EGU General Assembly 2020

Emerging contaminants in water resources of Croatian karst – boDEREC-CE PROJECT

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EMERGING CONTAMINANTS TERMINOLOGY

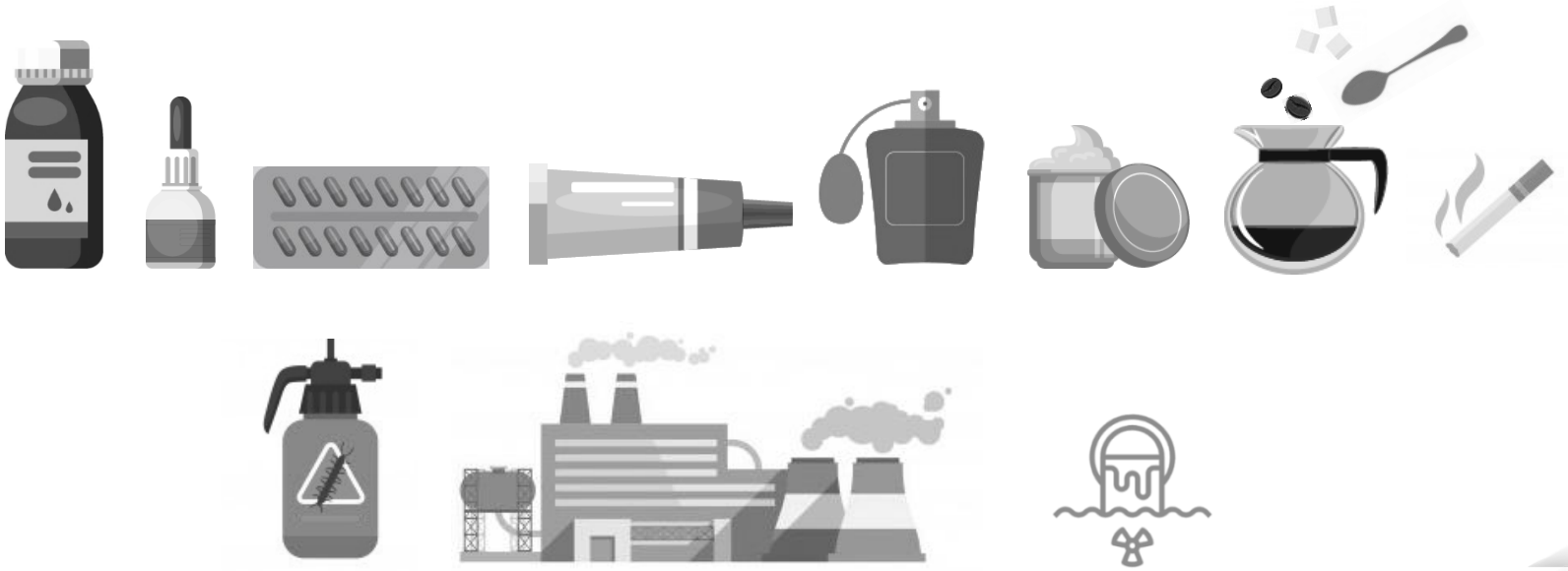
Emerging contaminants (EC):

- contaminants that are present in the environment for a quite some time and for which hasn't been perceived or known to have detrimental effects on the environment and human health;
- the ones that have appeared only recently;
- substances which **are currently not** submitted to a **routine environmental monitoring** programmes and which due to their adverse effects and/or persistency could be included in future legislation (NORMAN network; Lapworth et al., 2012; Sui et al., 2015; Geissen et al., 2015 etc.).

As for the **water environment**, the sources, occurrence, physico-chemical characteristics, environmental behavior and pathway, as well as resistance to different wastewater treatment techniques, are challenging topics to be comprehensively researched.

EMERGING CONTAMINANTS TYPES & SOURCES

EC encompass a **wide spectrum of chemicals**, out of which unfortunately many are being used daily, worldwide and are a requisite for today's society.



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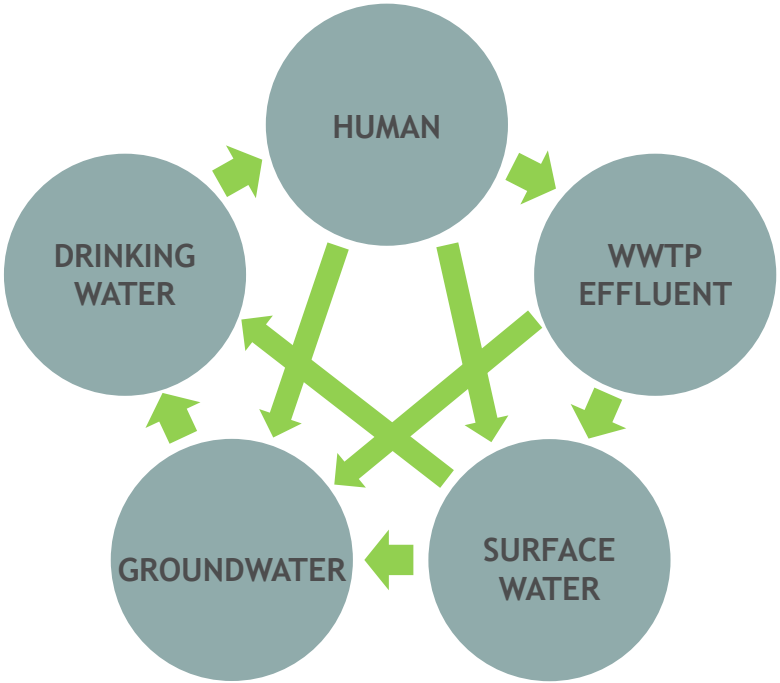
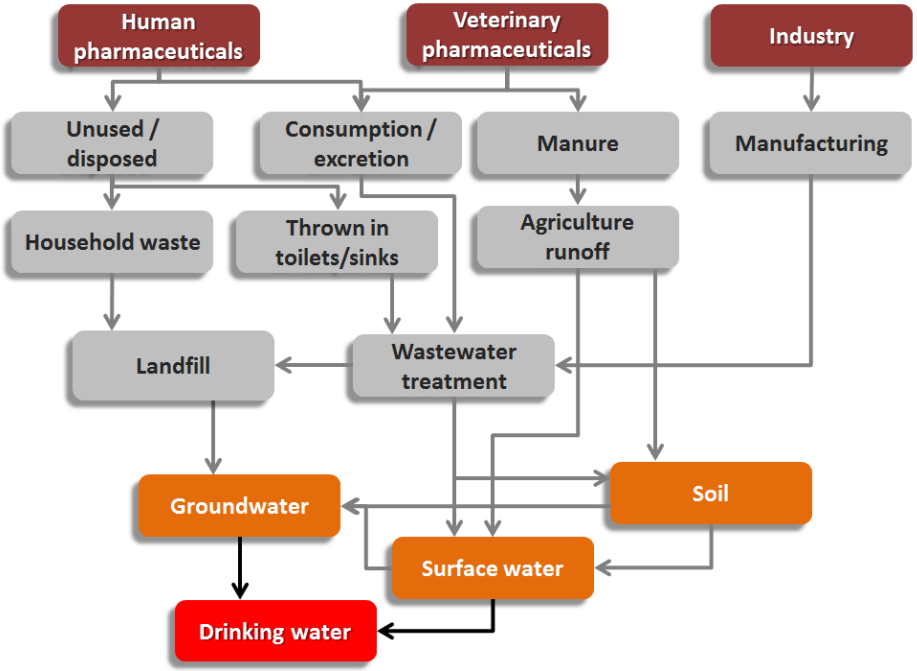
EMERGING CONTAMINANTS TYPES & SOURCES

PATHWAYS OF EC WITHIN WATER CYCLE

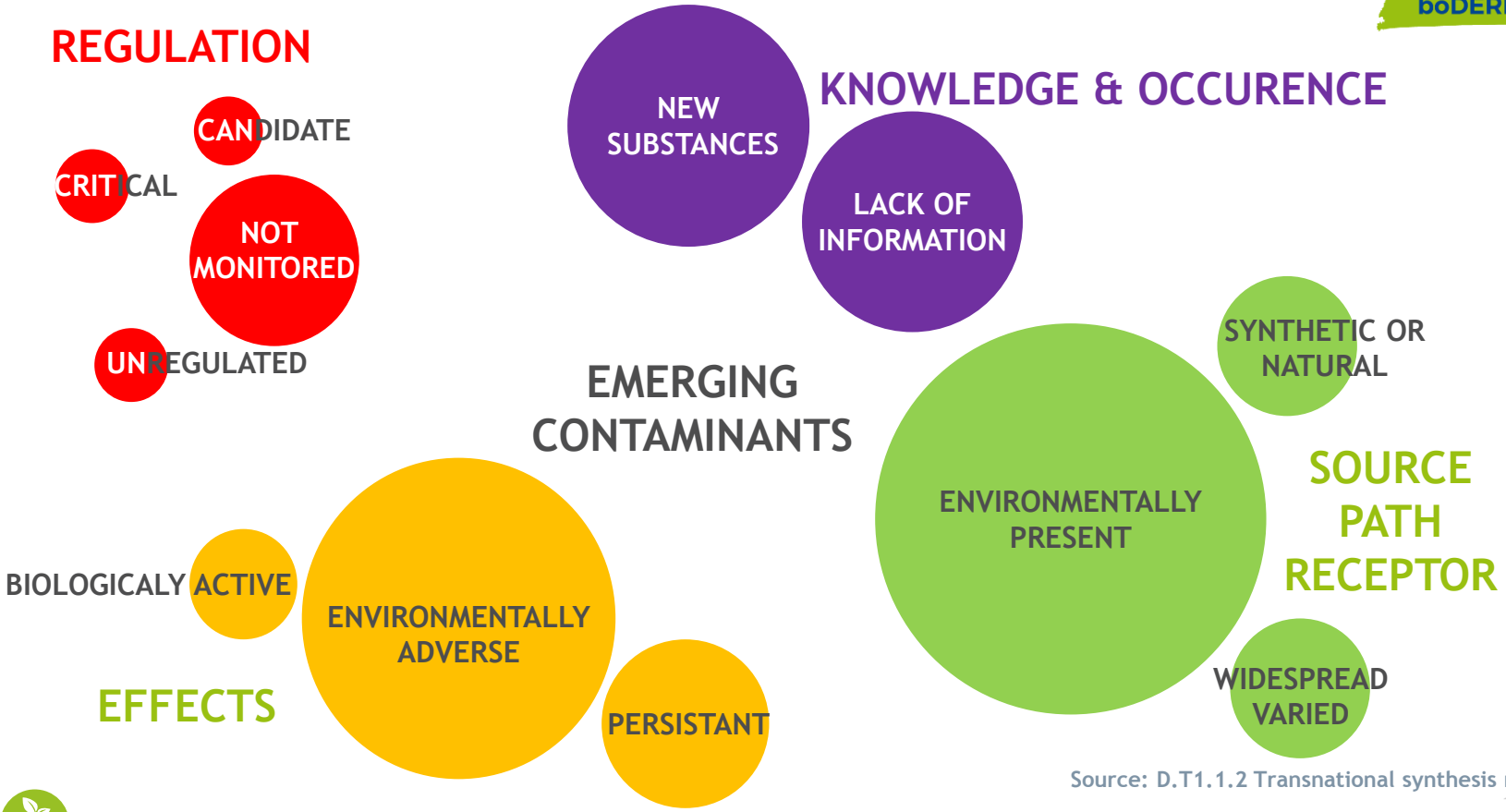


EXAMPLE OF PHARAMACEUTICALS'* PATHWAYS TO THE ENVIRONMENT MATRIX



*pharmaceuticals in water will be analyzed within boDEREC-CE project

MOST COMMON EC CHARACTERISTICS IN boDEREC-CE NATIONAL REPORTS



Source: D.T1.1.2 Transnational synthesis report

EMERGING CONTAMINANTS LEGISLATION

- WATER FRAMEWORK DIRECTIVE (2000/60/EC)
- GROUNDWATER DIRECTIVE (2006/118/EC)
- ENVIRONMENTAL STANDARDS DIRECTIVE (2008/105/EC)
- DIRECTIVE 2013/39/EU as regards priority substances in the field of water policy
- DIRECTIVE 2014/80/EU amending Annex II of GWD
- Commission implementing Decision (EU) 2015/495 establishing a watch list
- Commission implementing Decision (EU) 2018/840 establishing a watch list

LIST of PRIORITY SUBSTANCES

WATCH LIST

Groundwater Watch List still as voluntary tool

EMERGING CONTAMINANTS CHALLENGES

- Terminology and legislative
- Vast number of substances and their transformation products
- Insufficient data and lack of knowledge on EC in groundwater
- Lack of knowledge on EC's toxicological effects (cancerogenic, mutagenic, endocrine disruptors) on human health
- Bacteria resistance to antibiotics released in the environment
- Improvement of wastewater treatment techiques

boDEREC-CE FACTS AND FIGURES

01.04.2019 - 31.03.2022	8 COUNTRIES 12 PROJECT PARTNERS 7 ASSOCIATED PARTNERS	TOTAL BUDGET 2.328.140,81 ERDF CO-FINANCING 1.938.208,22

PROGRAMME PRIORITY
3. Cooperating on natural and cultural resources for sustainable growth in CENTRAL EUROPE

PROGRAMME PRIORITY SPECIFIC OBJECTIVE
3.1 To improve integrated environmental management capacities for the protection and sustainable use of natural heritage and resources

boDEREC-CE PARTNERSHIP

12 PROJECT PARTNERS

2 Croatia
2 Germany
2 Italy
2 Poland
2 Slovenia
1 Austria
1 Czech Republic

7 ASSOCIATED PARTNERS

2 Germany
1 Austria
1 Croatia
1 Czech Republic
1 France
1 Poland

PROJECT OBJECTIVES

Based on an innovative approach applied in identified pilot areas across CE countries, the lack of knowledge on **emerging contaminants** (EC), specifically origin, behavior, transport and fate of pharmaceuticals and personal care products (PPCP), will be tackled by means of developing and testing of appropriate **monitoring** and **modelling** activities in different **hydrological systems** under environmental pressures.

The design of an integrated management of waterworks that guarantees increased quality of drinking water.

STUDY PPCP IN THE NATURAL ENVIRONMENT

Study processes that determine the transformation of monitored substances into the metabolites and processes that lead to their natural attenuation.This specific objective will be implemented through detailed monitoring and mathematical modelling.

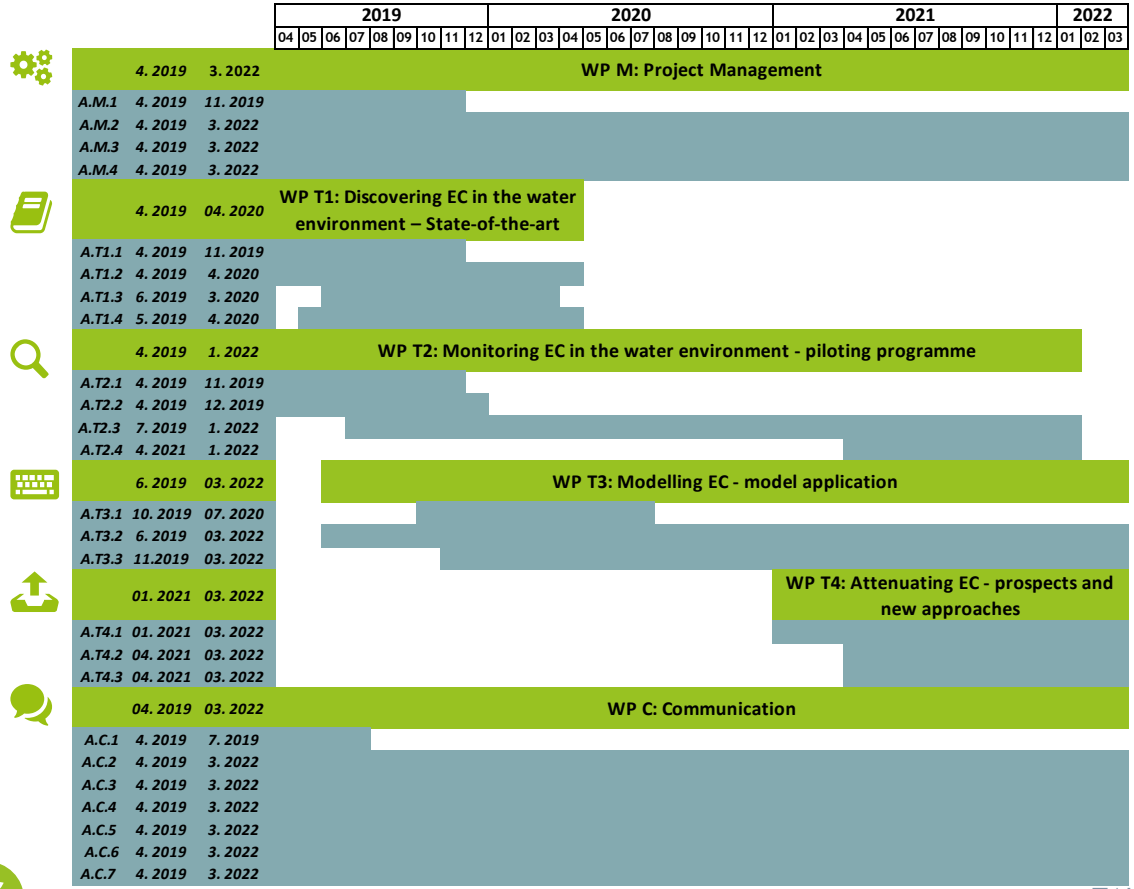
TECHNOLOGICAL ASPECTS OF PPCP ATTENUATION

Document in detail the behavior of monitored PPCPs in the various drinking water production processes and to assess the effectiveness of their elimination. Practical recommendations and conclusions will then be drawn from the results obtained.

WATERWORK DECISION SUPPORT SYSTEM

Develop a decision-making support tool for water suppliers to enable timely response for mitigating PPCP concentrations in raw water. Also form a strategy and baseline for risk assessment of "new" PPCP detected only in the future.

PROJECT STRUCTURE & TIMELINE



PROJECT WORK MEETINGS

- 04. 2019 ZAGREB
- 11. 2019 LJUBLJANA
- 06. 2020 KATOWICE
- 11. 2020 MUNICH
- 04. 2021 VIENNA
- 11. 2021 BOLOGNA
- 03. 2022 PRAGUE

PROJECT OUTPUTS

STRATEGIES

- O.T1.1 State-of-the-art of current practices in relation to EC in the water environment
- O.T4.2 Transnational Strategy for PPCP Mitigation in Drinking Water - TRAST-PPCP

TOOLS

- O.T1.1 State-of-the-art of current practices in relation to EC in the water environment
- O.T1.2 Data collection tool for EC
- O.T3.1 Model-based decision making tool for EC (modePROCON)
- O.T4.1 Decision-making Support Tool for Waterworks - wwDEMAST

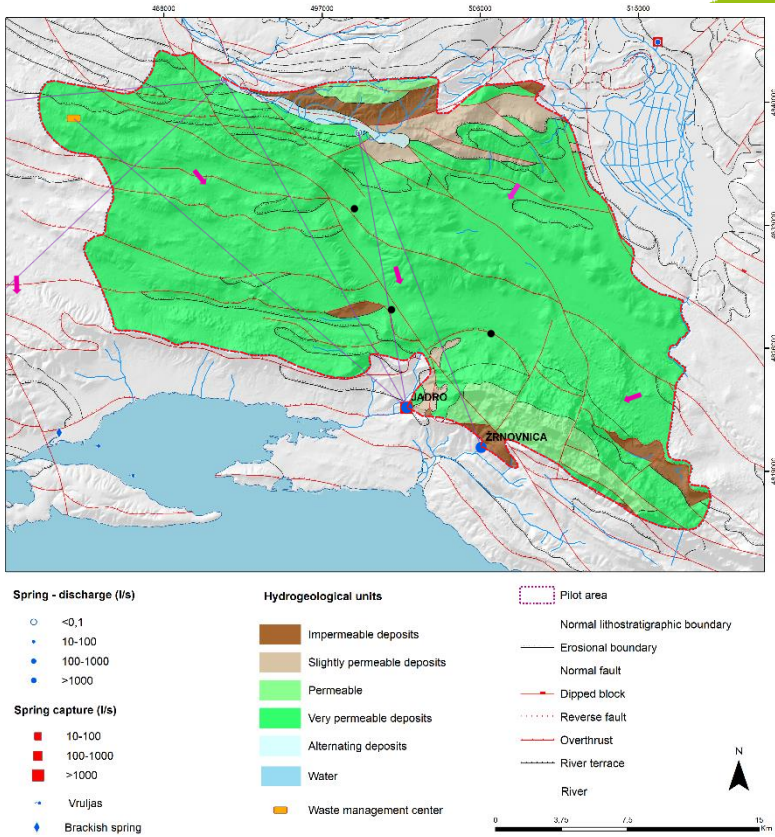
TRAININGS

- O.T3.2 Standardized training procedure for modePROCON, implemented in a Massive Open Online Course (MOOC)

PILOT ACTIONS

- O.T2.1 Pilot action Jadro catchment
- O.T2.2 Pilot action Karany – Jizera River
- O.T2.3 Pilot action Dresden - Hosterwitz
- O.T2.4 Pilot action Waidhofen an der Ybbs
- O.T2.5 Pilot action Upper Silesia Industrial Region
- O.T2.6 Pilot action Po River basin
- O.T2.7 Pilot action Neufahrn München
- O.T3.3 Implementation of modePROCON showcasing for groundwater pilot actions
- O.T3.4 Implementation of modePROCON showcasing for surface water pilot actions
- O.T3.5 Implementation of modePROCON showcasing for karst water pilot actions

PILOT ACTION JADRO & ŽRNOVNICA CATCHMENT



SPRING DISCHARGE

JADRO
MIN. 3.60 m³/s (Aug 1995) – 3.90 m³/s (Sep 1997),

MAX. aver. discharge 78.1 m³/s

ŽRNOVNICA
MIN. 0.25 m³/s (Sep, 1993),

MAX. 19.1 m³/s (Dec, 2004)

PILOT ACTION JADRO & ŽRNOVNICA CATCHMENT

Typical Dinaric karstic catchment (250-500km^2) located in the middle part of the Southern Croatia.

Jadro (4.5 km in length) and **Žrnovnica** (4.8 km in length) are karstic rivers which receive water through karstified underground and surface water inflow from the surrounding catchment area.

Due to the highly karstified area, and generally thin or completely absent surface protective layers, the **groundwater-surface water interchange is fairly quick**.

Water supply of City of Split and surrounding settlements depends on water uptake at karstic Jadro spring. In contrast, due to lower discharge of Žrnovnica spring during summer months, the water is used only for the water supply of the nearby Žrnovnica settlement and for irrigation of surrounding agricultural land.

The aim of pilot activities is to **identify main EC from the group of PPCP**, their **behaviour** and **fate in different hydrological conditions**, but also to gain better insight into the complex hydrogeological properties of this karstic catchment, consequently helping to improve protection of drinking water resources and thus human health.

PILOT ACTION JADRO & ŽRNOVNICA CATCHMENT

Experts from **Department of Hydrogeology and Engineering geology of Croatian Geological Survey** will be conducting **hydrogeological field investigation, *in situ* field measurements of physio-chemical parameters** (temperature, pH, electrical conductivity, dissolved oxygen and bicarbonates concentration) and **water sampling** on Jadro and Žrnovnica springs and surface water from Cetina River. The existing boreholes within Jadro and Žrnovnica catchment will be included in the monitoring, depending upon technical capabilities, in order to sample groundwater.

SURFACE WATER

GROUNDWATER
Boreholes
Karstic springs

DRINKING WATER

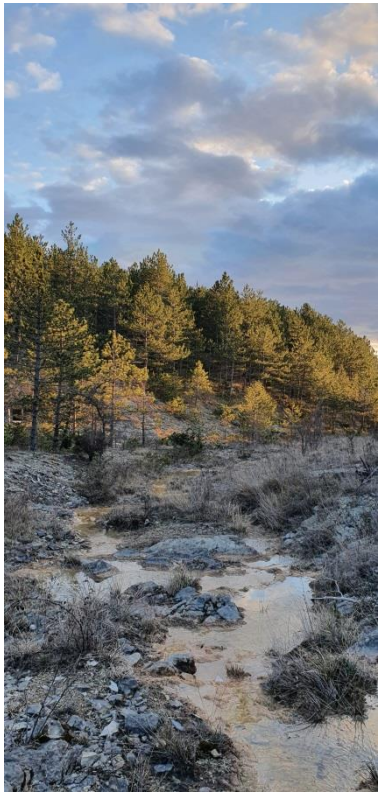
PHARMACEUTICALS
(mainly antibiotics)

CZECH POVODÍ VLTAVY STÁTNÍ PODNIK LABORATORY

MAJOR ANIONS & CATIONS,
TOTAL ORGANIC CARBON (TOC)
STABLE ISOTOPES ($\delta^{18}O$, $\delta^{16}O$, $\delta^{2}H$)

CROATIAN GEOLOGICAL SURVEY

PILOT ACTION JADRO & ŽRNOVNICA CATCHMENT



	Pharmaceuticals	Unit	Detection limit
1.	1-H-benzotriazole	ng/l	20
2.	4(5)-methyl-1-H-benzotriazole	ng/l	20
3.	4-formylaminoantipyrine	ng/l	10
4.	acebutulol	ng/l	10
5.	acesulfame	ng/l	50
6.	alfuzosin	ng/l	10
7.	atenolol	ng/l	10
8.	atorvastatin	ng/l	10
9.	azithromycin	ng/l	10
10.	bezafibrate	ng/l	10
...			
96.	triclosan	ng/l	20
97.	trimetoprim	ng/l	10
98.	valsartan	ng/l	10
99.	valsartan acid	ng/l	10
100.	venlafaxine	ng/l	10
101.	verapamil	ng/l	10
102.	warfarin	ng/l	10

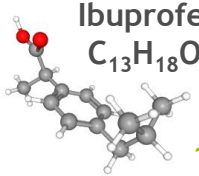
PILOT ACTION JADRO & ŽRNOVNICA CATCHMENT

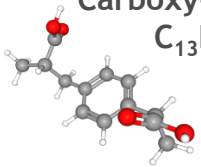
Specific sampling procedure provided by laboratory (e.g. jantar glass bottles, obligatory use of gloves, avoidance of PPCP use during sampling, freezing of samples in dry ice during shipping…)

Monitoring will be conducted at quarterly basis for the period of 2 years.

1st **Screening analysis** of the occurrence of 102 pharmaceuticals, done in October 2019
Nothing detected in springwater samples.

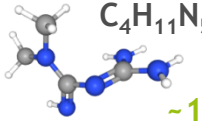
SURFACE WATER - Cetina River

Ibuprofen
$C_{13}H_{18}O_2$

~50 ng/L

Carboxy-Ibuprofen
$C_{13}H_{16}O_4$

~20 ng/L

Paracetamol
$C_8H_9NO_2$

~10 ng/L

Metformin
$C_4H_{11}N_5$

~170 ng/L

Given the specific natural characteristics, lower concentrations of PPCP were expected, as it is the general case for karstic aquifers. However, preliminary analysis results are insufficient for further research - **too high detection limits** for PPCP of chosen laboratory. Any further sampling and analysis might result in lower values due to expected hydrologic conditions.

LEAD PARTNER PROJECT TEAM

CROATIAN GEOLOGICAL SURVEY
Department of Hydrology and Engineering Geology

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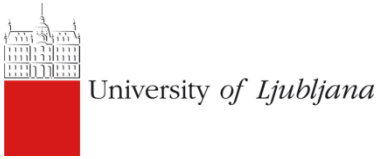
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BOKU

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THANK YOU FOR YOUR ATTENTION!