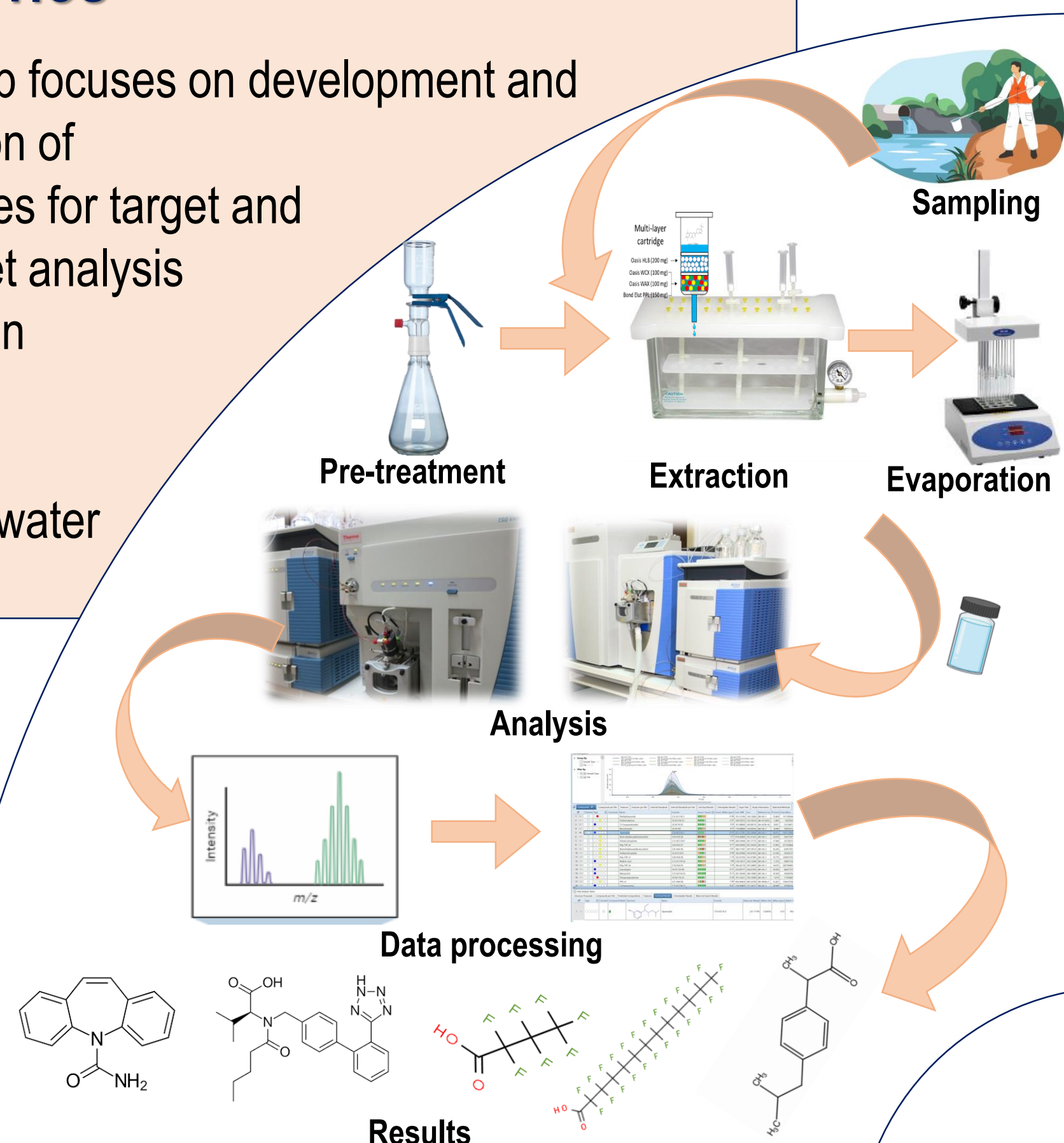


# TwINSol-CECs overview

Twinning for enhancing the scientific excellence of Faculty of Technology Novi Sad for innovative solutions to protect environmental resources from contaminants of emerging concern - TwINSol-CECs (GA 101059867)

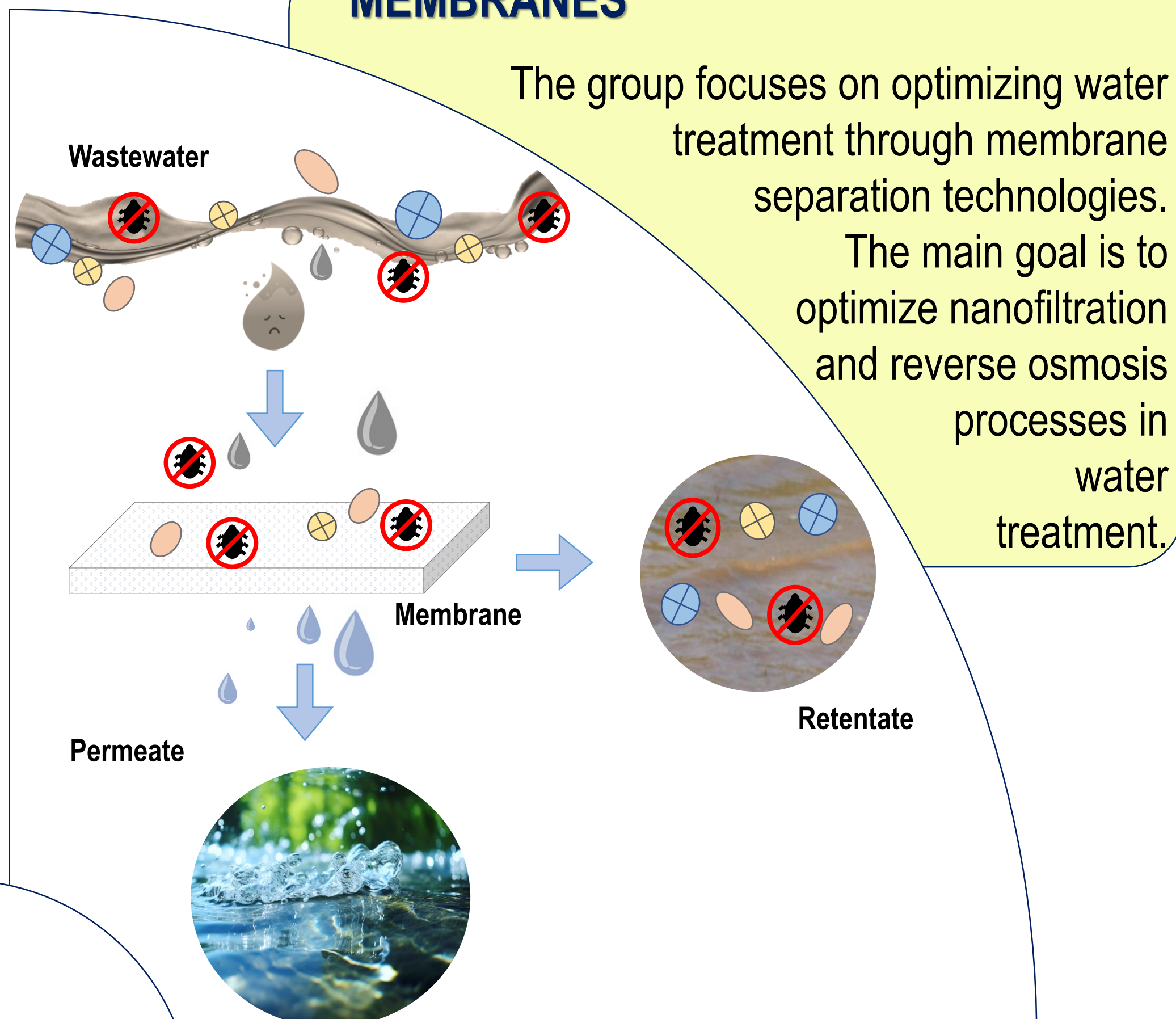
## ANALYTICS

The group focuses on development and application of procedures for target and non-target analysis of CECs in different samples, primarily water and soil.



## MEMBRANES

The group focuses on optimizing water treatment through membrane separation technologies. The main goal is to optimize nanofiltration and reverse osmosis processes in water treatment.



Wastewater

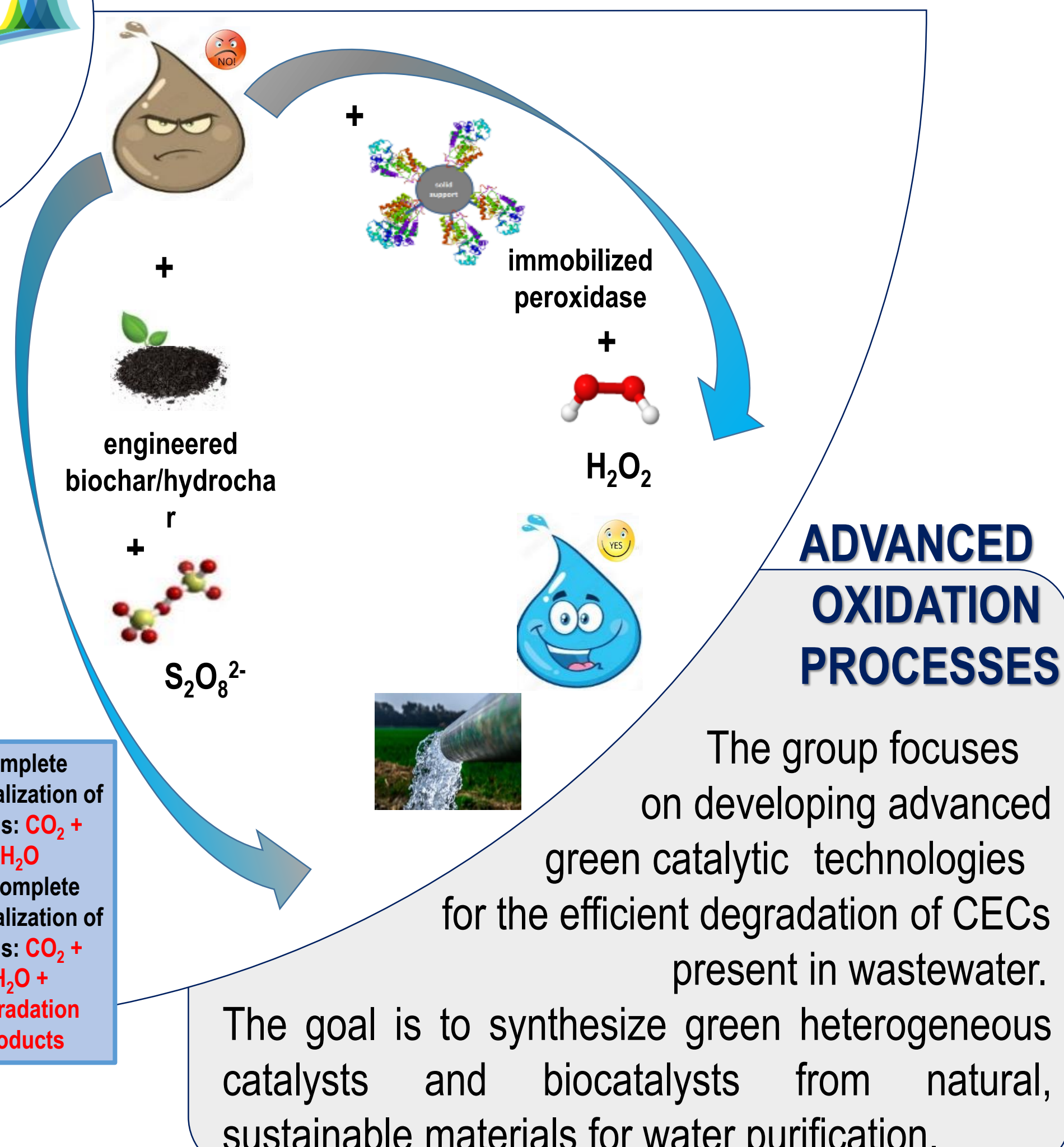
Adsorption

Clean water

## BIOMATERIALS

The group focuses on materials of biological origin as adsorbents for removing CECs from water.

The goal is to develop sustainable, low-cost, and eco-friendly solutions for water purification.



## ADVANCED OXIDATION PROCESSES

The group focuses on developing advanced green catalytic technologies for the efficient degradation of CECs present in wastewater.

The goal is to synthesize green heterogeneous catalysts and biocatalysts from natural, sustainable materials for water purification.

## LCA

assessment of wastewater treatment



# TwINSol-CECs RESEARCH GROUP ON TARGETED AND NON-TARGET ANALYSIS OF CECs

Prof. Nataša Đurišić-Mladenović, Dr. Jelena Živančev, Dr. Igor Antić, Dr. Maja Buljovčić, Dušan Rakić, PhD student

University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia

## MAIN GOAL:

Development and application of analytical procedures for the tentative identification and quantification of Contaminants of Emerging Concern (CECs) in different matrices through the following sub-activities:

- Development of sampling strategies (selection of sampling location, performing sampling, sample preservation, sample handling, etc.)
- Application of single-layer and multi-layer sorbents of different characteristics for extraction and clean-up of CECs belonging to different chemical classes
- Optimization and validation of high-performance liquid chromatography coupled with tandem mass spectrometry (UHPLC-MS/MS) parameters for quantification of CECs
- Optimization and validation of high-resolution mass spectrometry (HRMS) instrumental parameters for suspected screening analysis (SSA) of CECs and their transformation products (searching for the presence of hundreds of compounds available in online and offline databases)
- Optimization of workflow for processing of HRMS raw data using Compound Discoverer software for SSA of CECs
- Application of developed methods as analytical support in innovative water treatment solutions (membrane processes, advanced oxidation processes, and adsorption experiments) for CECs removal and monitoring of CECs in environmental matrices
- PhD thesis in progress entitled *Analysis of arable soil and sugar beet samples using modern methods based on mass spectrometry to determine the presence and distribution of contaminants of emerging concern* by Dušan Rakić, MSc.

## SAMPLING DESIGN WAS PERFORM TO INVESTIGATED:

- ✓ Seasonal variation
- 1st campaign (spring),
- 2nd campaign (summer),
- 3rd campaign (autumn)
- ✓ Antropogenic activities
- Before and after towns
- ✓ Status of different water type (i.e. hotspots)

- Number of samples per campaign: 10 (1st), 24 (2nd), 24 (3rd)
- Number of locations per campaign: 5 (1st), 12 (2nd), 12 (3rd)

## SAMPLING LOCATION COVERED:

### Key water bodies:

- The Danube river
- Tisza river
- Sava river
- Tamis river
- Great Bačka Canal

### Music festival (Exit, 06-09.07.2023) in Novi Sad:

- Before starting date
- During the festival
- After the festival
- Matrices of interest: waste water and surface water

### Agricultural soil:

- irrigated with surface water and ground water

## SAMPLE PREPARATION:

### Matrix of interest/Sample Extraction method:

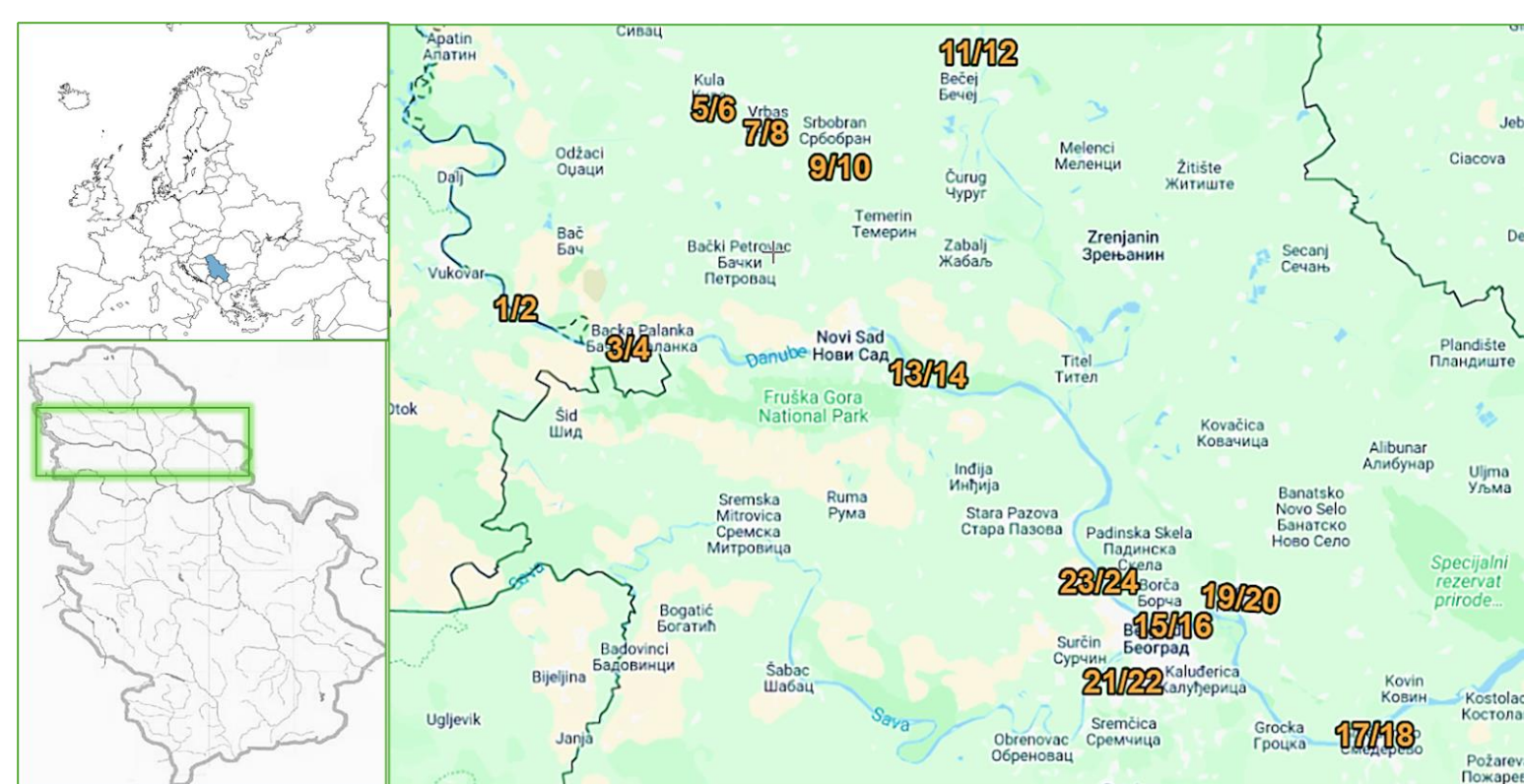
- Surface water samples / solid-phase extraction
- Waste-water samples / solid-phase extraction
- Soil samples / QuEChERS and Accelerated Solvent Extraction

## INSTRUMENTALS:

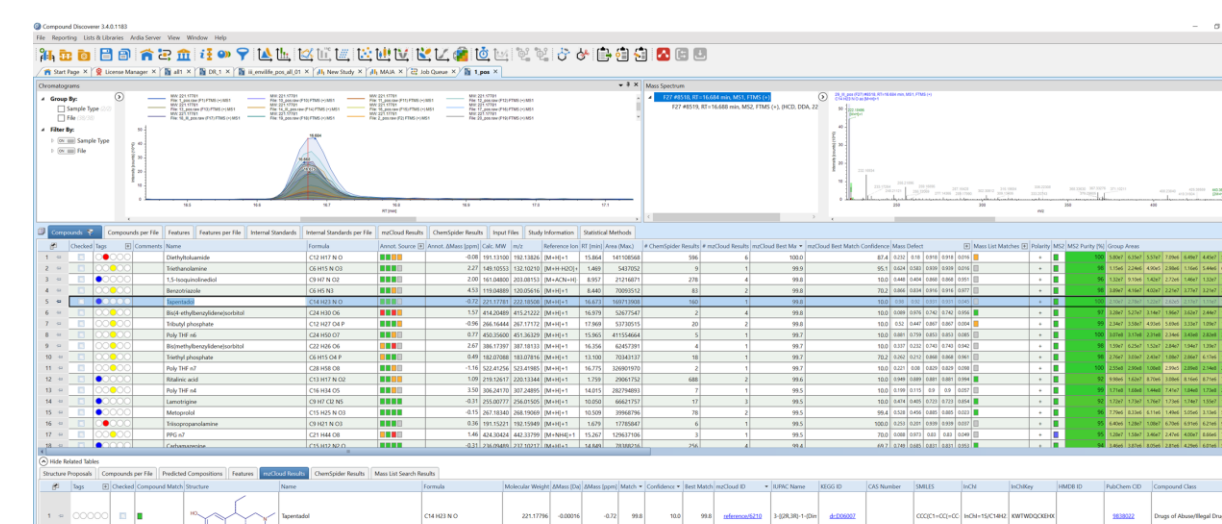
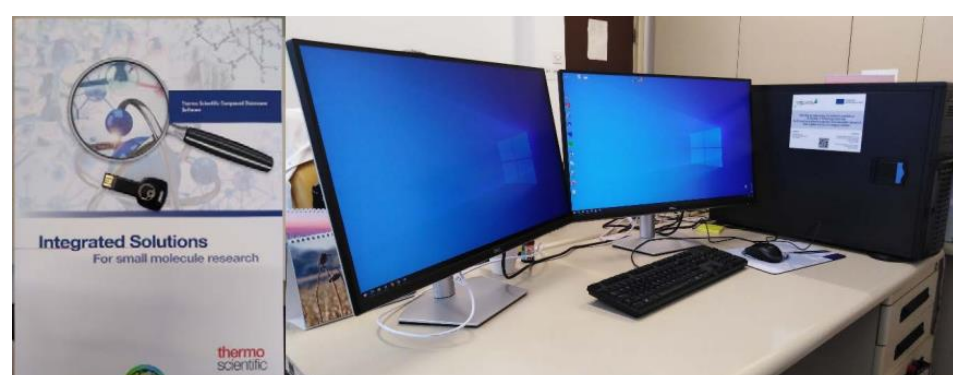
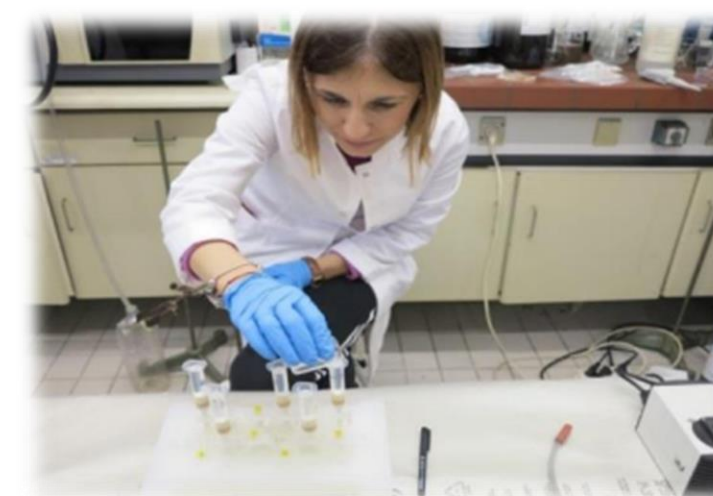
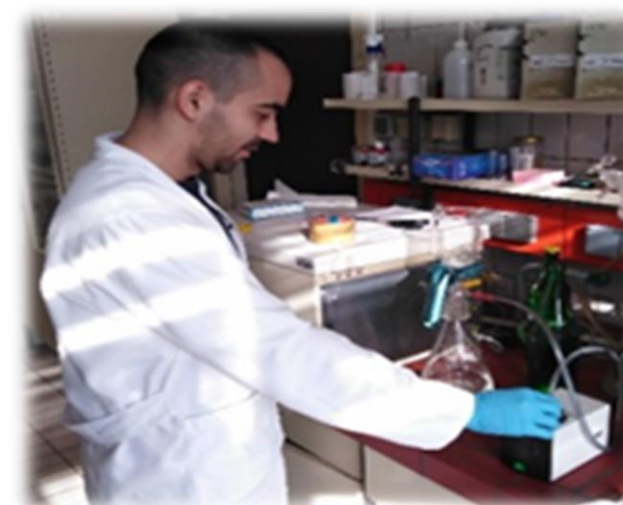
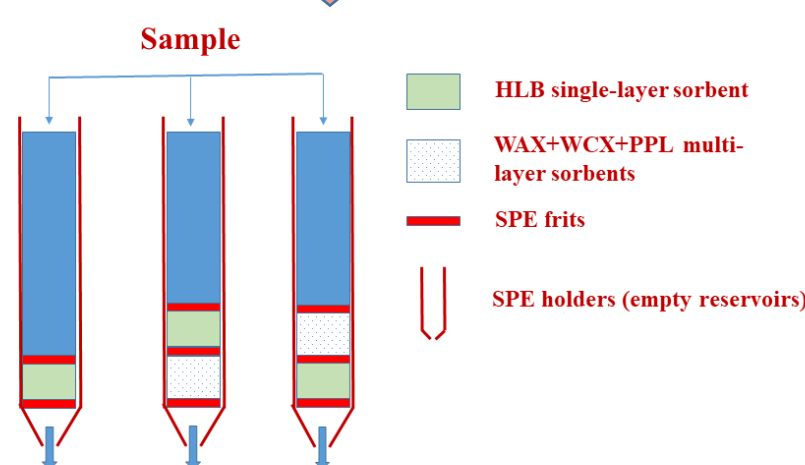
- For targeted analysis:  
UHPLC-MS/MS  
GC-MS (i.e. HS-SPME, Pyrolysis)
- For suspect screening analysis  
UHPLC-HRMS (Exactive Orbitrap)

## DATA PROCESSING

Compound Discoverer software (the latest version 3.4)



QuEChERS/Accelerated Solvent Extraction  
(soil samples)





## TwINSol-CECs Research Group - Membrane processes in water treatment

Prof. Zita Šereš, Dr. Nikola Maravić, MSc Jelena Šurlan

University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia

### Main goals within the TwINSol-CECs project:

- Evaluate impact of operating parameters, membrane properties and CECs properties on nanofiltration and reverse osmosis efficiency
- Provide valuable information regarding removal mechanisms
- Contribute to the industrial scale application of advanced membrane processes for CECs removal.

### Research results

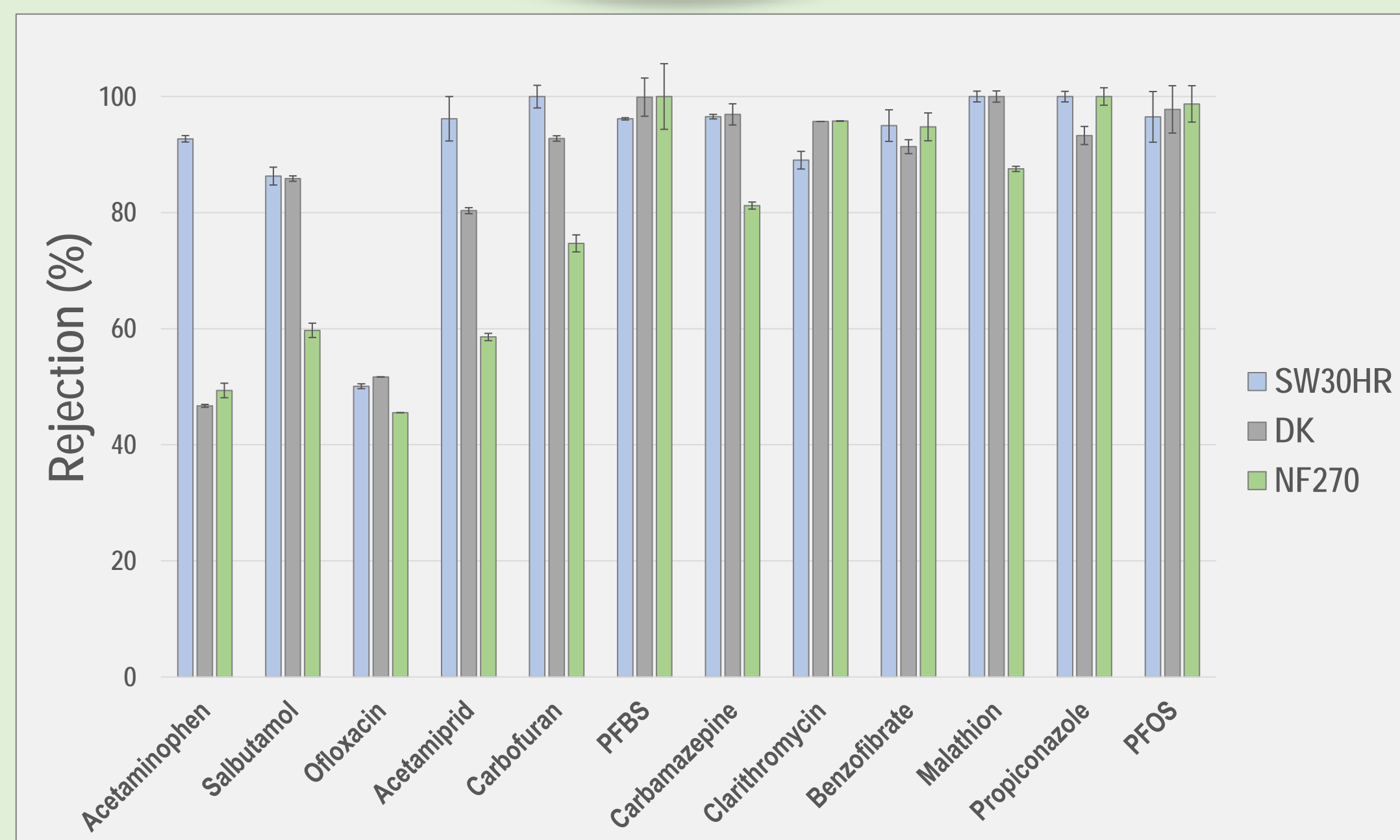
3  
MWCO

3  
membrane  
materials

12  
CECs

3  
pH

Dead-end and  
cross flow



### METcell® dead-end system



### Lab scale equipment

Main advantage – evaluation of optimal parameters using small sample and membrane quantities.

### Upgraded pilot scale equipment



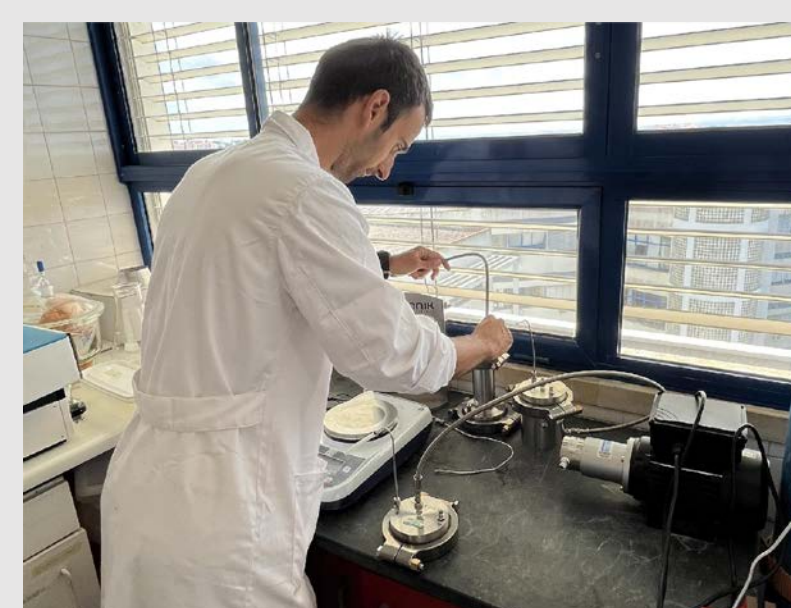
### Cross flow pilot scale unit

#### Main advantages:

- Supports high pressures required for NF and RO
- Processes large water volumes
- Easily transportable.

One PhD thesis is being developed within TwINSol-CECs project by the research group focused on membrane processes in water treatment, entitled:

*Removal of contaminants of emerging concern from water with advanced separation processes*





Twinning for enhancing the scientific excellence of Faculty of Technology Novi Sad  
for innovative solutions to protect environmental resources from contaminants of emerging concern  
*TwINSol-CECs (GA 101059867)*

## TwINSol-CECs Research Group - Biomaterials for Wastewater Treatment

dr Marina Šćiban, dr Vesna Vasić, dr Dragana Lukić

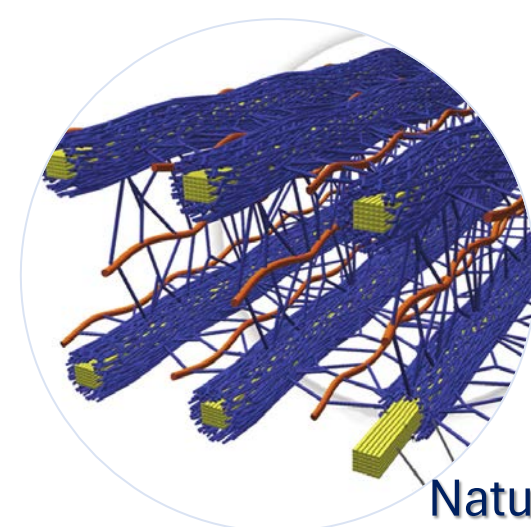
University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia

### Research area

- developing innovative and sustainable solutions for the removal of contaminants of emerging concern (CECs) from wastewater
- primary focus on adsorption-based treatment methods - the identification, preparation, and optimization of biosorbents
- biosorbents derived from locally available, renewable biomass
- environmentally friendly and low-cost alternatives to activated carbon



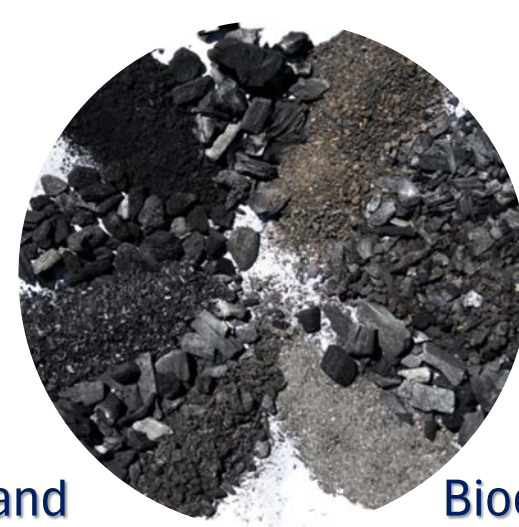
Microbial  
biomass



Natural  
macromolecules



Agricultural and  
forestry waste



Biochars and  
hydrochars



Industrial  
waste

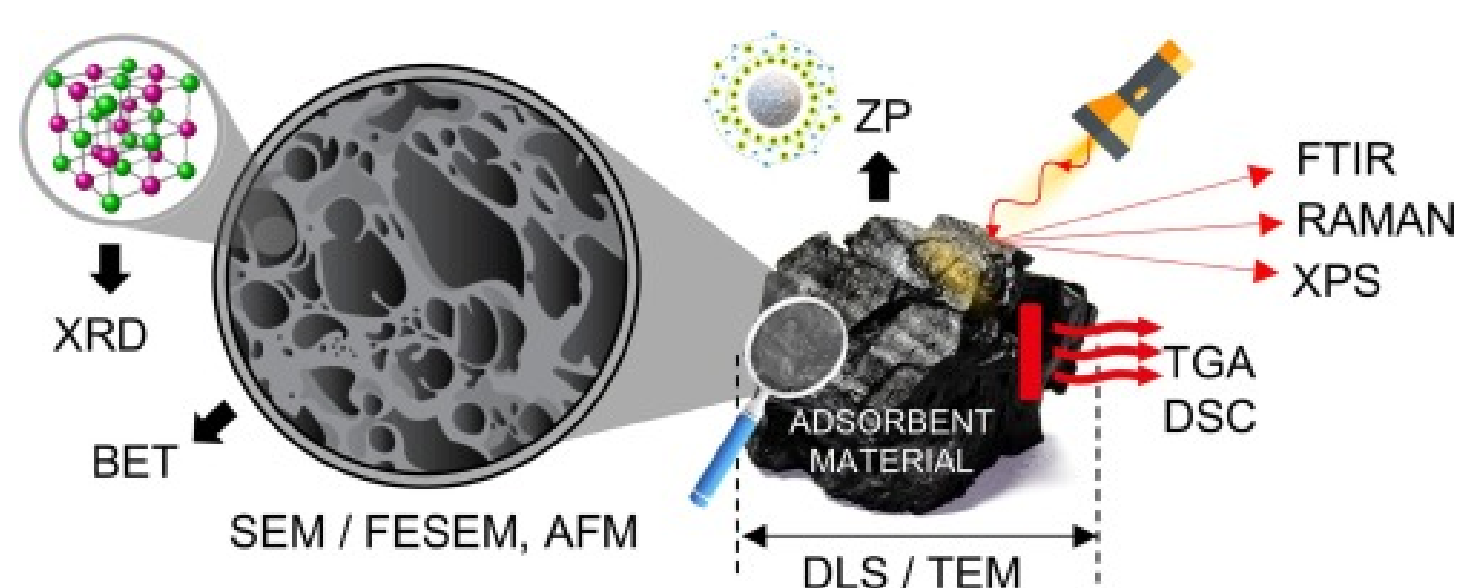


Powdered Activated  
Carbon  
(PAC)

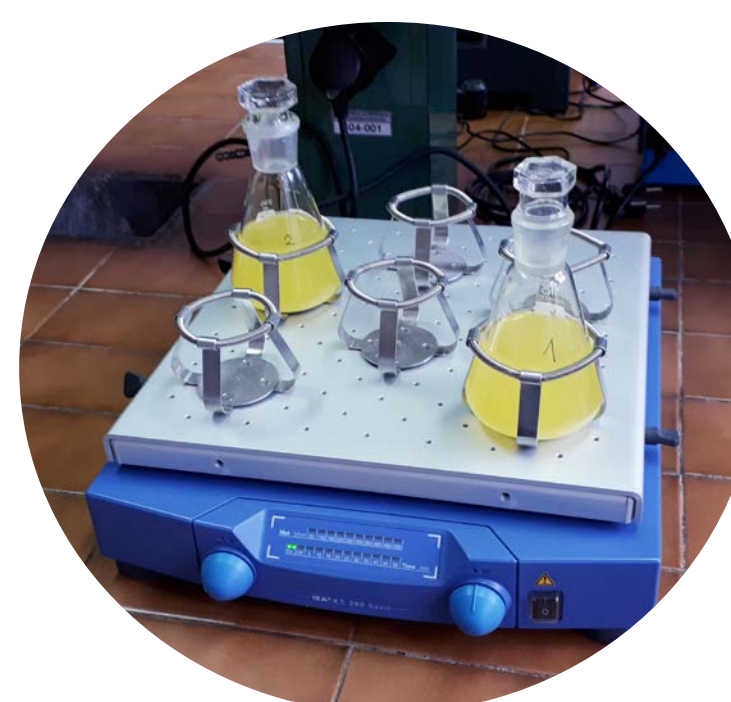
- the aim – developing materials that match or exceed the adsorption efficiency of commercial activated carbon, while offering greater sustainability and economic feasibility through valorization of waste resources.

### Evaluation of biosorbents

#### 1 Material characterization



#### 2 Batch adsorption tests



#### 3 Column adsorption experiments

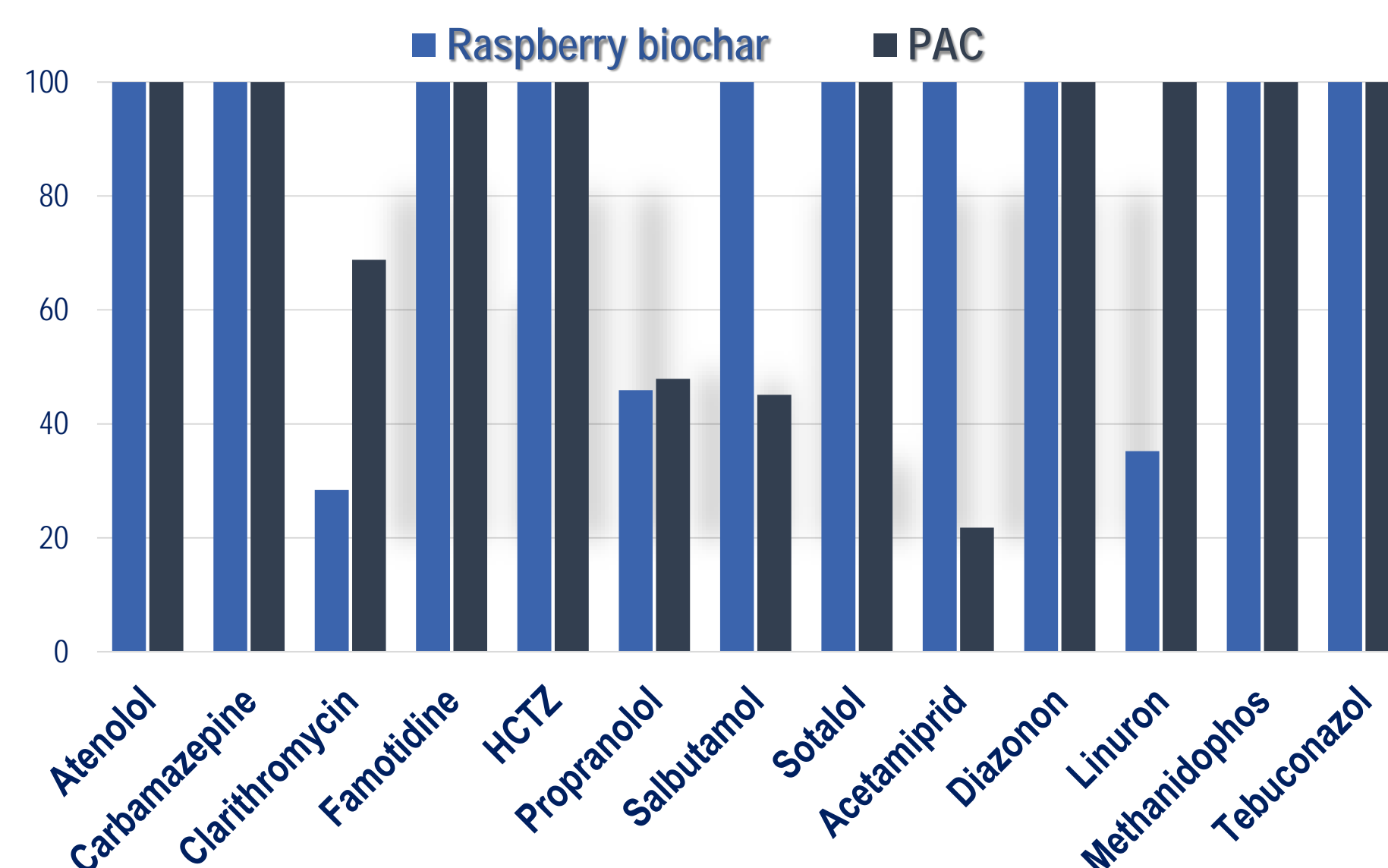


### Results

CECs removal efficiency of various biosorbents from WWTP effluent

CEC	C <sub>0</sub>	Removal efficiency (%)		
		Hydrochar	Kraft lignin (thistle)	Kraft lignin (pinecone)
Carbamazepine	112.6	60.7	94.38	100
Dichlofenac acid	284.1	71.89	100	100
Diltiazem	19.3	23.6	11.1	25.2
Furosemide	299.24	100	100	100
HCTZ	610.94	51.22	91.9	89.46
Losartan	122.96	21.5	100	100
Ofloxacin	64.61	100	100	100
Sotalol	182	43.3	88.6	98.4

CECs removal efficiency of raspberry based biochar and PAC from WWTP effluent



\* An efficiency of 100% was achieved when the residual concentration of the compound of interest after adsorption was below the quantification limit of the applied method



# TwINSol-CECs Research Group – Development of advanced green catalytic technologies for wastewater treatment

Dr. Sanja Panić, Dr. Mirjana Petronijević

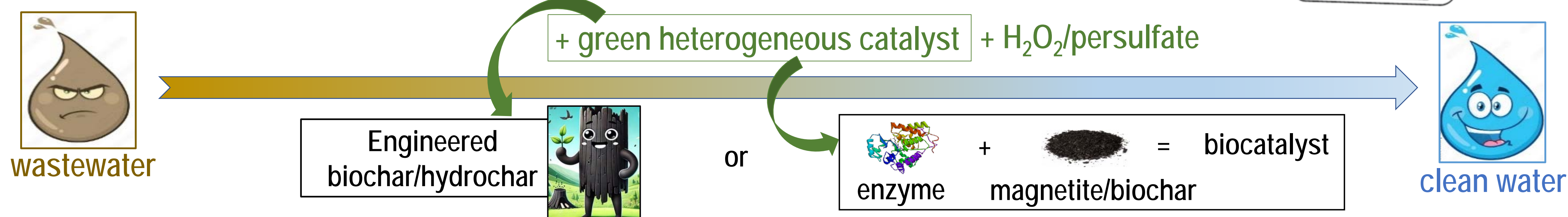
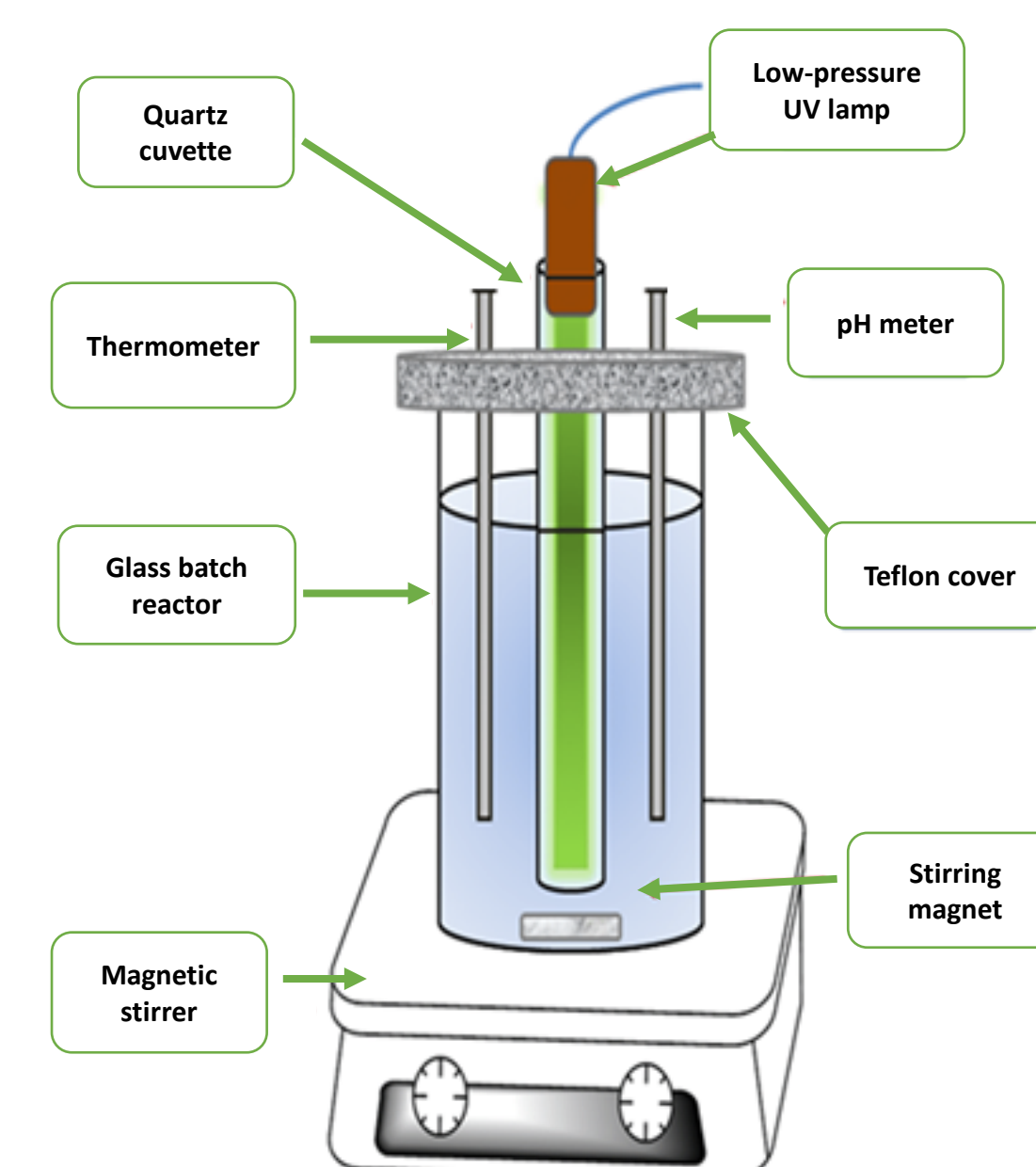
University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia

This research group focuses on developing **advanced green catalytic technologies** for the **efficient degradation of CECs** present in the wastewater.

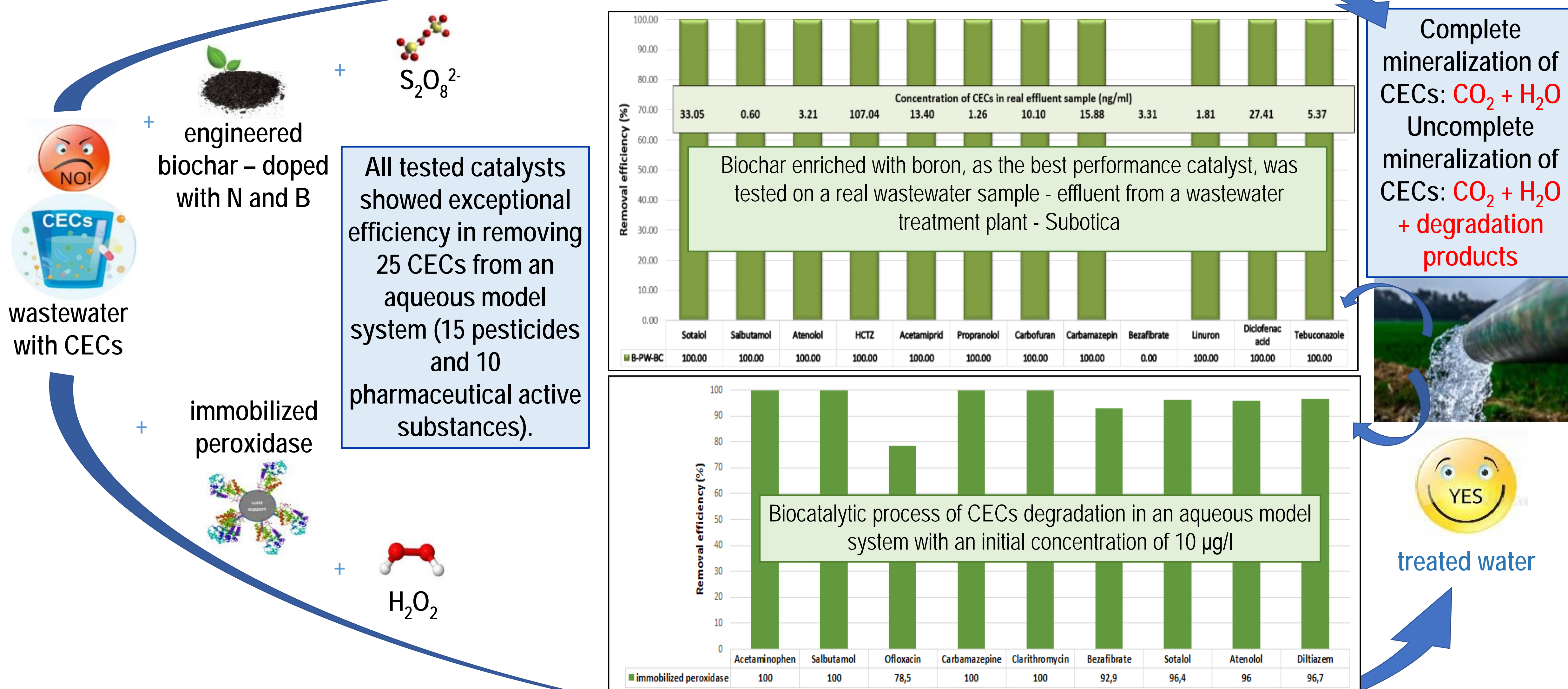
The primary goal of this research is to **design, synthesize and evaluate green heterogeneous catalysts and biocatalysts** from **locally available sources - natural, sustainable materials**.

The group developed new green synthetic routes for the production of **highly efficient metal-free carbocatalysts and immobilized biocatalysts**, starting from the waste biomass, which were further tested for the degradation of CECs by oxidation reaction.

Through the TwINSol-CECs project, this research group acquired mechanical stirrer (Hei-Torque core overhead stirrer), vacuum manifold set and UV-reactor for advanced oxidation processes.



## PROJECT RESULTS:



This research provides a green and feasible approach to produce metal-free carbonaceous catalysts and biocatalysts for highly efficient degradation of various CECs with a great potential to be implemented in practice.

In this way, TwINSol-CECs project contributes to the innovative process solutions in the field of heterogeneous (bio)catalysis towards pollutant free environment.

Two PhD theses have been under development within this group:

- Removal of emerging organic contaminants from water using hydrochar-based processes
- Development and application of biochar-based catalysts for degradation of CECs in wastewater via advanced persulfate oxidation process



# EXPERTISE IN LIFE CYCLE ASSESSMENT

Dr Ferenc Kiss

University of Novi Sad, Faculty of Technology Novi Sad, Novi Sad, Serbia  
e-mail: [fkiss@uns.ac.rs](mailto:fkiss@uns.ac.rs)

We combine cutting-edge **LCA software**, comprehensive **LCI databases**, and **expert knowledge** to evaluate and optimize environmental performance in wastewater treatment and sludge management.

## WHY LCA?

- Provides a **holistic view** of environmental impacts across the entire life cycle
- Helps identify trade-offs between emission reduction, energy use, and resource depletion
- Prevents burden shifting between impact categories and regions
- Produces **quantitative results** that enable comparisons between technologies or scenarios
- Essential for decision-making and policy development

## WHY US?

- Experienced in conducting LCAs
- Access to leading LCI databases and inventory modelling tools
- Utilization of state-of-the-art LCA software tools
- Expertise in environmental assessments according to ISO 14040 and ISO 14044 standards

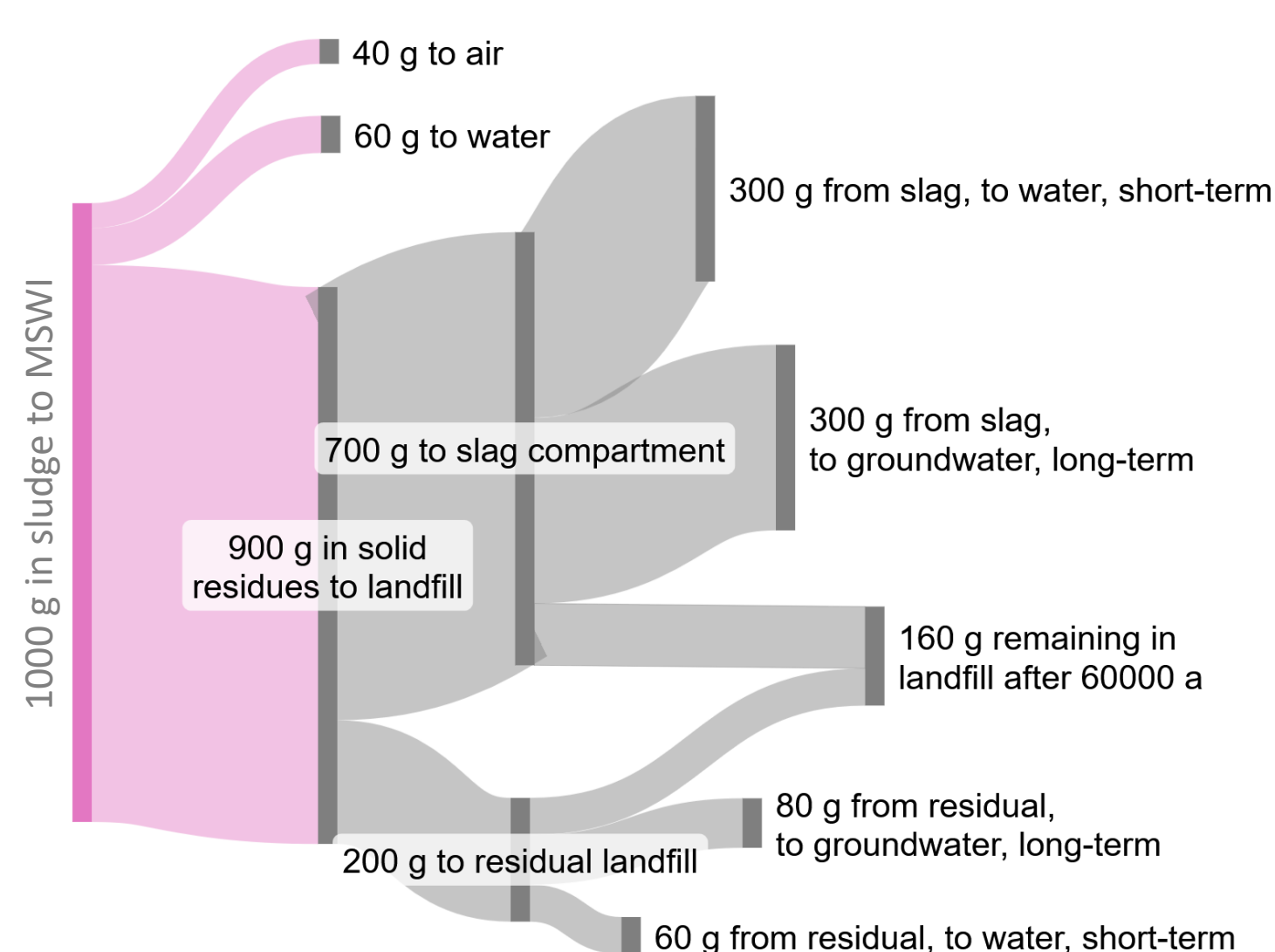
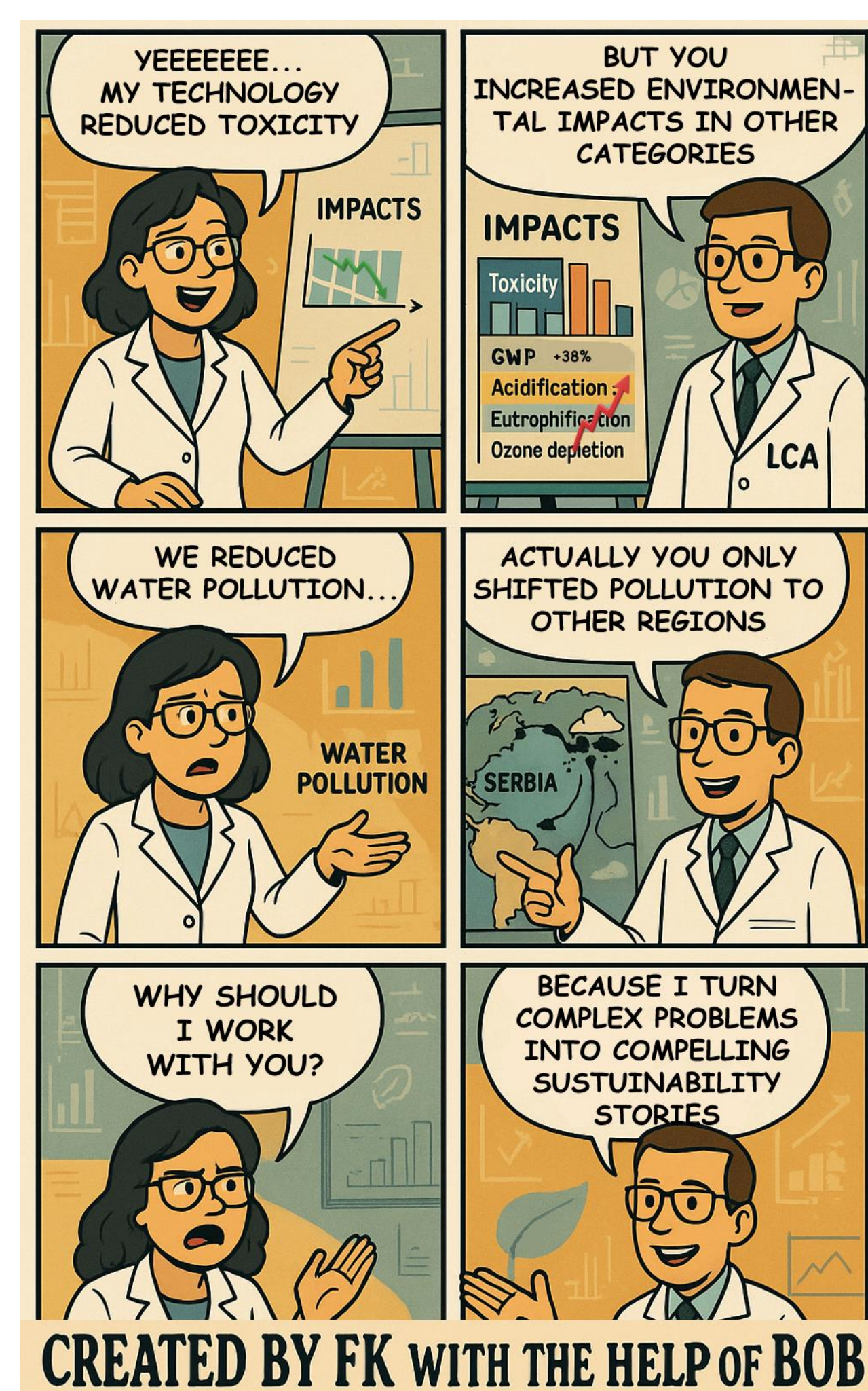


Fig. 1. Modelling the fate of pollutants

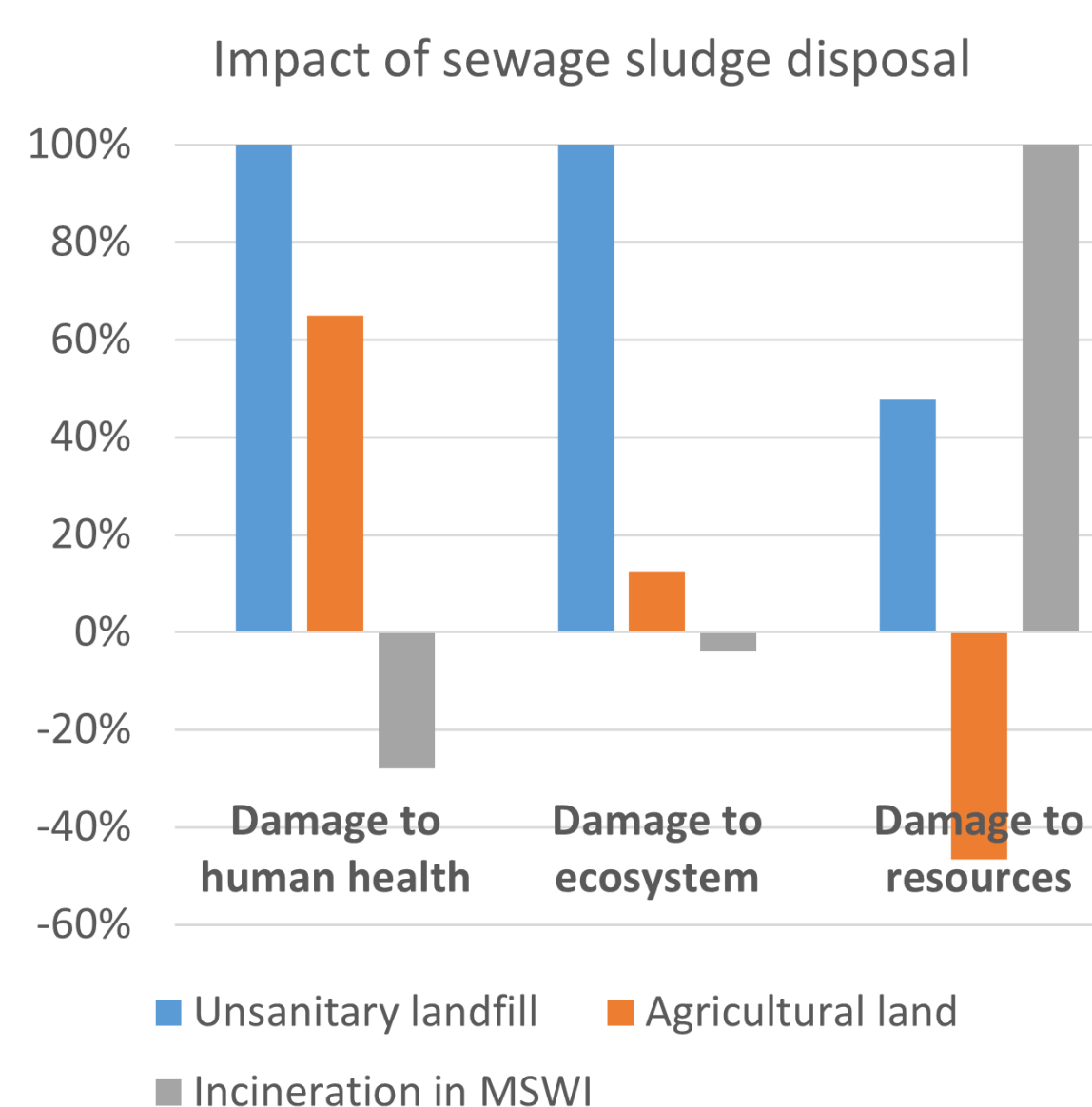


Fig. 2. Comparative assessment of alternatives

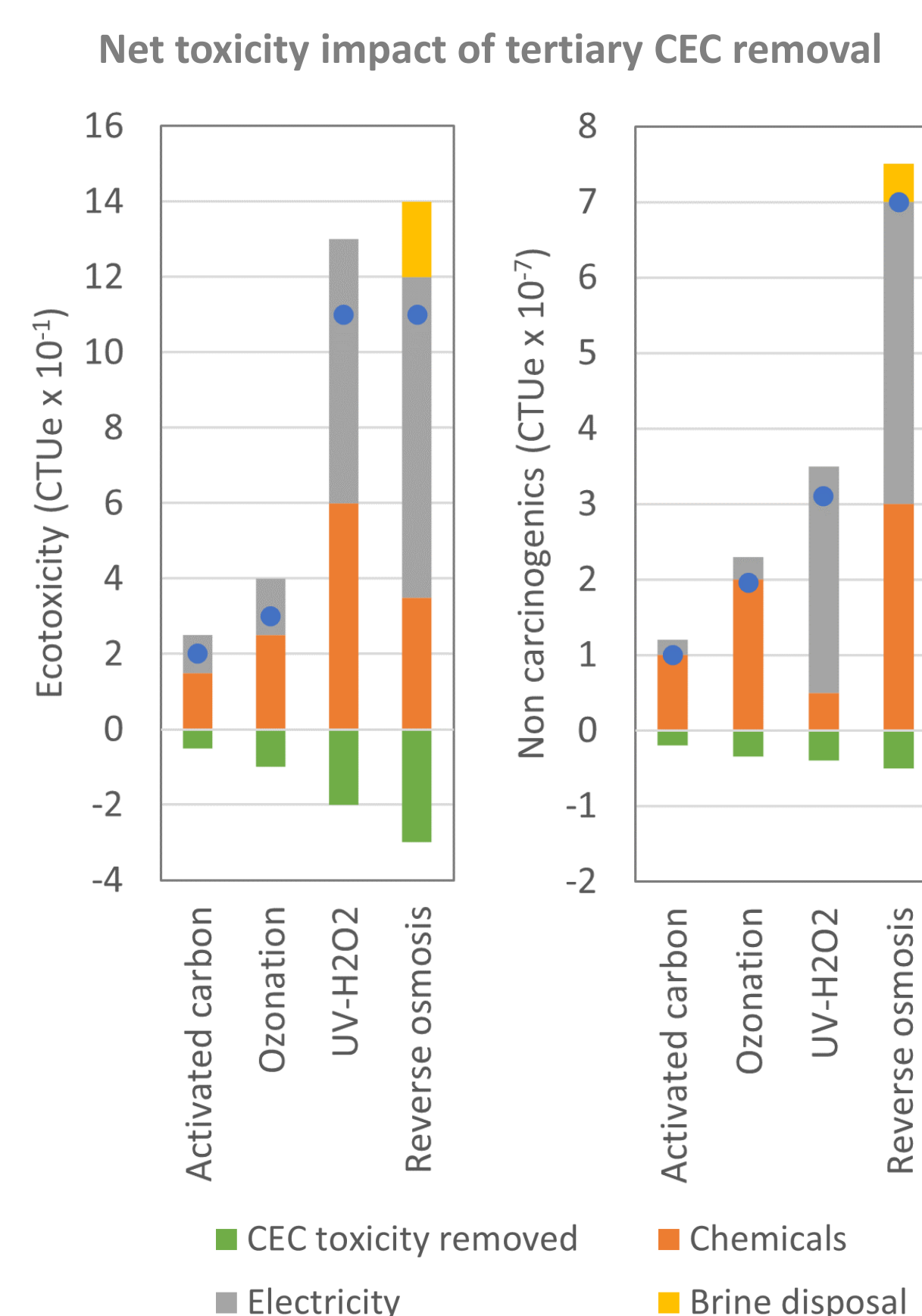


Fig. 3. Identifying potential trade-offs