in 2003 (83 days).

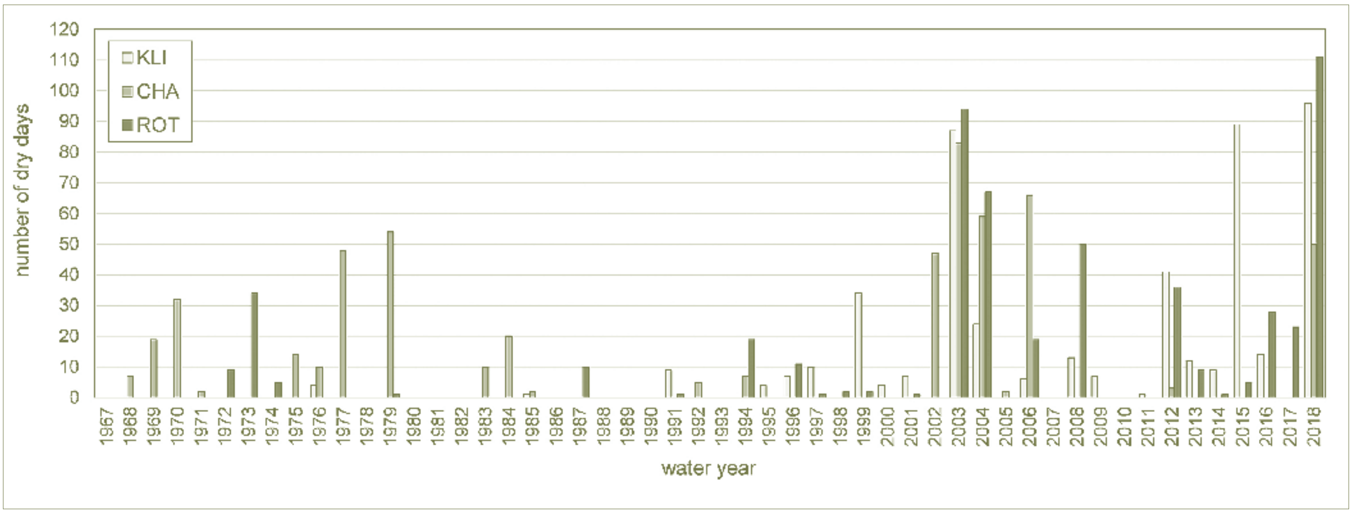

Fig. 1: *Annual occurrence of hydrologically dry days (Q_{355}) during the period 1967 – 2018 for each water gauging station (KLI = Klingenthal (Zwota); CHA = Chaloupky (Rolava); ROT = Rothenthal (Natzschung). Data: CHMI, LfULG*

The changes in drought seasonality were monitored for two periods of 26 years (1967 – 1992 and 1993 – 2018). The exact date (Julian day) of the Q_{minA} occurrence may indicate whether these minima have been shifting from the long-term perspective. All three catchments exhibit a shift; the annual minimum discharge moved closer to the beginning of the year in the second half of the study period. The most significant change has been recorded at the CHA gauge, where the average minimum has moved by 86 days backwards so far. The average minima have shifted towards the start of the year also at KLI (55 days) and ROT (58 days). In the 1967 – 1992 period, the monthly distribution of dry days was quite incoherent at all gauges. Since 1993, dry days have been concentrated mainly between July and October, which is quite different in comparison with the first half of the study period. Furthermore, after 1992, there was a strong decrease in the number of dry days in the colder half of the year, particularly for CHA and ROT. Monthly total deficit volumes rapidly increased in August and September after 1992 in all three catchments, whereas winter months showed an opposite pattern. For all study results, the readers are kindly recommended to read the full text of this research [5].

5. Conclusions

Most of our outputs indicated certain specifics in the response of selected catchments in the Ore Mountains to the precipitation deficit and the occurrence of hydrological drought. Although total precipitation in this area has not been declining from a long-term point of view, both average and minimum discharges show a downward trend over the study period. It can, therefore, be assumed that the main causes for the increasing drought occurrence with high intensity in the Ore Mountains are primarily due to climate warming. The increasing air temperature affects snow accumulations in winter, earlier snowmelt in spring, and increased evaporation demand as well. These factors contribute to a shift in the average date of Q_{minA}, which is now closer to the start of the year. This study also confirmed the exceptional nature of recent droughts in Central Europe. At the ROT water gauge, 2018 has been the driest year since 1929. Conversely, in the Rolava catchment (CHA gauge), the drought in summer 2018 was not nearly as significant as in 2003. This finding proves the fact that each catchment responds to lack of precipitation in a different manner, depending on other physical-geographical factors as well.

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Committee and Expert Group on Measures for Ensuring Fish Migration in the hydrological network of the Czech public

Zdeněk Vogl, Miloš Holub, Tereza Barteková, Pavel Marek, Jiří Musil

The fragmentation, hydropower and regulation of the river network in the Czech Republic are recognised fundamental ecological challenges over decades. Transversal river obstacles limit or block fish migrations and thus significantly reduce their natural range of distribution, availability of food resources, vital reproductive habitats etc. Apart of the barrier effect, river obstacles modify (due to swelling and accumulation of water, regulation treatments etc.) local habitats, having strong cumulative effects, and all act to affect the entire riverine ecosystem [1]. In order to eliminate these environmental impacts, it is necessary to select the appropriate adaptation measures, which include the complete obstacle removal or the construction of a functional fish pass at individual site. A fish pass defined here as any structure that allows (it is functional) fish to safely pass the river obstacle, bidirectional (upstream and downstream) movement of fish respectively. However, it must be taken into account that even functional fish passes as only one type of compensatory measures, can never fully mitigate the environmental impacts of fragmentation induced by a river obstacle.

In order to maximize the effectiveness of river connectivity related restoration actions, the Commission for Fish Passage (CFP) was established in 2000 under the Agency for Conservation and Landscape Protection (ACLP). Main goal of CFP is to improve/support the professional background for designing, implementing and assessing the functionality of fish passages, creating background documents and assistance on preparation of conceptual materials/strategies in aquatic ecosystems conservation, evaluation of site based studies and cooperation on projects dealing with river connectivity. Due to the multidisciplinary nature of fish passage issue, experts in fish biology, ecology, ethology, environmental protection, hydrology, hydraulics and, inter alia, hydraulic engineers are involved in the CFP. Since 2015, the CFP has been closely cooperating with T.G. Masaryk Water Research Institute, p.r.i. (TGM WRI), research organization of the Ministry of the Environment of the Czech Republic. Coordinating body, Ministry of the Environment of the Czech Republic (with support of ACPL, T.G. M. WRI and CFP), manages the setting of subsidy policy to support the realization of measures/actions facilitating free two ways migration, it defines priority migration corridors within the Concept of Passage of the hydrological network of the Czech Republic (CPCZ) last updated in 2020 [2], and oversees compliance with obligations under the Water Framework Directive [3]. In all supported projects, fish passes must be designed with respect to systematic aspect of recovery of river connectivity with requirements not to be species or size selective, allowing free migration ideally for all fish species present.

Until nowadays, the Commission evaluated more than 350 river sections, identified as migration barriers for aquatic organisms and more than 100 constructions were supported by public funds. Other important activities involve cooperation on monitoring of biological functionality of fishways (usually site-based evaluation), supporting long-term research projects, providing methodological guidance, training activities, organizing thematic seminars and conferences to increase public awareness. Without close cooperation/support of other state authorities, the given results could not be achieved.

Thanks to the joint efforts of the Ministry of the Environment and its organizations ACLP and TGM WRI, the Concept CPCZ has been recently updated. In particular, it has been made actualization of international priority corridors (directly linked to marine environment), national priority corridors (territorial protection of European importance sites and specially protected areas following Council Directive No. 92/43 / EEC [4]) along with new category defined as Regional Priority Corridors (taking into account only species protection). Finally, a new national database of transversal river obstacles/barriers in the Czech Republic is now available [5].

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[4] Evropská Unie (1992). Směrnice rady 92/43/EHS ze dne 21. května 1992 o ochraně přírodních stanovišť, volně žijících živočichů a planě rostoucích rostlin. Úřední věstník Evropských společenství. L206: 1 – 66

[5] Agentura ochrany přírody a krajiny České republiky (2017). Databáze migračních bariér (dostupná na www.vodnitoky.ochranaprirody.cz)

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NATURE
CONSERVATION AGENCY
OF THE CZECH REPUBLIC

VÚV TGM
T. G. Masaryk
Water Research
Institute
Public Research Institution

The Commission for Fish Passage

- Group of Experts ANCLP

The Commission for fish passages was found with the purpose of improving the professional background for projecting, realisation and evaluation of the functionality of fish passages, providing the supporting documents for the revision of the design materials within the aquatic ecosystems protection, as well as the evaluation of the particular studies and projects dealing with the restoration of migration permeability of the watercourses of Czech Republic, witch follows from the Water Framework Directive (60/200/EHS).

The Commission for fish passages includes the experts in the fish biology, ecology, ethology, environmentalism, hydrology or hydraulic engineers.

Documents:

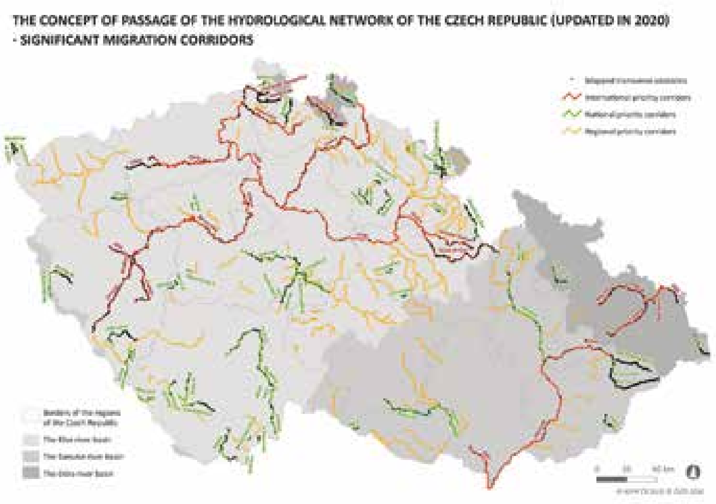
- The Concept of Watercourses passability of the Czech Republic
- Database of migration barriers of the Czech Republic (www.vodnitoky.ochranaprirody.cz)

Vertical-slot fish passage in the River Berounka (Řevnice)

Passable rock-ramp fishway in the River Smědá in the Jizera Mountains

Vertical-slot fish passage in Roudnice nad Labem

Bypass with the baffle fishway in the River Vltava (Planá)



THE CONCEPT OF PASSAGE OF THE HYDROLOGICAL NETWORK OF THE CZECH REPUBLIC (UPDATED IN 2020) - SIGNIFICANT MIGRATION CORRIDORS

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NATURE CONSERVATION AGENCY OF THE CZECH REPUBLIC

NATURE IS OUR
HERITAGE AND FUTURE

www.nature.cz

Internationale Kommission zum Schutz der Elbe

Mezinárodní komise pro ochranu Labe

8. Oktober 1990 in Magdeburg

Die Vertragsparteien unterzeichnen die **Vereinbarung über die Internationale Kommission zum Schutz der Elbe (IKSE).**

8. října 1990 v Magdeburku

Smluvní strany podepsaly **„Dohodu o Mezinárodní komisi pro ochranu Labe“ (MKOL).**

Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe Elbe Labe

Nachdem die Elbe Ende der 1980er Jahre zu den am stärksten belasteten Flüssen Europas gehörte, war der gesellschaftliche Umbruch in Osteuropa für die Elbe Rettung in letzter Minute.

In den ersten Jahren zielten die Schwerpunkte der Arbeit der IKSE auf die Senkung der Gewässerbelastung durch kommunales und industrielles Abwasser, den Bau von kommunalen Kläranlagen, die Verbesserung der Gewässergüte und der ökologischen Verhältnisse, später kam auch der Hochwasserschutz dazu.

Die europäischen Richtlinien (Wasserrahmenrichtlinie und Hochwasserrisikomanagement-Richtlinie) bilden die Grundlage der gegenwärtigen und zukünftigen Arbeit der IKSE.

Labe patřilo koncem 80. let 20. století k nejvíce znečištěným řekám v Evropě, společenské změny ve východní Evropě proto pro Labe představovaly záchranu na poslední chvíli.

V prvních letech byla práce MKOL zaměřena hlavně na snižování znečištění způsobeného komunálními a průmyslovými odpadními vodami, na výstavbu komunálních čistíren odpadních vod, na zlepšení jakosti vody a ekologických poměrů, později přibyla i oblast ochrany před povodněmi.

Evropské směrnice (Rámcová směrnice o vodách a Povodňová směrnice) jsou základem současné i budoucí práce MKOL.

Meilensteine in der Tätigkeit der IKSE / Milníky v činnosti MKOL

Meilensteine in der Tätigkeit der IKSE		Milníky v činnosti MKOL
3. Internationaler Bewirtschaftungsplan Elbe	2022 – 2027	3. Mezinárodní plán oblasti povodí Labe
2. Internationaler Hochwasserrisikomanagementplan Elbe		2. Mezinárodní plán pro zvládání povodňových rizik v oblasti povodí Labe
Strategie zur Minderung der Nährstoffeinträge in Gewässer	2018	Strategie ke snížení obsahu živin ve vodách
2. Internationaler Bewirtschaftungsplan Elbe	2016 – 2021	2. Mezinárodní plán oblasti povodí Labe
1. Internationaler Hochwasserrisikomanagementplan Elbe		1. Mezinárodní plán pro zvládání povodňových rizik v oblasti povodí Labe
Sedimentmanagementkonzept der IKSE	2014	Koncepce MKOL pro nakládání se sedimenty
1. Internationaler Bewirtschaftungsplan Elbe	2010 – 2015	1. Mezinárodní plán oblasti povodí Labe
Aktionsplan Hochwasserschutz Elbe	2003 – 2011	Akční plán povodňové ochrany v povodí Labe
Aktionsprogramm Elbe	1996 – 2010	Akční program Labe
Erstes Aktionsprogramm Elbe (Sofortprogramm)	1992 – 1995	První akční program Labe (Naléhavý program)
Erstes international abgestimmtes Messprogramm	1992	První program měření odsouhlasený na mezinárodní úrovni
Internationaler Warn- und Alarmplan Elbe (Havariemeldesystem)	1991	Mezinárodní varovný a poplachový plán Labe (systém hlášení havárií)

Arbeitsweise der IKSE

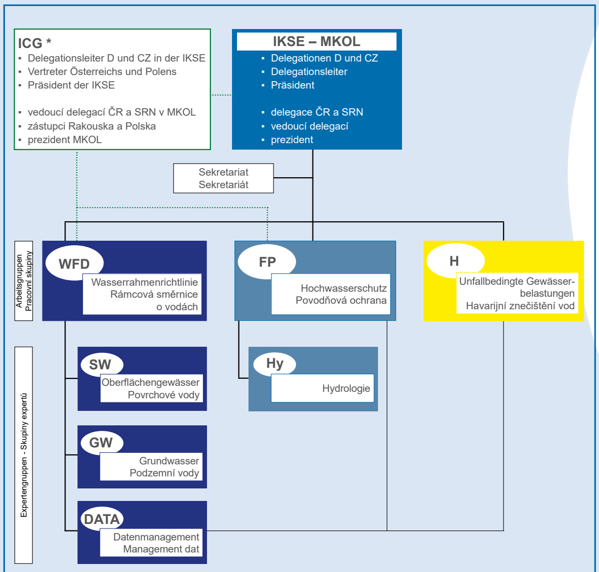
► Die IKSE erarbeitet Empfehlungen für die Vertragsparteien (Deutschland und Tschechien).

► In den Delegationen der IKSE sowie den Arbeits- und Expertengruppen sind insgesamt ca. 120 Vertreterinnen und Vertreter von deutschen und tschechischen Ministerien, Behörden und Institutionen sowie wissenschaftlichen Einrichtungen tätig. Außerdem wirken Delegierte aus Österreich und Polen sowie von Nichtregierungsorganisationen an der Arbeit mit.

► Verhandlungssprachen der Kommission sind Deutsch und Tschechisch.

► Das Sekretariat der IKSE mit acht Mitarbeiterinnen und Mitarbeitern unterstützt die Arbeit der Kommission und ihrer Arbeitsgruppen fachlich, sprachlich und organisatorisch. Es hat seinen Sitz in Magdeburg.

► Alle Publikationen werden zweisprachig herausgegeben (ausgewählte Beispiele siehe unten). Sie sind auch auf den Internetseiten der IKSE abrufbar.



ICG *
- Delegationsleiter D und CZ in der IKSE
- Vertreter Österreichs und Polens
- Präsident der IKSE

- vedoucí delegací ČR a SRN v MKOL
- zástupci Rakouska a Polska
- prezident MKOL

IKSE – MKOL
- Delegationen D und CZ
- Delegationsleiter
- Präsident

- delegace ČR a SRN
- vedoucí delegací
- prezident

Sekretariat
Sekretariát

Arbeitsgruppen
Pracovní skupiny

WFD Wasserrahmenrichtlinie
Rámcová směrnice o vodách

FP Hochwasserschutz
Povodňová ochrana

H Unfallbedingte Gewässerbelastungen
Havarijní znečištění vod

Expertengruppen - Skupiny expertů

SW Oberflächengewässer
Povrchové vody

GW Grundwasser
Podzemní vody

DATA Datenmanagement
Management dat

Hy Hydrologie

* Die internationale Koordinierungsgruppe ICG behandelt Fragen der internationalen Koordinierung im Zusammenhang mit der Umsetzung der europäischen Wasserrahmenrichtlinie und der Hochwasserrisikomanagement-Richtlinie im Einzugsgebiet der Elbe.

* Mezinárodní koordinační skupina ICG řeší otázky mezinárodní koordinace v souvislosti s implementací evropské Rámcové směrnice o vodách a Povodňové směrnice v povodí Labe.

Způsob práce MKOL

► MKOL vypracovává doporučení pro smluvní strany (Česká republika a Německo).

► V delegacích MKOL, v pracovních skupinách a ve skupinách expertů pracuje cca 120 zástupců českých a německých ministerstev, úřadů, institucí a vědeckých ústavů. Kromě toho se na práci podílejí zástupci Polska, Rakouska a nevládních organizací.

► Jednací jazyky Komise jsou čeština a němčina.

► Osmičlenný sekretariát MKOL podporuje práci Komise a jejích pracovních skupin po odborné, jazykové a organizační stránce. Sídlem sekretariátu je Magdeburk.

► Všechny publikace jsou vydávány dvojjazyčně (vybrané příklady viz níže). Jsou k dispozici také na internetových stránkách MKOL.

Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

DIE ELBE IST WIEDER EIN LEBENDIGER FLUSS
Abschlussbericht
Aktionsprogramm Elbe
1996 – 2010

INTERNATIONALE FLUSSGEBIETSEINHEIT ELBE

INTERNATIONALER BEWIRTSCHAFTUNGSPLAN
FÜR DIE FLUSSGEBIETSEINHEIT ELBE

nach Artikel 13 der Richtlinie 2000/60/EG
des Europäischen Parlaments und des Rates vom 23. Oktober 2000
zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft
im Bereich der Wasserpolitik

TEIL A

2009

Fachliche Bearbeitung und Redaktion:
Internationale Kommission zum Schutz der Elbe (IKSE)

Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

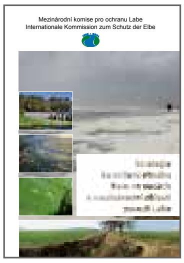
ABSCHLUSSBERICHT
ÜBER DIE ERFÜLLUNG DES
„AKTIONSPLANS HOCHWASSERSCHUTZ ELBE“
2003 – 2011

Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

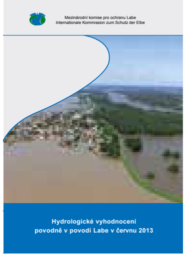
SEDIMENTMANAGEMENTKONZEPT DER IKSE
Vorschläge für eine gute Sedimentmanagementpraxis im Elbegebiet
zur Erreichung überregionaler Handlungsziele

Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

LABE JE OPĚT ŽIVOUCÍ ŘEKOU
Závěrečná zpráva
Akční program Labe
1996 – 2010



Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe



Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

Hydrologické vyhodnocení
povodně v povodí Labe v červnu 2013

Internationale Kommission zum Schutz der Elbe
August 2020

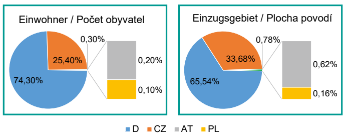
www.ikse-mkol.org

Mezinárodní komise pro ochranu Labe
srpen 2020

Die Elbe und ihr Einzugsgebiet

Im Einzugsgebiet der Elbe, die im Riesengebirge entspringt und in die Nordsee mündet, leben fast 25 Millionen Menschen. Die wichtigsten Nebenflüsse (in der Reihenfolge ab Elbequelle) sind Moldau, Eger, Schwarze Elster, Mulde, Saale und Havel.

Einteilung der Elbe	Elbeabschnitte	Elbelänge [km]	Einzugsgebiet [km²]
Obere Elbe	Elbequelle bis Schloss Hirschstein	463	54 170
Mittlere Elbe	Schloss Hirschstein bis Wehr Geesthacht	489	80 843
Untere Elbe	Wehr Geesthacht bis Mündung in die Nordsee an der Seegrenze bei Cuxhaven-Kugelbake (Elbe-km 727,7); dieser Abschnitt wird auch als Tideelbe bezeichnet, weil er durch Ebbe und Flut beeinflusst wird; ab dem Elbe-km 654,9 handelt es sich um ein Übergangsgewässer	142	13 255
Elbe gesamt	Elbequelle bis Mündung in die Nordsee	1 094	148 268



Das Einzugsgebiet der Elbe gehört zur gemäßigten Klimazone und liegt im Übergangsbereich vom mehr maritim zum mehr kontinental geprägten Klima. Kontinentaler Einfluss kommt in verhältnismäßig geringen Niederschlagshöhen und großen Temperaturunterschieden zwischen Winter und Sommer zum Ausdruck. Das trifft für den größten Teil des Elbeeinzugsgebiets zu, wobei mit ansteigender Geländehöhe in den Mittelgebirgen die Niederschlagshöhen zunehmen. Ein eher ausgeglichener Temperaturverlauf und für das Tiefland relativ große Niederschlagshöhen – Merkmale maritimen Klimas – kennzeichnen den Bereich der Unteren Elbe.

Die Lufttemperatur beträgt im Jahresmittel im Flachland 8 bis 9 °C und in den Gipfellagen der Mittelgebirge 1 bis 3 °C. Die mittleren jährlichen Niederschlagshöhen bewegen sich zwischen 1 700 mm in den Kammlagen von Riesen- und Isergebirge sowie im Oberharz und um 450 mm in Gebieten, die im Regenschatten von Mittelgebirgen liegen. Die mittlere jährliche Niederschlagshöhe für das gesamte Elbegebiet im Bezugszeitraum 1981 – 2010 beträgt durchschnittlich 665 mm (Information des DWD, 2020, basierend auf Daten von DWD und ČHMÚ).

Charakteristisch für dieses Übergangsklima ist das Abflussregime des Regen-Schnee-Typs. Ein Teil der Winterniederschläge fällt als Schnee, der in den Mittelgebirgen meist erst im Frühjahr abtaut und im langjährigen Durchschnitt allgemein zum Abflussmaximum in den Monaten März und April führt. Hochwasser werden jedoch häufig auch durch regionale Starkniederschläge im Sommer verursacht, wie bei den Hochwassern im August 2002 und im Juni 2013.

Die Mittelgebirge nehmen nur einen kleinen Teil des Einzugsgebiets der Elbe ein. Lediglich 2 % des Elbegebiets erreichen Höhen über 800 m ü. NHN, mehr als die Hälfte des Einzugsgebiets weist hingegen Geländehöhen bis 200 m ü. NHN auf. Die geringsten Abflüsse werden meistens im September und Oktober erreicht.

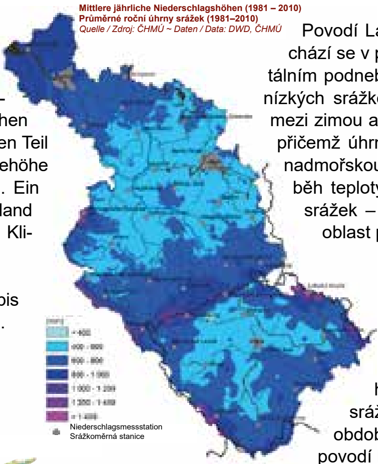
Der langjährige mittlere Abfluss der Elbe an der Seegrenze im Bezugszeitraum 1981 – 2010 beträgt 853 m³/s (Information der BfG, 2020). Das Elbegebiet ist eines der abflussärmsten großen Flussgebiete in Europa.

Im Einzugsgebiet der Elbe werden gemäß den im Projekt CORINE Land Cover von 2018 analysierten Daten 40,3 % der Fläche als Ackerland genutzt. Mit Wald sind 31,4 % der Fläche bedeckt, dabei entfallen 22,3 % auf Nadel- sowie 9,1 % auf Laub- und Mischwälder.

Labe a jeho povodí

V povodí Labe, které pramení v Krkonoších a ústí do Severního moře, žije téměř 25 milionů obyvatel. Nejdůležitějšími přítoky (řazeno od pramene Labe) jsou Vltava, Ohře, Černý Halštrov, Mulde, Sála a Havola.

Rozdělení Labe	Úseky Labe	Délka Labe [km]	Plocha povodí [km²]
Horní Labe	od pramene Labe po zámek Hirschstein	463	54 170
Střední Labe	od zámku Hirschstein po jez Geesthacht	489	80 843
Dolní Labe	od jezu Geesthacht po ústí do Severního moře na hranici s mořem u Cuxhavenu-Kugelbake (říční km 727,7); tento úsek je označován také jako slapový úsek Labe, protože je ovlivňován mořským přílivem a odlivem; od říčního km 654,9 se jedná o brakické vody.	142	13 255
Labe celkem	od pramene Labe po ústí do Severního moře	1 094	148 268


Mittlere jährliche Niederschlagshöhen (1981 – 2010)
Průměrné roční úhrny srážek (1981–2010)
Quelle / Zdroj: ČHMÚ ~ Daten / Data: DWD, ČHMÚ

Povodí Labe patří k mírnému podnebnému pásmu, nachází se v přechodné oblasti mezi přímořským a kontinentálním podnebím. Kontinentální vliv se projevuje v poměrně nízkých srážkových úhrnech a velkých teplotních rozdílech mezi zimou a létem. To platí na většině území povodí Labe, přičemž úhrny srážek v horských regionech se s rostoucí nadmořskou výškou terénu zvyšují. Celkem vyrovnaný průběh teploty vzduchu a pro nížinu poměrně vysoký úhrn srážek – tj. jevy přímořského podnebí – charakterizují oblast podél Dolního Labe.

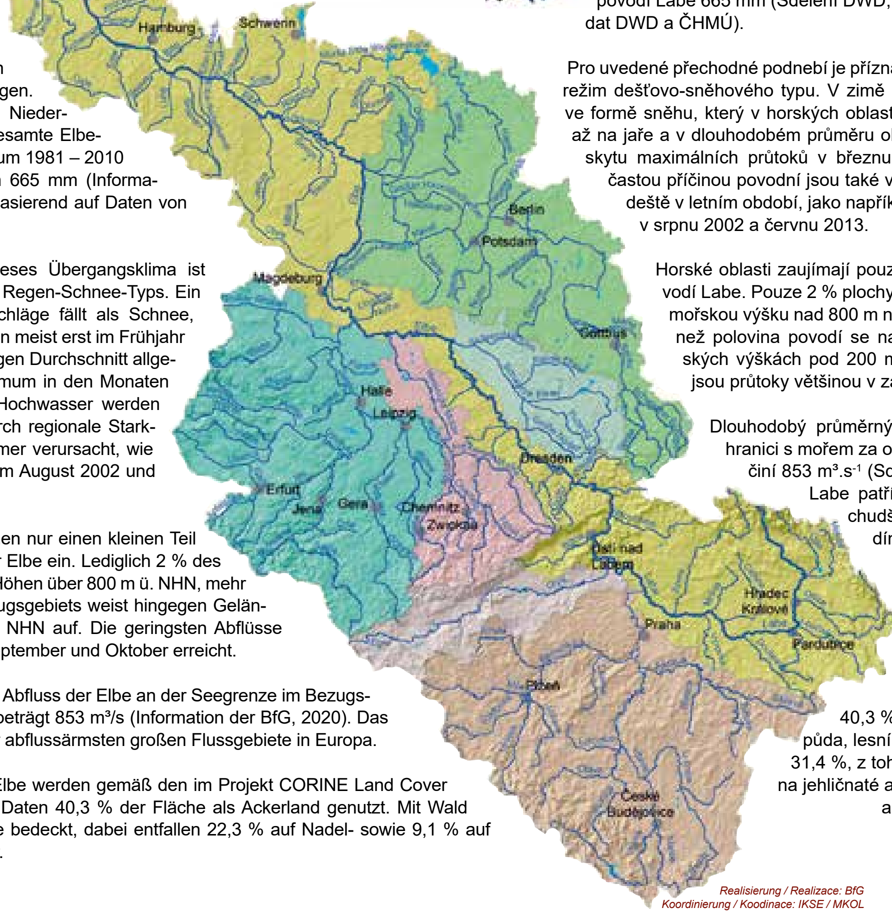
Průměrná roční teplota vzduchu se v nížinách pohybuje od 8 do 9 °C a na hřebenech hor od 1 do 3 °C. Průměrný roční úhrn srážek se pohybuje v rozmezí od 1 700 mm na hřebenech Krkonoš, Jizerských hor a ve vyšších polohách Harcu do 450 mm v oblastech ležících ve srážkovém stínu hor. V dlouhodobém průměru za období 1981–2010 činí roční srážkový úhrn v celém povodí Labe 665 mm (Sdělení DWD, 2020, na základě dat DWD a ČHMÚ).

Pro uvedené přechodné podnebí je příznačný hydrologický režim dešťovo-sněhového typu. V zimě padá část srážek ve formě sněhu, který v horských oblastech taje většinou až na jaře a v dlouhodobém průměru obvykle vede k výskytu maximálních průtoků v březnu a dubnu. Avšak častou příčinou povodní jsou také vydatné regionální deště v letním období, jako například při povodních v srpnu 2002 a červnu 2013.

Horské oblasti zaujímají pouze malou část povodí Labe. Pouze 2 % plochy povodí mají nadmořskou výšku nad 800 m n. m., zatímco více než polovina povodí se nachází v nadmořských výškách pod 200 m n. m. Nejmenší jsou průtoky většinou v září a v říjnu.

Dlouhodobý průměrný průtok Labe na hranici s mořem za období 1981–2010 činí 853 m³.s⁻¹ (Sdělení BfG, 2020). Labe patří k odtokově nejchudším velkým povodím v Evropě.

V povodí Labe je dle analýzy dat projektu CORINE Land Cover z roku 2018 využíváno 40,3 % plochy jako orná půda, lesní porosty pokrývají 31,4 %, z toho připadá 22,3 % na jehličnaté a 9,1 % na listnaté a smíšené porosty.



Realisierung / Realizace: BfG
Koordinierung / Koodinace: IKSE / MKOL

Internationale Kommission zum Schutz der Elbe
August 2020

www.ikse-mkol.org

Mezinárodní komise pro ochranu Labe
srpen 2020

Umsetzung der Wasserrahmenrichtlinie

Implementace Rámcové směrnice o vodách

INTERNATIONALE FLUSSGEBIETSEINHEIT ELBE

INTERNATIONALER BEWIRTSCHAFTUNGSPLAN
FÜR DIE FLUSSGEBIETSEINHEIT ELBE

nach Artikel 13 der Richtlinie 2000/60/EG
des Europäischen Parlaments und des Rates vom 23. Oktober 2000
zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft
im Bereich der Wasserpolitik

TEIL A

2009

Fachliche Bearbeitung und Redaktion:
Internationale Kommission zum Schutz der Elbe (IKSE)

Die Staaten im Einzugsgebiet der Elbe – Deutschland, Tschechien, Österreich und Polen – haben sich darauf geeinigt, einen gemeinsamen „Internationalen Bewirtschaftungsplan für die Flussgebietseinheit Elbe“ zu erarbeiten.

Státy v povodí Labe – Česká republika, Německo, Rakousko a Polsko – se dohodly, že bude zpracován jeden společný „Mezinárodní plán oblasti povodí Labe“.

MEZINÁRODNÍ OBLAST POVODÍ LABE

MEZINÁRODNÍ PLÁN
OBLASTI POVODÍ LABE

podle článku 13 Směrnice Evropského parlamentu a Rady 2000/60/ES
ze dne 23. října 2000,
kterou se stanoví rámec pro činnost Společenství
v oblasti vodní politiky

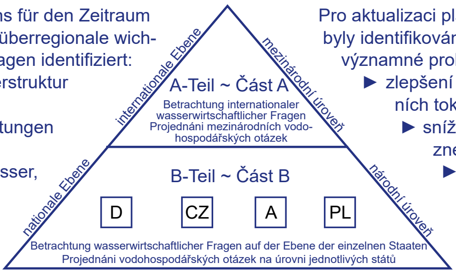
ČÁST A

2009

Odborné zpracování a redakce:
Mezinárodní komise pro ochranu Labe (MKOL)

Für die Aktualisierung des Plans für den Zeitraum 2022 – 2027 wurden folgende überregionale wichtige Wasserbewirtschaftungsfragen identifiziert:

- ► Verbesserung der Gewässerstruktur und Durchgängigkeit,
- ► Reduktion der signifikanten stofflichen Belastungen mit Nähr- und Schadstoffen,
- ► Auswirkungen des Klimawandels (Niedrigwasser, Wasserknappheit, hydrologische Extremereignisse und weitere Auswirkungen).



A-Teil ~ Část A

Betrachtung internationaler wasserwirtschaftlicher Fragen
Projednáni mezinárodních vodohospodářských otázek

B-Teil ~ Část B

D CZ A PL

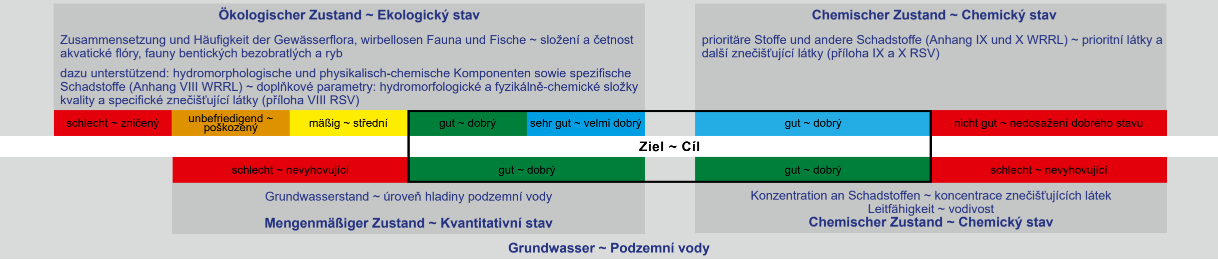
Betrachtung wasserwirtschaftlicher Fragen auf der Ebene der einzelnen Staaten
Projednáni vodohospodářských otázek na úrovni jednotlivých států

Pro aktualizaci plánu na období 2022–2027, byly identifikovány následující nadregionální významné problémy nakládání s vodami:

- ► zlepšení struktury a průchodnosti vodních toků,
- ► snížení významného látkového zatížení živinami a znečišťujícími látkami,
- ► dopady klimatické změny (sucho, nedostatek vody, extrémní hydrologické jevy a další dopady).

Das Ziel ist der
gute Zustand aller Gewässer.
Das bedeutet, dass alle relevanten Qualitätskomponenten bei der Bewertung die Kriterien des guten Zustands erreichen.

Cílem je
dobrý stav všech vod.
To znamená, že všechny relevantní složky kvality dosahují při hodnocení kritérií dobrého stavu.



Oberflächengewässer ~ Povrchové vody

Ökologischer Zustand ~ Ekologický stav

Zusammensetzung und Häufigkeit der Gewässerflora, wirbellosen Fauna und Fische ~ složení a četnost akvatické flóry, fauny bentických bezobratlých a ryb

dazu unterstützend: hydromorphologische und physikalisch-chemische Komponenten sowie spezifische Schadstoffe (Anhang VIII WRRL) ~ doplňkové parametry: hydromorfologické a fyzikálně-chemické složky kvality a specifické znečišťující látky (příloha VIII RSV)

🟥 schlecht ~ zničený | 🟧 unbefriedigend ~ poškozený | 🟨 mäßig ~ střední | 🟩 gut ~ dobrý | 🟦 sehr gut ~ velmi dobrý

Chemischer Zustand ~ Chemický stav

prioritäre Stoffe und andere Schadstoffe (Anhang IX und X WRRL) ~ prioritní látky a další znečišťující látky (příloha IX a X RSV)

🟦 gut ~ dobrý | 🟥 nicht gut ~ nedosažení dobrého stavu

Ziel ~ Cíl

🟥 schlecht ~ nevyhovující | 🟩 gut ~ dobrý

Grundwasserstand ~ úroveň hladiny podzemní vody

Mengenmäßiger Zustand ~ Kvantitativní stav

🟩 gut ~ dobrý | 🟥 schlecht ~ nevyhovující

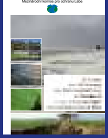
Konzentration an Schadstoffen ~ koncentrace znečišťujících látek
Leitfähigkeit ~ vodivost

Chemischer Zustand ~ Chemický stav

Grundwasser ~ Podzemní vody

Bewertung nach Wasserrahmenrichtlinie ~ Hodnocení podle Rámcové směrnice o vodách (RSV)

3. Bewirtschaftungszeitraum	**2022 – 2027**	**3. plánovací období**
2. Bewirtschaftungszeitraum wichtiges Ergebnis: Strategie zur Minderung der Nährstoffeinträge in Gewässer	**2016 – 2021**	**2. plánovací období** významný výsledek: Strategie ke snížení obsahu živin ve vodách
1. Bewirtschaftungszeitraum wichtiges Ergebnis: Sedimentmanagementkonzept der IKSE	**2010 – 2015**	**1. plánovací období** významný výsledek: Koncepce MKOL pro nakládání se sedimenty
Aktualisierung des internationalen Bewirtschaftungsplans	**2015 / 2021**	**Aktualizace Mezinárodního plánu povodí**
Entwurf der Aktualisierung des internationalen Plans*	**2014 / 2020**	Návrh aktualizace Mezinárodního plánu povodí*
Identifizierung der wichtigen Wasserbewirtschaftungsfragen*	**2013 / 2019**	Identifikace významných problémů nakládání s vodami*
Entwurf des Zeitplans und des Arbeitsprogramms*	**2012 / 2018**	Návrh časového plánu a programu prací*



Überprüfung und Aktualisierung des Plans alle 6 Jahre. ~ Přezkumy a aktualizace plánu každých 6 let.

Internationaler Bewirtschaftungsplan	**2009**	**Mezinárodní plán povodí**
Entwurf des internationalen Bewirtschaftungsplans*	**2008**	Návrh Mezinárodního plánu povodí*
Identifizierung der wichtigen Wasserbewirtschaftungsfragen*	**2007**	Identifikace významných problémů nakládání s vodami*
Bericht „Überwachungsprogramme gemäß Art. 8 der WRRL“		Zpráva „Monitorovací programy podle čl. 8 RSV“
Entwurf des Zeitplans und des Arbeitsprogramms*	**2006**	Návrh časového plánu a programu prací*
Bericht „Merkmale der Flussgebietseinheit“	**2005**	Zpráva „Charakteristiky oblasti povodí“

**veröffentlicht zur Anhörung der Öffentlichkeit*

**zveřejněno k připomínkám veřejnosti*

Die Wasserrahmenrichtlinie tritt in Kraft.	**22.12.2000**	**Rámcová směrnice o vodách nabyla účinnosti.**

Bei der Umsetzung der Wasserrahmenrichtlinie konnten die Staaten an die Ergebnisse des Sofortprogramms und des Aktionsprogramms Elbe anknüpfen.

Při implementaci Rámcové směrnice o vodách mohly státy v povodí Labe navázat na výsledky Naléhavého programu a Akčního programu Labe.

Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe

DIE ELBE IST WIEDER EIN LEBENDIGER FLUSS

Abschlussbericht
Aktionsprogramm Elbe
1996 – 2010

Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

LABE JE OPĚT ŽIVOUCÍ ŘEKOU

Závěrečná zpráva
Akční program Labe
1996 – 2010

Abschlussbericht **Aktionsprogramm Elbe 1996 – 2010**	**2010**	**Závěrečná zpráva** **Akční program Labe 1996–2010**
Aktionsprogramm Elbe mit den Schwerpunkten: ► Senkung der Belastung aus Punktquellen ► Verringerung der diffusen Belastungen ► Verbesserung der Biotopstrukturen ► Schutz vor unfallbedingten Gewässerbelastungen ► Verbesserung des Hochwasserschutzniveaus	**1996 – 2010**	**Akční program Labe** zaměřen na: ► snížení znečištění z bodových zdrojů ► snížení plošného znečištění ► zlepšení struktury biotopů ► ochranu před havarijním znečištěním vod ► zlepšení úrovně ochrany před povodněmi
Sofortprogramm ► mit Schwerpunkt auf den dringendsten Problemen im Bereich der punktuellen Einleitungen	**1992 – 1995**	**Naléhavý program** ► zaměřen na nejnaléhavější problémy v oblasti bodových zdrojů znečištění

Internationale Kommission zum Schutz der Elbe
August 2020

www.ikse-mkol.org

Mezinárodní komise pro ochranu Labe
srpen 2020

Hochwasserschutz

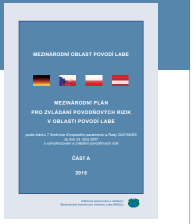
Ochrana před povodněmi

Die Staaten im Einzugsgebiet der Elbe – Deutschland, Tschechien, Österreich und Polen – haben sich geeinigt, einen „Internationalen Hochwasserrisikomanagementplan für die Flussgebietseinheit Elbe“ nach der „Richtlinie über die Bewertung und das Management von Hochwasserrisiken“ (RL 2007/60/EG) zu erarbeiten.

Der internationale Plan besteht aus dem gemeinsam erstellten A-Teil mit zusammenfassenden Informationen für die internationale Ebene und den von den einzelnen Staaten erarbeiteten nationalen B-Teilen.

Der A-Teil des internationalen Plans stellt die Maßnahmen dar, für die es teilweise nationalstaatlich übergreifende Lösungen geben muss. Die Koordinierung sichert die IKSE durch Beratungen der Fachgremien und in internationalen Workshops ab. Der Anhörungsprozess (Beteiligung der Öffentlichkeit) wird unterstützt durch Internationale Elbeforen.

Státy v povodí Labe – Česká republika, Německo, Rakousko a Polsko – se dohodly, že bude zpracován jeden „Mezinárodní plán pro zvládání povodňových rizik v oblasti povodí Labe“ dle „Směrnice o vyhodnocování a zvládání povodňových rizik“ (2007/60/ES).



Tento plán se skládá ze společně zpracované části A se souhrnnými informacemi na mezinárodní úrovni a z národních částí B, které zpracovaly jednotlivé státy.

V části A Mezinárodního plánu jsou popsána opatření, pro která je třeba zčásti najít řešení přesahující hranice států. Koordinaci zajišťuje MKOL pomocí odborných grémií a mezinárodních workshopů. Konzultace s veřejností je podporována organizací Mezinárodních labských fór.

Überprüfung und Aktualisierung des Plans alle 6 Jahre | Přezkumy a aktualizace plánu každých 6 let

2. Planungszeitraum	2022 – 2027	2. plánovací období
Aktualisierung des internationalen Plans	**2021**	**Aktualizace Mezinárodního plánu**
Entwurf der Aktualisierung des internationalen Plans	**2020**	Návrh aktualizace Mezinárodního plánu
Überprüfungen der Hochwassergefahren- und -risikokarten	**2019**	Přezkumy map povodňového nebezpečí a povodňových rizik
Überprüfungen der vorläufigen Bewertung des Hochwasserrisikos	**2018**	Přezkumy předběžného vyhodnocení povodňových rizik

Eine gemeinsame Kartenanwendung ermöglicht den Zugang zu den nationalen Portalen, auf denen die entsprechenden Hochwassergefahren und -risikokarten zur Verfügung stehen.

https://geoportal.bafg.de/mapapps/resources/apps/IKSE_DE/index.html?lang=de

Společná mapová aplikace umožňuje přístup k národním portálům, na kterých jsou příslušné mapy povodňového nebezpečí a povodňových rizik k dispozici.

http://geoportal.bafg.de/mapapps/resources/apps/MKOL_CZ/index.html?lang=en

Karte
Insgesamt wurden 423 Gebiete mit potenziellem signifikantem Hochwasserrisiko bestimmt, davon 342 in Deutschland, 80 in Tschechien und 1 in Polen (Gesamtlänge der Wasserläufe mehr als 10 700 km).

Mapa: Bylo vymezeno celkem 423 oblastí s potenciálně významným povodňovým rizikem, z toho 80 v České republice, 342 v Německu a 1 v Polsku, o celkové délce vodních toků více než 10 700 km.

1. Planungszeitraum	2016 – 2021	1. plánovací období
Internationaler Plan	**2015**	**Mezinárodní plán**
Entwurf des internationalen Plans	**2014**	Návrh Mezinárodního plánu
Hochwassergefahren- und -risikokarten	**2013**	Mapy povodňového nebezpečí a povodňových rizik
Vorläufige Bewertung des Hochwasserrisikos	**2011**	Předběžné vyhodnocení povodňových rizik

► Aktionsplan Hochwasserschutz Elbe Seine inhaltlichen Themen werden im Rahmen der Umsetzung der „Richtlinie über die Bewertung und das Management von Hochwasserrisiken“ (RL 2007/60/EG) integriert und fortgeführt.	**2003 – 2011**	► Akční plán povodňové ochrany v povodí Labe Jeho obsahová témata jsou začleněna a dále rozpracovávána v rámci implementace „Směrnice o vyhodnocování a zvládání povodňových rizik“ (2007/60/ES).
► Gemeinsame grenzüberschreitende Auswertungen der bedeutsamen Hochwasserereignisse der Jahre 2002, 2006, 2010 und 2013		► Společná přeshraniční vyhodnocení významných povodní 2002, 2006, 2010 a 2013
► Bestandsaufnahme des vorhandenen Hochwasserschutzniveaus	**2001**	► Zmapování stávající úrovně povodňové ochrany
► Analysen der hydrologischen Aspekte der Entstehung von Hochwasser und deren Vorhersagen	**2000**	► Analýzy hydrologických aspektů vzniku povodní a jejich předpovědi
► Strategie des Hochwasserschutzes im Einzugsgebiet der Elbe	**1998**	► Strategie povodňové ochrany v povodí Labe

Internationale Kommission zum Schutz der Elbe
August 2020

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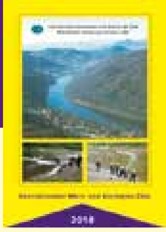
Mezinárodní komise pro ochranu Labe
srpen 2020

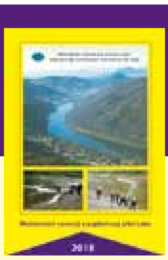
Warn- und Alarmsystem an der Elbe

Varovný a poplachový systém na Labi



Dem **Internationalen Warn- und Alarmplan Elbe (IWAPE)** kommt eine außerordentliche Bedeutung insbesondere bei grenzüberschreitenden Unfällen zu. Die Hauptstruktur bilden 5 Internationale Hauptwarnzentralen (IHWZ).

Mezinárodní varovný a poplachový plán Labe (MVPPL) má mimořádný význam zejména v případě havárií přesahujících státní hranice. Hlavní strukturu tvoří 5 mezinárodních hlavních varovných central (MHVC).



- ► Er gewährleistet seit 1991 die Weiterleitung von Informationen über Ort, Zeit und Ausmaß einer unfallbedingten Gewässerbelastung im Einzugsgebiet der Elbe.
- ► Er wird anhand neuer Erkenntnisse und Erfahrungen ständig angepasst.
- ► Die Regeln für das Verschicken von Meldungen berücksichtigen nicht nur das Ausmaß des Unfalls, sondern orientieren sich auch am potenziellen Interesse der Medien und der Öffentlichkeit.
- ► Die Überschreitung der Alarmschwellenwerte (Konzentrationen ausgewählter Stoffe) für das Grenzprofil Schmilka/Hřensko wird seit 2019 gemeldet.
- ► Das **Alarmmodell Elbe (ALAMO)** wurde 2004 in den IWAPE integriert. Im Januar 2017 wurde das ALAMO auf die Nebenflüsse Moldau und Saale erweitert, die Erweiterung für die Bílina ist in Vorbereitung. Für die Kalibrierung des Modells wurden Tracerversuche durchgeführt.

ALAMO
Vorhersagemodell für die Ausbreitung von Schadstoffwellen in der Elbe; ermöglicht im Falle einer unfallbedingten Gewässerbelastung, den Zeitpunkt des Eintreffens, die Dauer sowie die Maximalkonzentration einer Schadstoffwelle an Profilen der Elbe unterhalb des Unfallortes abzuschätzen.

Modellierte Abschnitte: ▬ Elbe ▬ Moldau ▬ Saale ▬ Bílina (in Vorbereitung)

- ► Zajišťuje již od roku 1991 přenos informací o místě, času a rozsahu havarijního znečištění vod v povodí Labe.
- ► Je neustále upravován podle nových poznatků a zkušeností.
- ► Pravidla pro rozesílání hlášení zohledňují nejen rozsah havárie, ale i případný zájem hromadných sdělovacích prostředků a veřejnosti.
- ► Hlášení při překročení varovných prahových hodnot (koncentrací vybraných látek) v hraničním profilu Hřensko/Schmilka se podávají od roku 2019.
- ► **Poplachový model Labe (ALAMO)** byl do MVPPL zařazen v roce 2004. V lednu 2017 byl ALAMO rozšířen o přítoky Vltavu a Sálu. Připravuje se další rozšíření o Bílinu. Pro kalibraci modelu byly provedeny pokusy se značkovací látkou.

ALAMO
Model pro prognózu šíření vln znečišťujících látek v Labi; umožňuje provést v případě havarijního znečištění vod odhad doby dotoku, trvání a maximální koncentrace vlny znečišťujících látek v profilech Labe pod místem havárie.

Modelované úseky: ▬ Labe ▬ Vltava ▬ Sála ▬ Bílina (připravuje se)

Zuständigkeitsbereich der IHWZ
Oblast působnosti MHVC
Karte / Mapa: BfG, ČHMÚ, IKSE / MKOL

Foto: BfG
Tracerversuch an der Elbe / Pokus se značkovací látkou na Labi

Foto: IKSE / MKOL
Feierliche Inbetriebnahme / Slavnostní uvedení do provozu

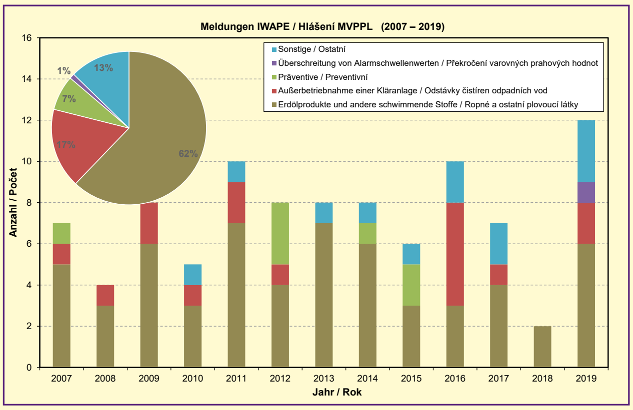
Foto: MKOL / IKSE
Pokus se značkovací látkou na Vltavě / Tracerversuch an der Moldau

Für die Abwehr von unfallbedingten Gewässerbelastungen mit Erdölprodukten und anderen schwimmenden Stoffen wurde 2016 im Grenzabschnitt der Elbe ein **stationärer Unfallbekämpfungspunkt** fertiggestellt.

V roce 2016 byl dokončen **stabilní havarijní profil** v hraničním úseku Labe pro zvládání havarijních znečištění ropnými a ostatními plovoucími látkami.

- ► Der IWAPE ist vor allem bei der Weitergabe von Informationen aus Tschechien an Deutschland von großer Bedeutung. Deshalb werden im tschechischen Elbeabschnitt in der Nähe des tschechisch-deutschen Grenzprofils auch Informationen über unbedeutende unfallbedingte Gewässerbelastungen und eventuelle Verdachtsfälle auf mögliche Belastungen sorgfältig überwacht und von der Hauptwarnzentrale Hradec Králové weitergeleitet. Die meisten gemeldeten Ereignisse beziehen sich auf den 45 km langen tschechischen Elbeabschnitt zwischen Ústí nad Labem und dem tschechisch-deutschen Grenzprofil.

- ► MVPPL má mimořádný význam především při předávání informací z České republiky do Německa. Proto jsou na českém úseku Labe v blízkosti česko-německého hraničního profilu pečlivě monitorovány a mezinárodní hlavní varovnou centrálou v Hradci Králové pomocí hlášení dále předávány také informace o nevýznamných případech havarijního znečištění vod i případná podezření na možná znečištění. Většina hlášených případů se vztahuje k 45 km dlouhému českému úseku Labe mezi Ústím nad Labem a česko-německým hraničním profilem.



Meldungen im Rahmen des IWAPE (2007 – 2019)
Erdölprodukte und andere schwimmende Stoffe waren der Hauptgrund (62 % der Ereignisse) für den Versand einer Meldung. In 6 Fällen handelte es sich um eine größere Menge (zwischen 1,5 und 6 m^3) von Erdölprodukten. In 7 Fällen wurde eine präventive Meldung verschickt *(siehe Abb.)*, obwohl offensichtlich war, dass es sich nicht um eine unfallbedingte Belastung handelt (Blütenstaub und anderes Pflanzenmaterial).

Hlášení v rámci MVPPL (2007–2019)
Ropné a ostatní plovoucí látky byly hlavním důvodem (62 % případů) pro zaslání hlášení. V 6 případech se jednalo o větší množství ropných látek mezi 1,5 až 6 m^3. V 7 případech bylo zasláno preventivní hlášení *(viz obrázek)*, i když bylo zřejmé, že se nejedná o havarijní znečištění (pyly a další rostlinný materiál).

Internationale Kommission zum Schutz der Elbe
August 2020

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Mezinárodní komise pro ochranu Labe
srpen 2020

Revitalisierung von Gewässern und der Wasserhaushalt im Einzugsgebiet der Elbe

Internationales Messnetz und Messprogramm

Mezinárodní měřicí síť a program měření


Messstrategie der IKSE

Seit Beginn der 90er Jahre des 20. Jahrhunderts wird eine positive Entwicklung der Wasserbeschaffenheit der Elbe und ihrer Nebenflüsse beobachtet.

Od začátku devadesátých let 20. století je v Labi a jeho přítocích sledován pozitivní vývoj jakosti vody.


Strategie měření MKOL

Internationales Wassergütemessnetz und internationales Messprogramm

Die Untersuchung der Wasserbeschaffenheit im Einzugsgebiet der Elbe auf der Grundlage des „Internationalen Messprogramms Elbe“ wird an 9 Messstellen in Deutschland und 6 Messstellen in Tschechien (10 direkt an der Elbe und 5 an den Nebenflüssen) durchgeführt *(siehe Karte)*. Diese sind gleichzeitig Stellen der überblicksweisen Überwachung gemäß europäischer Wasserrahmenrichtlinie und liefern einen Überblick über die aktuelle Situation in der Flussgebietseinheit Elbe.


Messstellen des Internationalen Messprogramms Elbe
Měrné profily Mezinárodního programu měření Labe
Bearbeiter / Zpracování:
BfG, ČHMÚ, IKSE / MKOL
● *Messstelle / měrný profil*

An den Messstellen, die mit Messstationen ausgestattet sind, werden einige Parameter, z. B. Wassertemperatur, pH-Wert, elektrische Leitfähigkeit, gelöster Sauerstoff und Durchfluss, kontinuierlich gemessen. Für die Bestimmung der anderen Parameter werden die Proben automatisch entnommen und anschließend in Laboren analysiert.

Das erste international abgestimmte Messprogramm wurde für das Jahr 1992 mit 63 Parametern aufgestellt. Die einzelnen Parameter werden in den Komponenten untersucht, in denen sie in relevanten Konzentrationen auftreten. Neben der Untersuchung in der Wasserphase wurden 1996 routinemäßige Untersuchungen schwebstoffbürtiger Sedimente eingeführt. Das „Internationale Messprogramm Elbe“ umfasst die Untersuchung von ca. 200 Parametern in der Wasserphase und ca. 70 Parametern in schwebstoffbürtigen Sedimenten. Im biologischen Teil des Messprogramms werden ca. 10 Parameter untersucht. Die Bioakkumulation von Schadstoffen wird anhand von ca. 20 Parametern untersucht.

Die Messstellen mit der größten Anzahl der untersuchten Parameter sind die Wächtermessstellen Hřensko-Schmilka an der deutsch-tschechischen Grenze und Seemannshöft. An dieser Messstelle wird der Schadstoffeintrag der Elbe in die Nordsee bilanziert.

Das Messprogramm wird jährlich aktualisiert. Die im Oktober 2018 verabschiedete „Messstrategie der IKSE“ bildet gegenwärtig die Grundlage für die Aktualisierung des Messprogramms.

Mezinárodní měřicí síť a mezinárodní program měření

V rámci „Mezinárodního programu měření Labe“ se jakost vody sleduje *(viz mapa)* na 6 měrných profilech v České republice a 9 měrných profilech v Německu (10 přímo na Labi a 5 na přítocích), které jsou zároveň i profily situačního monitoringu podle evropské Rámcové směrnice o vodách a poskytují přehled o aktuální situaci v oblasti povodí Labe.

Na měrných profilech, které jsou vybaveny měřicími stanicemi, se některé ukazatele, např. teplota vody, pH, konduktivita, rozpuštěný kyslík a průtok, měří kontinuálně. Pro stanovení ostatních ukazatelů probíhá automatický odběr vzorků, které se následně analyzují v laboratoři.

První mezinárodní program měření byl sestaven pro rok 1992 a zahrnoval 63 ukazatelů. Jednotlivé ukazatele se sledují v těch složkách, ve kterých se vyskytují ve významných koncentracích. Vedle sledování ve vodné fázi bylo v roce 1996 zavedeno rutinní sledování sedimentovatelných plavenin. V rámci „Mezinárodního programu měření Labe“ se sleduje cca 200 ukazatelů ve vodné fázi a cca 70 ukazatelů v sedimentovatelných plaveninách. Biologická část programu měření zahrnuje cca 10 ukazatelů. Pomocí cca 20 ukazatelů se sleduje bioakumulace znečišťujících látek.

Měrnými profily s největším počtem sledovaných ukazatelů jsou pilotní profily Hřensko-Schmilka na česko-německé hranici a Seemannshöft, na kterém se bilancuje vnos znečišťujících látek z Labe do Severního moře.

Program měření se každý rok aktualizuje. „Strategie měření MKOL“, která byla schválena v říjnu 2018, tvoří v současné době základ aktualizace programu měření.

Analytische Qualitätssicherung

Eine wichtige Voraussetzung für die gemeinsame Interpretation der gemessenen Werte ist ihre Vergleichbarkeit. Dafür sorgen Maßnahmen zur Qualitätssicherung auf internationaler Ebene im Rahmen der IKSE wie Auswahl und Anwendung identischer oder vergleichbarer Messmethoden, Durchführung von Kontroll- und Vergleichsmessungen, gemeinsamen Probenahmen sowie gemeinsame Auswertung der Messergebnisse.

Zabezpečení kvality analytických výsledků

Důležitým předpokladem pro společnou interpretaci naměřených hodnot je jejich porovnatelnost. Ta je zajišťována na mezinárodní úrovni v rámci MKOL pomocí opatření k zabezpečení kvality, jako je výběr a aplikace stejných nebo porovnatelných metod měření, provádění kontrolních a mezilaboratorních porovnání, společných odběrů vzorků a společné vyhodnocování výsledků měření.

Entwicklung der Gewässergüte

Die positiven Veränderungen der Gewässergüte der Elbe in den Jahren 1990 – 1992 resultierten insbesondere aus Produktionsstilllegungen und -reduzierungen auf dem Gebiet der neuen Bundesländer. In den Folgejahren wurde eine weitere Verbesserung der Gewässergüte als Ergebnis von Sanierungsmaßnahmen erreicht, vor allem durch den Bau von kommunalen und industriellen Kläranlagen sowie durch technologische Veränderungen in den Industriebetrieben.

Trotz des erreichten großen Fortschritts ist die Belastung in der Wasserphase mit Nährstoffen (Stickstoff- und Phosphorverbindungen) immer noch hoch. Ein Teil der Schadstoffe ist an Schwebstoffe und in Sedimenten gebunden. Es handelt sich vor allem um Schwermetalle (Quecksilber, Cadmium, Blei, Zink), spezifische organische Stoffe (chlorierte Benzene, chlorierte Pestizide, polychlorierte Biphenyle, polyzyklische aromatische Kohlenwasserstoffe) sowie Tributylzinn. Diese Schadstoffe können bei erhöhten Wasserführungen aus den Sedimenten freigesetzt werden.

Vývoj jakosti vody

Pozitivní změny jakosti vody v Labi v letech 1990–1992 byly podmíněny zejména uzavíráním podniků a poklesem výroby na území nových spolkových zemí Německa. Další zlepšení jakosti vody v následujících letech je výsledkem sanačních opatření, především výstavby komunálních a průmyslových čistíren odpadních vod a technologických změn v průmyslových podnicích.

Přes dosažený velký pokrok je ve vodné fázi nadále zjišťováno značné znečištění živinami (sloučeninami fosforu a dusíku). Kromě toho je část znečišťujících látek vázána na plaveniny a sedimenty. Jedná se především o těžké kovy (rtuť, kadmium, olovo, zinek), specifické organické látky (chlorované benzeny, chlorované pesticidy, polychlorované bifenyly, polycyklické aromatické uhlovodíky) a tributylcín. V případě větších průtoků se mohou tyto látky uvolňovat ze sedimentů.

Internationale Kommission zum Schutz der Elbe
August 2020

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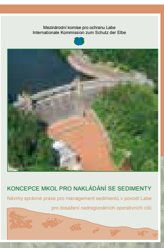
Sedimentmanagement

Nakládání se sedimenty

Sedimente erfüllen grundlegende Funktionen als Gewässerbett, aquatischer Lebensraum und in Stoffkreisläufen der Gewässer. Sie haben durch ihre Menge und Qualität eine Schlüsselfunktion für unverzichtbare Ökosystemleistungen und bedeutsame Gewässernutzungen.

Sedimenty plní základní funkce při utváření koryt vodních toků, jako akvatická stanoviště a v koloběhu látek vodních toků. Svým množstvím a svou jakostí hrají klíčovou roli pro nepostradatelné funkce ekosystémů a významné způsoby užívání vod.



Im Zuge der Ausarbeitung des ersten internationalen Bewirtschaftungsplans nach der Wasserrahmenrichtlinie (IKSE, 2009) und der laufenden Umsetzung der Meeresstrategie-Rahmenrichtlinie wurde deutlich, dass Defizite sowohl im Sedimenthaushalt, bei der Hydromorphologie als auch in der Sedimentqualität bedeutsame Hindernisse bei der Erreichung des guten Gewässerzustands sind.

Durch die Veröffentlichung des „Sedimentmanagementkonzepts der IKSE“ im Jahr 2014 wurde die Voraussetzung geschaffen, um das Thema Sediment seiner Bedeutung entsprechend zu einem integralen Bestandteil der wasserwirtschaftlichen Planung und Praxis im Flussgebiet Elbe zu machen. Die Analysen und Schlussfolgerungen des Konzepts sind insbesondere bedeutsam für die Verbesserung der Gewässerstruktur und bei der Reduktion der signifikanten stofflichen Belastungen bis in den Meeresbereich. Dazu sind im Konzept Handlungsempfehlungen aufgeführt. Die höchste Priorität haben dabei die Maßnahmen, die das betreffende Problem direkt an der Quelle lösen oder die Ursache der Probleme beseitigen.

Zur Klassifizierung der Schwebstoffe und Sedimente führte das Konzept für die elberelevanten Schadstoffe ein System von unteren (strengeren) und oberen Schwellenwerten (OSW) ein. Dieses System wurde 2018 um den sog. Sedimentqualitätsindex (SQI) erweitert, der als Quotient aus dem Jahresmittelwert der Gehalte des jeweiligen Schadstoffes in den Monatsmischproben der frischen, schwebstoffbürtigen Sedimente und seinem oberen Schwellenwert berechnet wird.

Der SQI dient zur Darstellung und Dokumentation zeitlicher und räumlicher Veränderungen (Trends) sowie der Intensität der Schadstoffbelastung in Schwebstoffen und Sedimenten. Die Anwendung des SQI in der internationalen Flussgebietseinheit Elbe ermöglicht eine Darstellung und Wichtung der zeitlichen Qualitätsentwicklung der schwebstoffbürtigen Sedimente an einem Standort sowie auch deren räumliche Differenzierung entlang des Gewässerverlaufs.

Při vypracování prvního mezinárodního plánu povodí podle Rámcové směrnice o vodách (MKOL, 2009) a probíhající implementaci Rámcové směrnice o strategii pro mořské prostředí se ukázalo, že nedostatky v režimu sedimentů, v hydromorfologii i v jakosti sedimentů jsou podstatnou překážkou pro dosažení dobrého stavu vod.

Zveřejněním „Koncepce MKOL pro nakládání se sedimenty“ v roce 2014 byl vytvořen předpoklad k tomu, aby se téma sedimentů vzhledem ke svému významu stalo nedílnou součástí plánování a praxe vodohospodářského v povodí Labe. Analýzy a závěry koncepce jsou důležité zejména pro zlepšení struktury vodních toků a při snižování významného látkového zatížení až do oblasti moře. K tomu jsou v koncepci uvedeny doporučené postupy. Nejvyšší prioritu přitom mají opatření, která řeší daný problém přímo u zdroje nebo odstraňují příčinu problémů.

Za účelem klasifikace sedimentovatelných plavenin a sedimentů zavedla koncepce pro znečišťující látky relevantní pro Labe systém dolních (přísnějších) a horních prahových hodnot (HPH). V roce 2018 byl tento systém rozšířen o tzv. index kvality sedimentů (SQI), který se vypočítá jako podíl ročního průměru obsahu příslušné znečišťující látky v měsíčních směsných vzorcích čerstvých sedimentovatelných plavenin a její horní prahové hodnoty.

SQI slouží ke znázornění a zdokumentování časových a prostorových změn (trendů) a intenzity kontaminace znečišťujícími látkami v sedimentovatelných plaveninách a sedimentech. Aplikace SQI v mezinárodní oblasti povodí Labe umožňuje váženým způsobem zobrazit časový vývoj kvality sedimentovatelných plavenin v jedné lokalitě a jeho prostorovou diferenciaci v podélném profilu toku.

Bezugsmessstellen Sedimentmanagement
Referenční profily managementu sedimentů

Karte / Mapa: FGG Elbe, BfG, ČHMÚ, IKSE / MKOL

Legende / Legenda
- ▲ *Qualität / kvalita*
- ■ *Quantität / kvantita*
- // *Grenzen frei fließende Elbe / hranice volně tekoucího úseku Labe*

Elbe-Grenzprofil Schmilka/Hřensko

Hraniční profil Labe Hřensko / Schmilka

Stoff	OSW	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Látka	HPH
Quecksilber	0,47 mg/kg	26	16	10	18	7,1	5,7	5,7	4,6	4,1	3,5	3,4	2,8	3,6	1,7	2,1	3,1	3,4	1,6	1,4	1,2	1,1	1,9	2,1	2,4	1,5	1,5	**Rtuť**	0,47 mg/kg
Cadmium	2,3 mg/kg	1,8	1,7	1,4	1,2	2,4	1,4	1,1	1,1	1,4	1,0	1,5	1,2	0,9	1,1	1,0	1,1	0,9	0,8	0,7	0,6	0,6	0,7	0,7	0,7	0,7	0,8	**Kadmium**	2,3 mg/kg
Blei	53 mg/kg	2,7	2,8	2,1	1,9	2,3	1,6	1,7	2,0	1,8	1,6	1,8	1,9	1,7	1,8	1,6	1,6	1,6	1,4	1,2	1,1	1,1	1,0	1,3	1,1	1,1	1,2	**Olovo**	53 mg/kg
Zink	800 mg/kg	1,3	1,1	0,8	0,8	0,9	0,8	0,9	1,3	1,1	0,8	1,6	1,1	0,6	0,7	0,6	0,7	0,6	0,5	0,6	0,5	0,4	0,6	0,6	0,6	0,6	0,8	**Zinek**	800 mg/kg
Kupfer	160 mg/kg	0,9	0,8	0,6	0,6	0,6	0,6	0,5	0,6	0,6	0,5	0,6	0,6	0,5	0,5	0,5	0,5	0,5	0,5	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,5	**Měď**	160 mg/kg
Nickel	53 mg/kg	1,2	1,3	1,1	0,9	1,0	0,9	0,8	1,0	1,1	0,9	0,9	1,0	0,9	0,9	1,0	1,0	0,9	0,9	1,0	0,8	0,8	0,9	1,0	0,9	1,0	1,1	**Nikl**	53 mg/kg
Arsen	40 mg/kg	1,1	0,9	0,8	0,7	0,8	0,6	0,6	0,7	0,6	0,6	0,8	0,8	0,7	0,8	0,8	0,7	0,7	0,8	0,6	0,5	0,5	0,6	0,7	0,6	0,6	0,6	**Arzen**	40 mg/kg
Chrom	640 mg/kg	0,3	0,2	0,2	0,2	0,2	0,2	0,1	0,2	0,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	**Chrom**	640 mg/kg
α-HCH	1,5 µg/kg	0,5	0,9	1,8	<3,3	2,3	2,4	<2,0	<2,0	2,3	3,1	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<0,7	<0,7	<0,7	<0,7	<0,7	<0,7	**α-HCH**	1,5 µg/kg
β-HCH	5 µg/kg	2,1	0,8	0,3	<1,0	1,1	<0,6	<0,6	1,1	3,7	1,0	<0,6	0,8	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,6	<0,2	<0,2	<0,2	<0,2	1,2	<0,2	**β-HCH**	5 µg/kg
γ-HCH	1,5 µg/kg	1,0	1,3	2,6	<3,3	1,4	<2,0	<2,0	<2,0	<2,0	4,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<0,7	<0,7	<0,7	<0,7	<0,7	<0,7	**γ-HCH**	1,5 µg/kg
p,p'-DDT	3 µg/kg	25	56	62	24	82	19	28	22	73	21	43	62	48	30	73	87	132	29	26	18	63	67	172	156	47	37	**p,p'-DDT**	3 µg/kg
p,p'-DDE	6,8 µg/kg	3,5	2,6	2,6	4,1	2,8	3,5	4,7	3,4	4,9	4,2	3,3	5,1	5,0	3,4	9,9	5,6	7,3	2,8	3,1	2,5	5,3	4,4	8,1	9,9	4,0	2,8	**p,p'-DDE**	6,8 µg/kg
p,p'-DDD	3,2 µg/kg	16	22	14	32	39	28	55	53	38	23	53	22	16	11	28	16	24	7,9	9,4	5,0	13	15	52	38	20	8,1	**p,p'-DDD**	3,2 µg/kg
PCB Nr. 28	20 µg/kg	0,5	0,6	0,8	0,9	0,4	0,5	0,5	1,3	0,9	0,6	0,3	0,3	0,3	0,3	0,5	0,3	0,2	0,2	0,3	0,3	0,2	0,3	0,6	0,3	0,2	0,2	**PCB 28**	20 µg/kg
PCB Nr. 52	20 µg/kg	0,7	0,7	1,9	2,1	1,0	2,1	0,7	0,9	0,6	0,5	0,3	0,4	0,2	0,3	0,4	0,6	0,5	0,2	0,2	0,2	0,2	0,2	0,9	0,2	0,1	0,2	**PCB 52**	20 µg/kg
PCB Nr. 101	20 µg/kg	0,8	0,8	0,6	2,0	0,6	1,0	0,9	0,9	0,8	0,8	0,6	1,0	0,5	0,7	0,9	0,6	0,6	0,3	0,4	0,3	0,4	0,6	5,7	0,9	0,4	0,5	**PCB 101**	20 µg/kg
PCB Nr. 118	20 µg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	0,3	0,4	0,3	0,2	0,2	0,1	0,1	0,2	0,2	1,6	0,3	0,2	0,2*	**PCB 118**	20 µg/kg
PCB Nr. 138	20 µg/kg	1,9	1,9	1,7	3,8	1,4	1,7	2,0	2,2	1,9	2,0	1,5	2,9	1,6	1,8	2,6	2,4	2,0	1,0	1,2	1,0	1,3	2,1	18	3,3	1,4	1,9	**PCB 138**	20 µg/kg
PCB Nr. 153	20 µg/kg	1,9	1,7	2,0	3,9	1,3	1,7	2,0	2,2	2,0	2,0	1,5	3,1	1,6	2,0	3,1	2,3	2,0	1,2	1,2	1,0	1,4	2,4	19	3,6	1,4	1,9	**PCB 153**	20 µg/kg
PCB Nr. 180	20 µg/kg	1,5	1,4	1,6	3,4	0,9	1,4	1,7	1,8	1,6	1,6	1,3	3,1	1,5	1,8	2,3	1,9	1,5	0,8	1,0	0,7	1,0	2,1	20	3,2	1,2	1,6	**PCB 180**	20 µg/kg
Summe 7 PCB	140 µg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	1,0	1,5	1,2	1,0	0,6	0,6	0,5	0,7	1,1	9,5	1,7	0,7	0,9*	**Suma 7 PCB**	140 µg/kg
Pentachlorbenzen	400 µg/kg	0,1	0,1	0,1	0,1	<0,1	<0,1	<0,1	<0,1	-	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	**Pentachlorbenzen**	400 µg/kg
HCB	17 µg/kg	46	24	32	60	36	47	56	44	27	74	16	20	14	6,6	10	9,8	9,0	4,6	8,9	3,3	11	9,6	13	9,0	4,4	4,0	**HCB**	17 µg/kg
Benzo(a)pyren	600 µg/kg	-	1,7	0,8	1,2	0,8	1,1	1,1	1,0	1,2	1,2	1,1	1,1	1,2	1,1	1,0	1,0	1,1	1,3	1,2	0,9	1,5	1,1	1,2	1,0	0,8	0,7	**Benzo(a)pyren**	600 µg/kg
Anthracen	310 µg/kg	-	1,0	0,6	1,0	0,7	0,8	0,8	0,8	0,8	0,6	0,8	1,1	0,8	0,8	0,7	0,6	0,7	0,9	0,9	0,5	0,8	0,5	0,6	0,5	0,5	0,5	**Anthracen**	310 µg/kg
Fluoranthen	250 µg/kg	-	9,9	4,0	4,4	4,5	6,9	6,6	6,3	7,2	7,7	5,4	5,6	5,3	6,0	6,0	4,9	6,3	5,7	4,5	4,7	7,7	4,5	4,8	4,3	3,8	3,0	**Fluoranthen**	250 µg/kg
Summe 5 PAK	2500 µg/kg	-	1,8	0,9	1,3	1,0	1,4	1,3	1,2	1,4	1,5	1,3	1,1	1,2	1,2	1,3	1,2	1,3	1,3	1,0	0,9	1,4	1,1	1,2	0,9	0,8	0,7	**Suma 5 PAU**	2500 µg/kg
Tributylzinn Kation	20 µg/kg	6,1	2,0	1,5	3,1	1,4	1,6	1,5	1,3	1,1	0,9	1,1	1,1	0,7	0,5	0,3	0,3	0,4	0,2	0,2	0,1	0,2	0,1	0,1	<0,1	0,1	<0,1	**Kationt tributylcínu**	20 µg/kg
Dioxine/Furane	20 ng TEQ/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	16	23	-	-	-	-	-	0,3	0,5	0,9	0,7	0,5	0,4	**Dioxiny / furany**	20 ng TEQ/kg

**Prüfvorbehalt ~ s výhradou prověření*

Klassen / Třídy
- SQI > 8
- SQI ≤ 8
- SQI ≤ 4
- SQI ≤ 2
- SQI ≤ 1
- -

Übersicht der SQI-Werte inklusive der oberen Schwellenwerte der schwebstoffbürtigen Sedimente am Elbe-Grenzprofil Schmilka/Hřensko für den Zeitraum 1993 – 2018
Přehled hodnot SQI včetně horních prahových hodnot sedimentovatelných plavenin v hraničním profilu Labe Hřensko/Schmilka za období 1993–2018

Internationale Kommission zum Schutz der Elbe
August 2020

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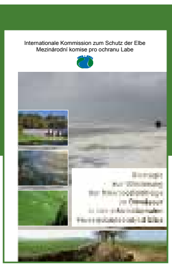
Revitalisierung von Gewässern und der Wasserhaushalt im Einzugsgebiet der Elbe

Reduzierung der Nährstoffeinträge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Nährstoffeinträge in die Oberflächengewässer und das Grundwasser bleiben auch weiterhin eine der wichtigen Wasserbewirtschaftungsfragen im Einzugsgebiet der Elbe.

Trotz der bedeutenden Verbesserung in den letzten zwanzig Jahren werden u. a. aufgrund der Nährstoffbelastung Ziele der Wasserrahmenrichtlinie (RL 2000/60/EG) und der Meeresstrategie-Rahmenrichtlinie (RL 2008/56/EG) noch nicht erreicht. Obwohl alle Mitgliedstaaten, die zur internationalen Flussgebietseinheit Elbe gehören, auf ihrem Gebiet die von der WRRL vorgeschriebenen Prinzipien des Gewässerschutzes anwenden, ist es für den Schutz des Elbestroms sowie der Küsten- und Meeresgewässer im Einzugsgebiet der Elbe erforderlich, überregionale Ziele festzulegen und geeignete Maßnahmen abzuleiten, um die Reduzierung der aus verschiedenen Teilen des Einzugsgebiets und unterschiedlichen Quellen stammenden Nährstoffbelastung zu koordinieren.

Der herausgehobenen Bedeutung der Nährstoffproblematik wurde in der IKSE durch die 2014 eingerichtete **Ad-hoc-Expertengruppe „Nährstoffe“** Rechnung getragen. Sie wurde beauftragt, eine **„Strategie zur Minderung der Nährstoffeinträge in Gewässer in der internationalen Flussgebietseinheit Elbe“** zu erarbeiten. Diese Strategie wurde im Oktober 2018 beschlossen und anschließend als Publikation der IKSE herausgegeben (www.ikse-mkol.org). Die Strategie enthält:

- ► eine Beurteilung und einen Vergleich der Methoden und Verfahren zur Bewertung der **Nährstoffe (Stickstoff und Phosphor)** in Deutschland und Tschechien,
- ► eine gemeinsame Bewertung der aktuellen Belastungssituation der Gewässer mit Nährstoffen anhand einheitlich aufbereiteter Daten,
- ► Festlegungen gemeinsamer überregionaler Ziele für die Nährstoffe und die entsprechenden Gewässertypen einschließlich des Minderungsbedarfs für Nährstoffeinträge für die ausschlaggebenden Messstellen der Elbe mit dem Ziel, die Nordsee zu schützen,
- ► eine Auswertung von Umfang und Bedeutung sowie regionaler Schwerpunkte der Nährstoffeintragsquellen und -pfade sowie die Bestimmung der entscheidenden Typen der Belastungsquellen, die die Zielerreichung gefährden,
- ► geeignete Maßnahmenvorschläge und weitere Empfehlungen, die zur effektiven Minderung des Nährstoffgehalts in den Gewässern im Einzugsgebiet der Elbe führen sollen.

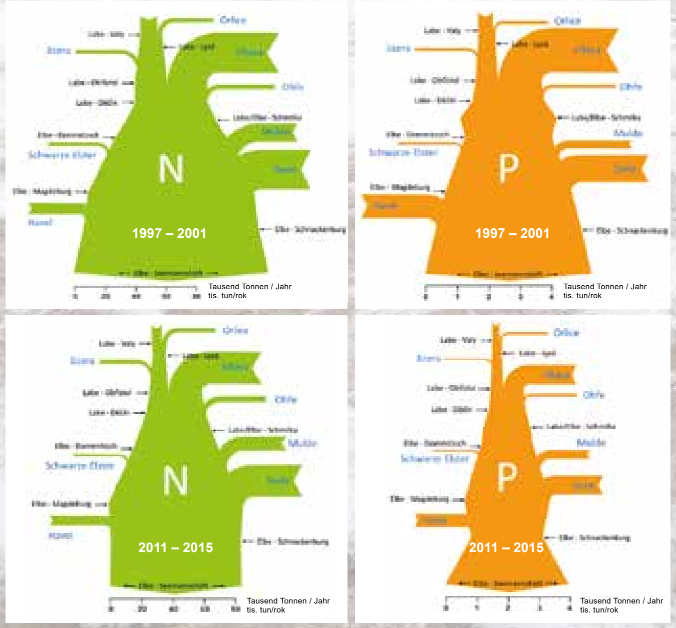
Die gewonnenen Erkenntnisse werden bei der Erarbeitung der nationalen Bewirtschaftungspläne und des „Internationalen Bewirtschaftungsplans für die Flussgebietseinheit Elbe“ für den Zeitraum 2022 – 2027 angewendet.

1997 – 2001: Stand vor der Umsetzung der WRRL
Abflussnormierte **Ist-Fracht** an der Messstelle Seemannshöft in t/a:
N: 126 970 **P: 5 340**

2011 – 2015: Phase der Umsetzung des 1. Bewirtschaftungsplans
Abflussnormierte **Ist-Fracht** an der Messstelle Seemannshöft in t/a:
N: 84 400 **P: 3 940**

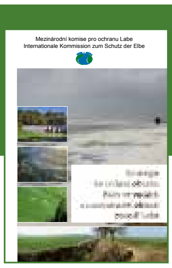
2014 – 2018: Auswertung für den 3. Bewirtschaftungsplan
Abflussnormierte **Ist-Fracht** an der Messstelle Seemannshöft in t/a:
N: 75 082 **P: 4 310**

► Abflussnormierte **Zielfracht** an der Messstelle Seemannshöft in t/a:
N: 66 850 **P: 2 385**



Mittlere Jahresfrachten für Gesamtstickstoff (N) und Gesamtphosphor (P) in der Elbe und ihren bedeutenden Nebenflüssen in den Zeiträumen 1997 – 2001 und 2011 – 2015
Průměrné roční odnosy celkového dusíku a fosforu na Labi a v jeho významných přítocích v obdobích 1997–2001 a 2011–2015

Snížení vnosu živin


Mezinárodní komise pro ochranu Labe
Internationale Kommission zum Schutz der Elbe

Vnosy živin do povrchových a podzemních vod zůstávají i nadále jedním z významných problémů nakládání s vodami v povodí Labe.

I přes výrazné zlepšení v minulých dvou desetiletích nejsou mimo jiné vzhledem k zatížení živinami dosud dosaženy cíle Rámcové směrnice o vodách (2000/60/ES) a Rámcové směrnice o strategii pro mořské prostředí (2008/56/ES). Přestože všechny členské státy, které náleží do mezinárodní oblasti povodí Labe, uplatňují na svém území principy ochrany vod předepsané Rámcovou směrnicí o vodách, je nutné pro ochranu toku Labe i pobřežních a mořských vod v povodí Labe stanovit nadregionální cíle a vyvodit vhodná opatření s cílem koordinovat snižování zátěže živinami pocházející z různých částí povodí a z různých zdrojů.

Vzhledem k mimořádnému významu problematiky živin ustavila MKOL v roce 2014 **ad-hoc skupinu expertů Živiny** a pověřila ji, aby vypracovala **„Strategii ke snížení obsahu živin ve vodách v mezinárodní oblasti povodí Labe“**. Tato strategie byla schválena v říjnu 2018 a následně vydána jako publikace MKOL (www.ikse-mkol.org).

Strategie obsahuje

- ► posouzení a srovnání metod a způsobů hodnocení **živin (dusíku a fosforu)** v České republice a v Německu,
- ► společné zhodnocení aktuálního stavu zatížení vod živinami v povodí Labe na základě jednotně zpracovaných dat,
- ► stanovení společných nadregionálních cílů pro živiny a příslušné typy vod v povodí Labe včetně potřeby snížení vnosu živin pro klíčové profily na Labi s cílem zajistit ochranu Severního moře,
- ► vyhodnocení rozsahu, významu a hlavních oblastí zdrojů a cest vnosu živin a určení rozhodujících typů zdrojů znečištění, které ohrožují dosažení cílů,
- ► návrh vhodných opatření a další doporučení, která by měla vést k efektivnímu snížení obsahu živin ve vodách v povodí Labe.

Získané poznatky budou uplatněny při zpracování národních plánů povodí a „Mezinárodního plánu oblasti povodí Labe“ na období 2022–2027.

1997–2001: stav před implementací Rámcové směrnice o vodách
Skutečný odnos normovaný na průtok v profilu Seemannshöft v t/rok:
N: 126 970 **P: 5 340**

2011–2015: fáze realizace 1. plánu povodí
Skutečný odnos normovaný na průtok v profilu Seemannshöft v t/rok:
N: 84 400 **P: 3 940**

2014–2018: vyhodnocení pro 3. plán povodí
Skutečný odnos normovaný na průtok v profilu Seemannshöft v t/rok:
N: 75 082 **P: 4 310**

► **Cílový odnos** normovaný na průtok v profilu Seemannshöft v t/rok:
N: 66 850 **P: 2 385**

Internationale Kommission zum Schutz der Elbe
August 2020

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Mezinárodní komise pro ochranu Labe
srpen 2020

Revitalizace vod a vodní režim v povodí Labe

Niedrigwasser

Sucho

Die Elbe gehört in Mitteleuropa zu den großen Fließgewässern mit dem geringsten verfügbaren Wasserdargebot pro Einwohner des Einzugsgebiets.

Im Zusammenhang mit dem Auftreten von Niedrigwasser wird auf die Bilanzierung des Wasserhaushalts, auch vor dem Hintergrund der sich verändernden klimatischen Bedingungen, großes Augenmerk gelegt. So wurde im Jahr 2012 die Publikation „Hydrologische Niedrigwasserkenngrößen der Elbe und bedeutender Nebenflüsse“ veröffentlicht, die auch eine Trendanalyse ausgewählter Niederschlags- und Abflussparameter enthält.

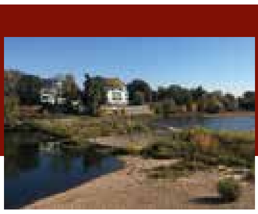
Internationale Kommission zum Schutz der Elbe
Mezinárodní komise pro ochranu Labe
International Commission for the Protection of the Elbe River

Hydrologische Niedrigwasserkenngrößen
der Elbe und bedeutender Nebenflüsse

Hydrologické charakteristiky malých průtoků
na Labi a jeho významných přítocích

Hydrological low-flow characteristics
of the River Elbe and its major tributaries

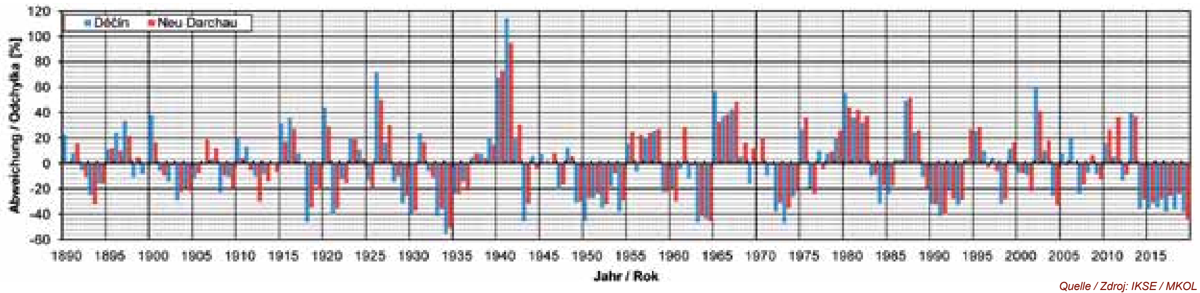
Ve srovnání s velkými toky ve střední Evropě patří povodí Labe k oblastem s nejmenšími dostupnými vodními zdroji na jednoho obyvatele.



V souvislosti s výskytem suchých období je věnována velká pozornost bilancím vodního režimu, a to i na základě měnících se klimatických podmínek. V roce 2012 byla zveřejněna publikace „Hydrologické charakteristiky malých průtoků na Labi a jeho významných přítocích“, která obsahuje také analýzu trendů vybraných charakteristik srážek a průtoků.

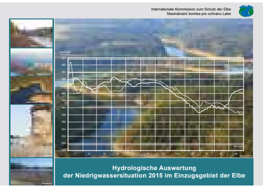
Aus dem Diagramm mit der Darstellung der Abweichungen der mittleren Jahresabflüsse vom vieljährigen mittleren Abfluss (1981 – 2010) an den Pegeln Děčín und Neu Darchau ist zu erkennen, dass sich mehrjährige wasserreiche und wasserarme Zeiträume abwechseln.

Z grafu vyjadřujícího odchylky průměrných ročních průtoků od dlouhodobého průměru (1981–2010) ve vodoměrných stanicích Děčín a Neu Darchau je patrné střídání víceletých vodných a málovodných období.



Quelle / Zdroj: IKSE / MKOL
Daten / Data: ČHMÚ, BfG

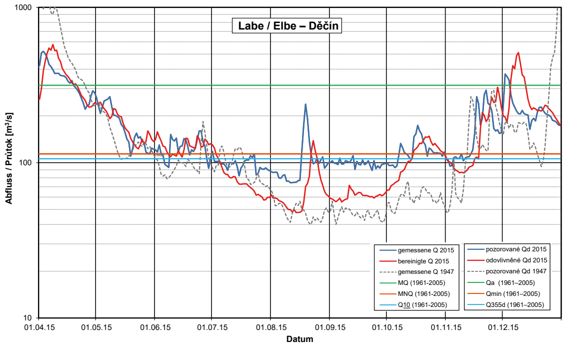
Im Einzugsgebiet der Elbe dauert die Niedrigwasserperiode bereits seit 2014 an (Stand August 2020). Unter Federführung der IKSE ist eine gemeinsame grenzüberschreitende hydrologische Auswertung der Niedrigwassersituation 2015 erarbeitet worden. Sie enthält eine Dokumentation der meteorologischen Rahmenbedingungen (Entwicklung der Schneerücklagen, Lufttemperaturen, Niederschlagsgang) sowie eine Auswertung der Auswirkungen auf die Oberflächengewässer und das Grundwasser. Vorbereitet wird eine Analyse der gesamten Niedrigwasserperiode ab 2014.



Hydrologische Auswertung
der Niedrigwassersituation 2015 im Einzugsgebiet der Elbe

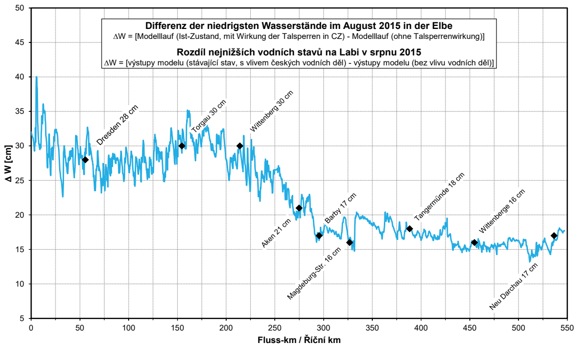
V povodí Labe již od roku 2014 (stav srpen 2020) přetrvává suché období. Pod záštitou MKOL bylo zpracováno společné přeshraniční hydrologické vyhodnocení sucha v roce 2015, ve kterém byly zdokumentovány rámcové meteorologické podmínky (vývoj sněhových zásob, teploty vzduchu, průběh srážek) a vyhodnoceny dopady na povrchové i podzemní vody. Analýza celého suchého období od roku 2014 se připravuje.

Wesentlich für das Verständnis der wirksamen Prozesse bei Entstehung und Ausmaß dieses Niedrigwasserereignisses ist die Kenntnis von Bewirtschaftungseinflüssen. Das Hauptaugenmerk wird auf die Steuerung der bedeutenden Talsperren gelegt, deren Einfluss teils über Schätzverfahren, teils über hydraulische Modellierung untersucht wurde. Die Ergebnisse zeigen, dass es nur dank der Abflussstützung durch Talsperren, insbesondere der Moldaukaskade, 2015 bis weit in die deutsche Elbestrecke hinein zu keinem noch extremeren Niedrigwasser gekommen ist.



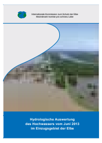
Quelle / Zdroj: ČHMÚ

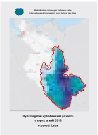
Pro pochopení procesů ovlivňujících vznik a rozsah sucha je důležitá znalost vlivů hospodaření s vodou. Hlavní pozornost byla zaměřena na manipulace na významných vodních dílech, jejichž vliv byl zkoumán zčásti pomocí metod odhadu, zčásti pomocí hydraulických modelů. Z výsledků vyplývá, že jen díky dotování průtoků z vodních děl, zejména z Vltavské kaskády, se v roce 2015 podařilo zabránit i na úseku německého Labe ještě extrémnějšímu suchu.

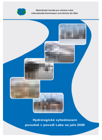


Quelle / Zdroj: BfG

Gemeinsame grenzüberschreitende Auswertungen hydrologischer Extremereignisse (Niedrig- und Hochwasser) im Einzugsgebiet der Elbe sind ein wichtiger Arbeitsschwerpunkt der IKSE. Aus dem gesamten Einzugsgebiet werden Daten und Erkenntnisse gesammelt und in Publikationen veröffentlicht.







Společná přeshraniční vyhodnocování mimořádných hydrologických situací (sucha a povodní) v povodí Labe jsou důležitou součástí aktivit MKOL. Data a poznatky z celého povodí jsou shromažďovány a zveřejňovány v publikacích.

Internationale Kommission zum Schutz der Elbe
August 2020

www.ikse-mkol.org

Mezinárodní komise pro ochranu Labe
srpen 2020

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