University of Luxembourg

Chair of Urban Water Treatment

Main achievements of CoMinGreat Demonstration Center

Atelier transfrontalier « Gestion des micropolluants »
Jeudi 8 décembre 2022 - Metz

Interreg
EUROPEAN UNION
Grande Région | Großregion
CoMinGreat
Fonds européen de développement régional | Europäischer Fonds für regionale Entwicklung

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Motivation behind CoMinGreat

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- To centralize the knowledge acquired in terms of micropollutants mitigation;
- To give instruments to stakeholders and decision-makers;
- **To face (on time) the coming Water Frame Directive (WFD) challenges.**


European Commission

JRC TECHNICAL REPORT

Development of the first Watch List under the Environmental Quality Standards Directive

Directive 2008/105/EC, as amended by Directive 2013/39/EU, in the field of water policy


EUROPEAN COMMISSION

Brussels, 26.10.2022
COM(2022) 541 final

2022/0345 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

concerning urban wastewater treatment (recast)


EUROPEAN COMMISSION

Brussels, 26.10.2022
COM(2022) 540 final

2022/0344 (COD)

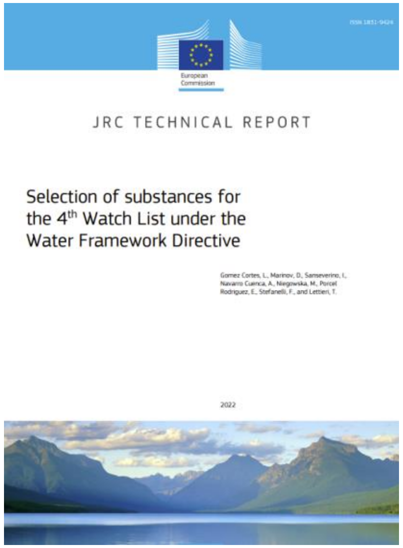
Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Directive 2000/60/EC establishing a framework for Community action in the field of water policy, Directive 2006/118/EC on the protection of groundwater against pollution and deterioration and Directive 2008/105/EC on environmental quality standards in the field of water policy

(Text with EEA relevance)

{SEC(2022) 540 final} - {SWD(2022) 540 final} - {SWD(2022) 543 final}


European Commission

JRC TECHNICAL REPORT

Selection of substances for the 4th Watch List under the Water Framework Directive

Gomez Cortes, L., Marinov, D., Sanseverino, I., Navarro Cuenca, A., Niegowska, M., Porcel Rodriguez, E., Stefanelli, F., and Lettieri, T.

2022

CoMinGreat project: mission

- Creation and implementation of a platform dedicated to the micropollutants challenge for the Greater Region (rural areas)

CoMinGreat project: main actions

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- Analysis of the situation in the Greater Region (production of a data inventory);
- Demonstrator of technologies (pilot plant);
- Information and demonstration Center;
- Data modelling to describe the WWTP, the impact of the technologies and the catchment.

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Axe prioritaire-Priorité d'investissement-Objectif spécifique 2-1-1

Axe 2 : Assurer un développement respectueux de l'environnement et du cadre de vie

6c : en conservant, protégeant, favorisant et développant le patrimoine naturel et culturel

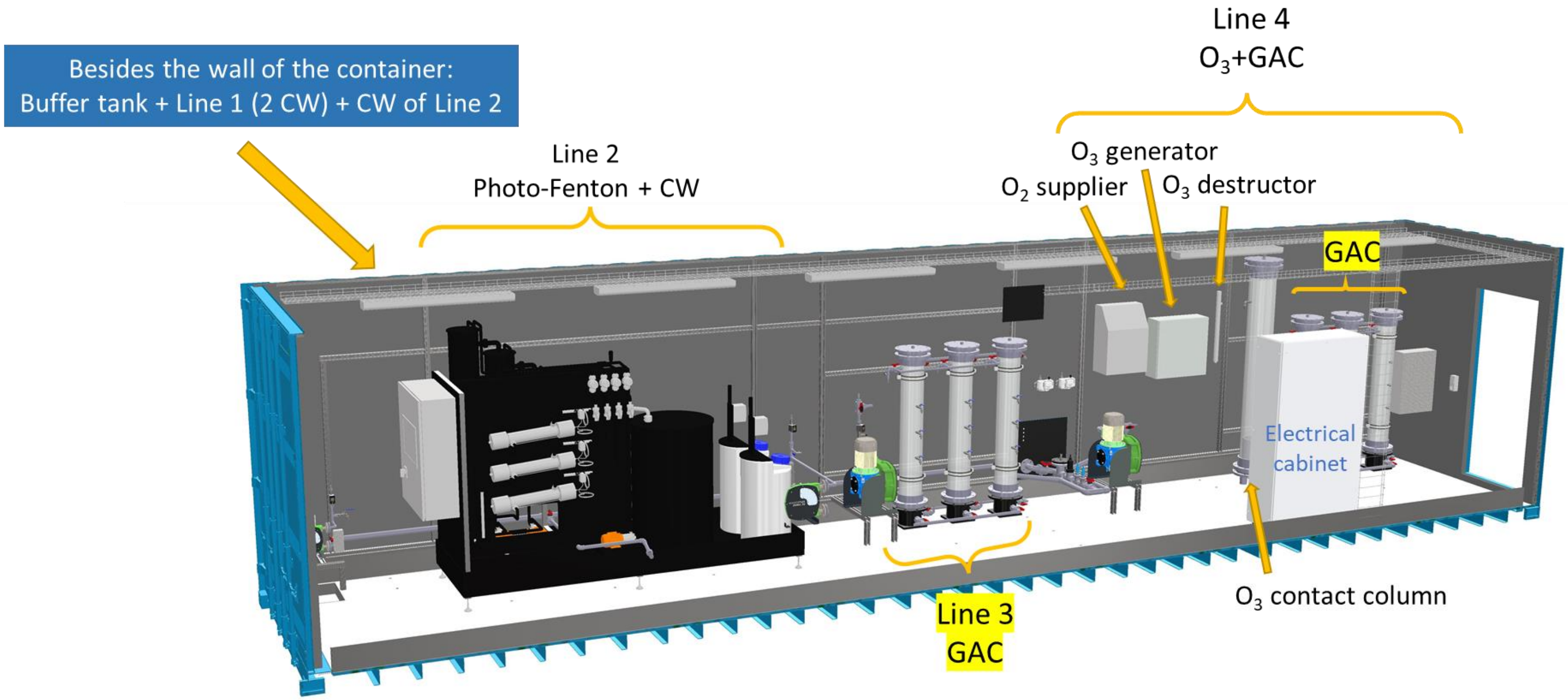
OS 3 : Atteindre un état de conservation favorable du milieu naturel

CoMinGreat's Demonstrator

Description: real scenario Bliesen WWTP (13000 PE), Germany

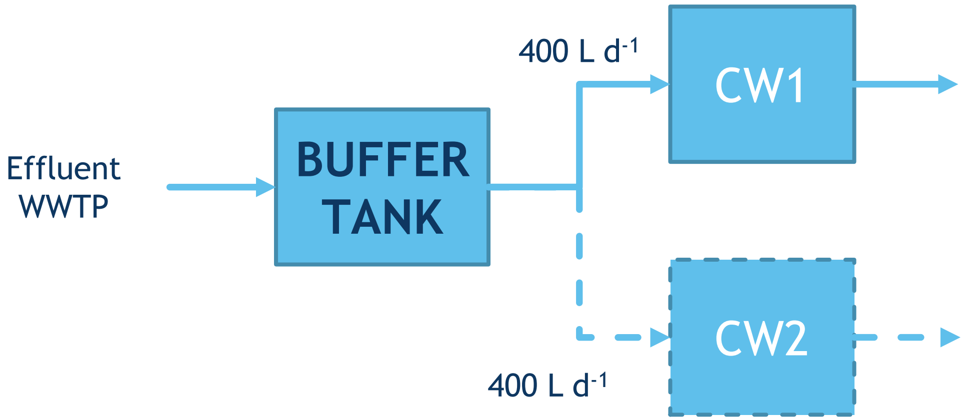
Four technologies:

- **Constructed Wetlands (CW) (1)**
- **Photo-Fenton + Constructed Wetlands (2)**
- GAC (3)
- O3+GAC (4)

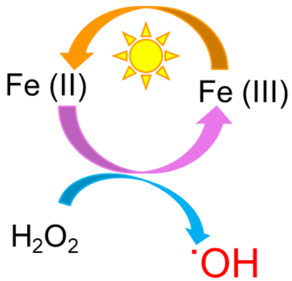


CoMinGreat Demo: Line 1

- *Phragmites australis* and *Iris pseudacorusm*
- Activated biochar (15%) + sand (85%)
- 3 cycles d^{-1}
- CW operated in parallel



CoMinGreat Demo: Line 2



$$Fe^{2+} + H_2O_2 \longrightarrow Fe^{3+} + {}^{\cdot}OH + OH^-$$
$$Fe^{3+} + H_2O \xrightarrow{h\nu} Fe^{2+} + {}^{\cdot}OH + H^+$$
$$H_2O_2 \xrightarrow{h\nu} 2\ {}^{\cdot}OH$$

Effluent WWTP → BUFFER TANK → Photo Fenton → Transition tank

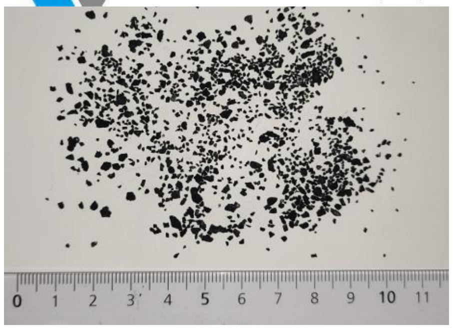
→ d1: 800 L d^{-1}, d2: rest → CW3 →

→ d1: rest, d2: 800 L d^{-1} → CW4 →

- 150 W Medium Pressure lamp
- 45 W each in UV
- V 19 m^3 d^{-1}
- HRT=5.5 s in each lamp, total 16.5 s
- Natural pH (using complexing agents to maintain iron in solution)

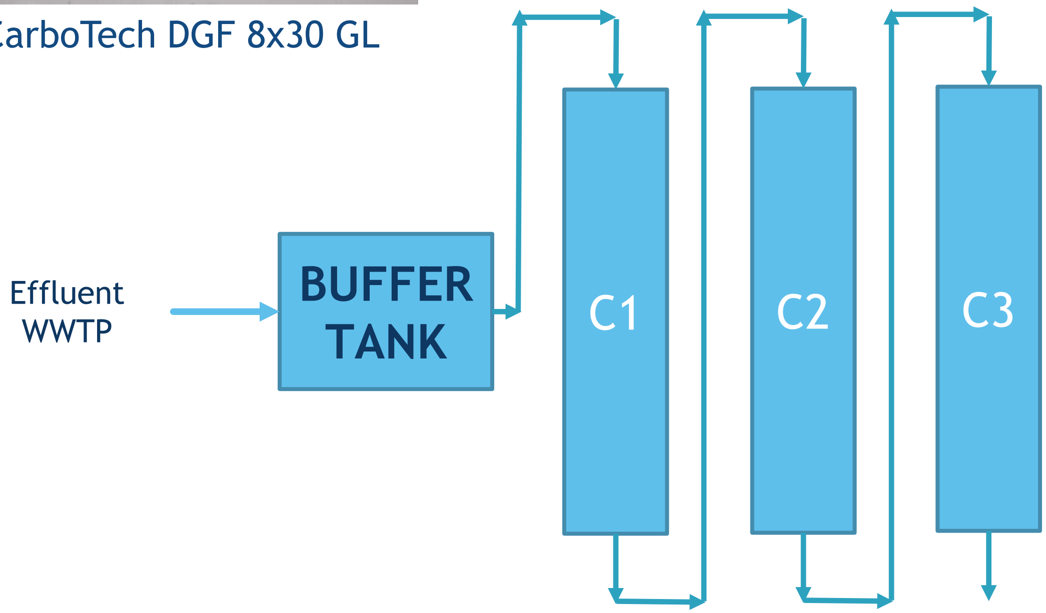
CoMinGreat Demo: Line 3

CarboTech
The activated carbon people

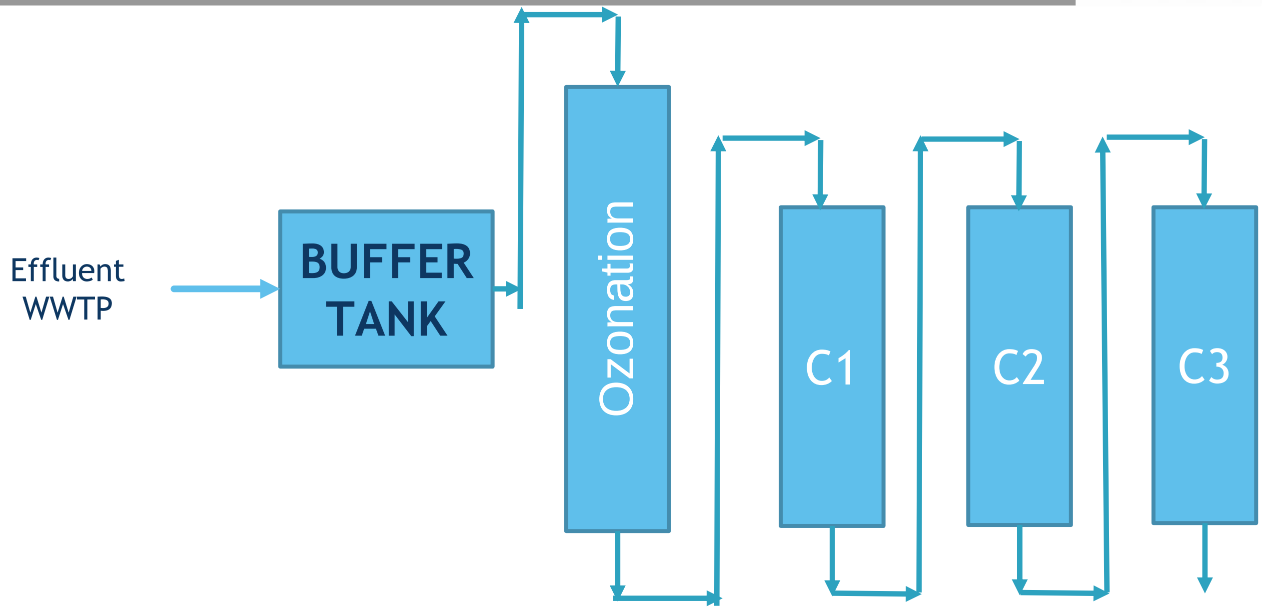


CarboTech DGF 8x30 GL

Setup:
- Velocity = 3.7 m/h
- Contact time = 60 min (20 min each column)



CoMinGreat Demo: Line 4



Setup:

Ozone

- 0.012 gO3/l (0.688 gO3/g COD)
- HRT = 34 min

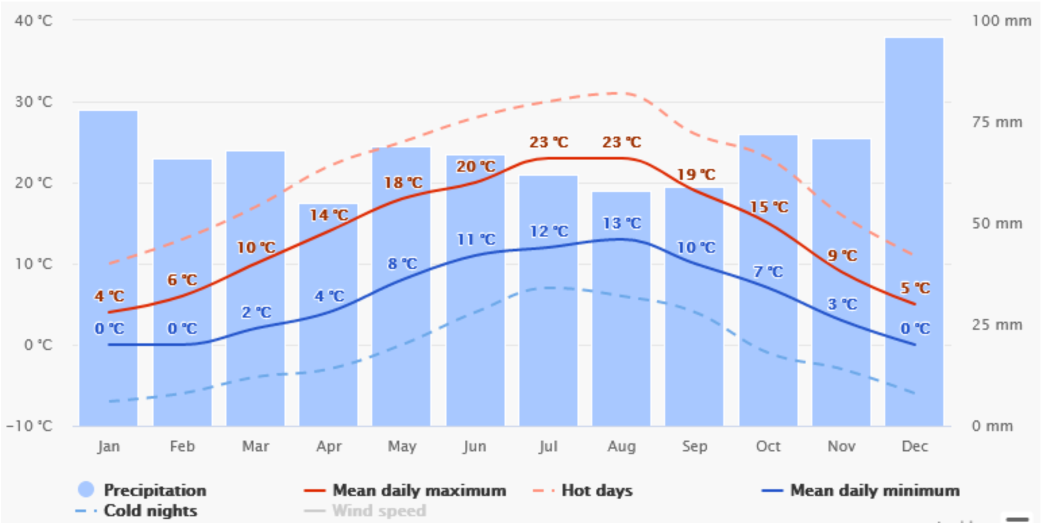
GAC

- Velocity = 3.7 m/h
- Contact time = 60 min (20min each column)

Design of sampling strategy

Purpose of the campaign	Light	Intensive	Sampling location
WWTP assessment	1 x 24 hr composite	1 x 72 hr composite	Influent, Effluent
WWTP leaching assessment	1 x 24 hr composite	1 x 72 hr composite	Influent, Effluent
Line 1,2,3,4 performance	1 x 24 hr composite	1 x 72 hr composite	Influent, Effluent
Receiving water assessment	grab sample	grab sample	Upstream,downstream

Average temperature and precipitations in Bliesen

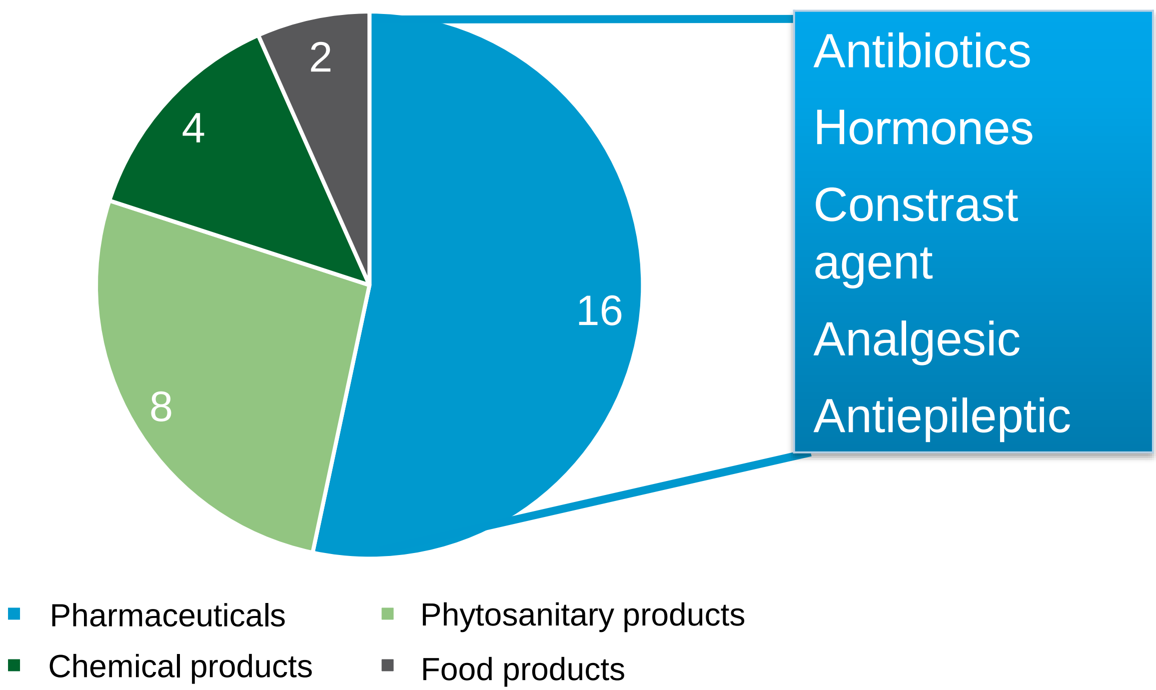


Intensive campaigns in February, May, August and October (seasonality dry/rainy weather)

Every 2-3 weeks **light campaigns** for process control

Selected micropollutants

30 compounds monitored, selected based on previous experience in EmiSûre, relevance for Bliesen, eco-toxicity data, excretion amount, legislative obligations etc.

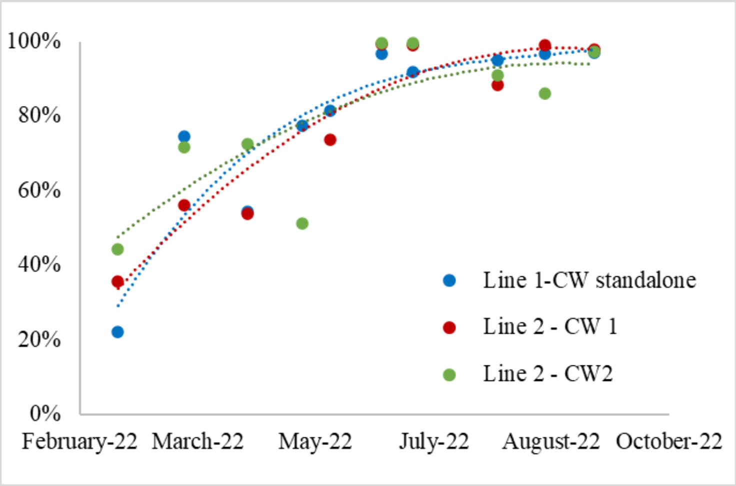


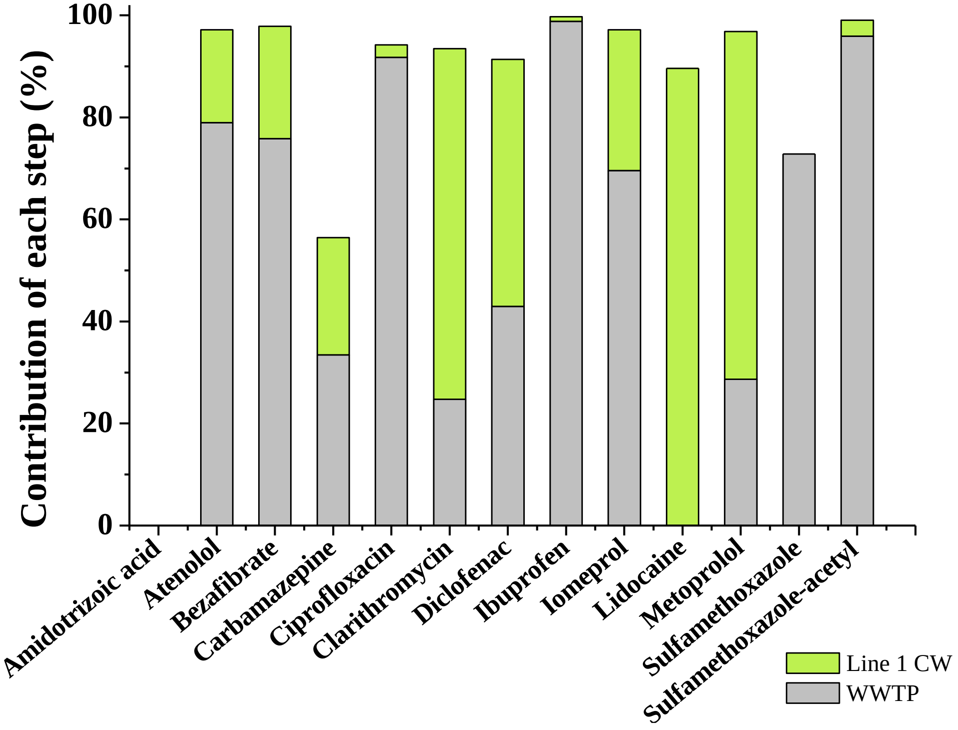
- Amidotrizoic acid
- Atenolol
- Bezafibrate
- Carbamazepine
- Ciprofloxacin
- Clarithromycin
- Diclofenac
- Estradiol-beta
- Estrone
- Ethinylestradiol
- Ibuprofen
- Iomeprol
- Lidocaine
- Metoprolol
- Sulfamethoxazole
- Sulfamethoxazole-acetyl

Micropollutants removal

Line 1 CW standalone

Stabilization of the CWs
Trend of diclofenac removal in the first months of operation (Removal regarding WWTP outlet)





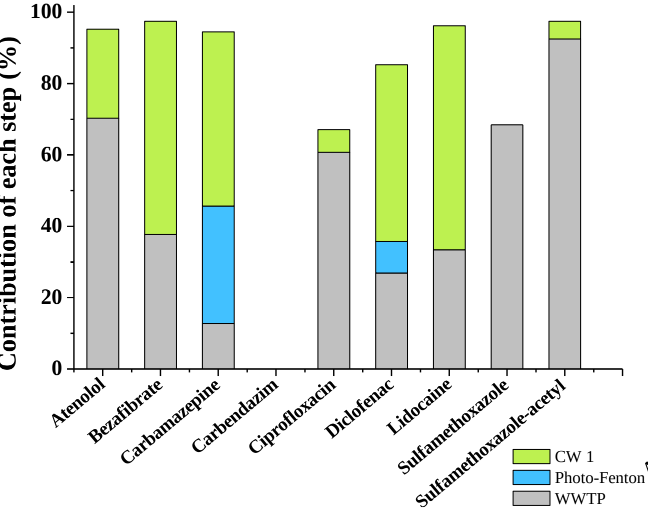
It took some months to have a fully developed and stable system (plants and microorganism in the soil). This probably affect the overall assessment since the evaluation address the full year. In any case, CW significantly enhanced the removal of MP.

Amidotriazoic acid is not removed while **Lidocaine** is fully removed by CW

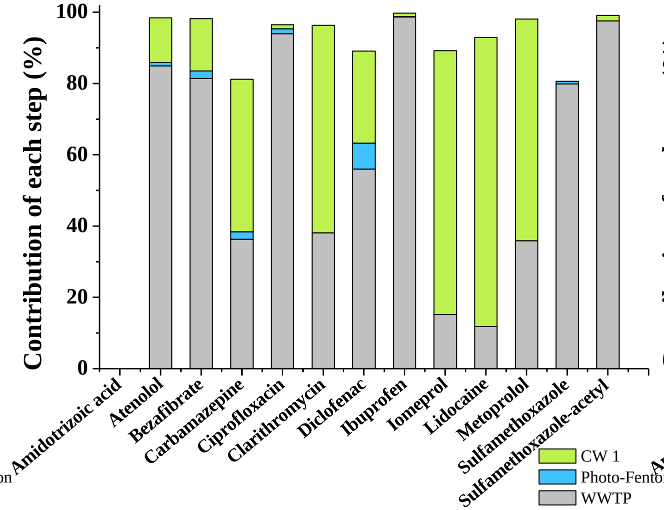
Micropollutants removal

Line 2 - photoFenton + Constructed wetlands

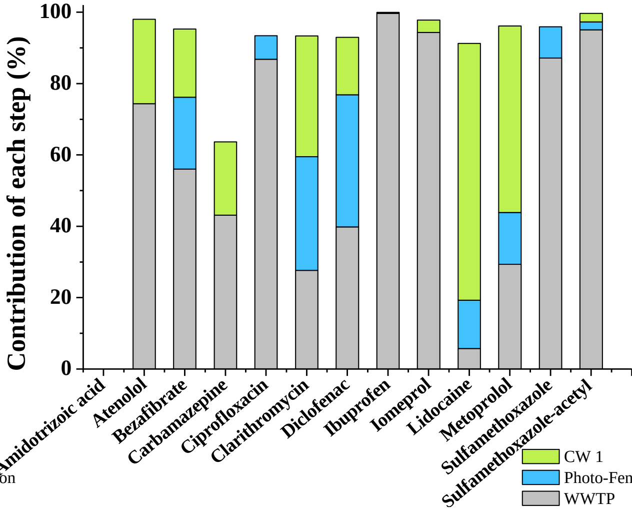
Fe:NTA molar ratio 1:1



Fe:Citric acid molar ratio 1:1



Fe:Citric acid molar ratio 1:2



High MP removal was reached at the end of the line, but the main role was taken by CW. Photo-Fenton showed lower efficiency than in the literature mainly for the use of commercial reagents instead of analytical ones (high purity).

NTA was discarded for its precipitation and clogging of the dosing system.

Chelating agent changed to citric acid but the photo-Fenton efficiency was even lower. Probably iron complex is not stable, precipitates and also hinders the transmission of the radiation through the solution.

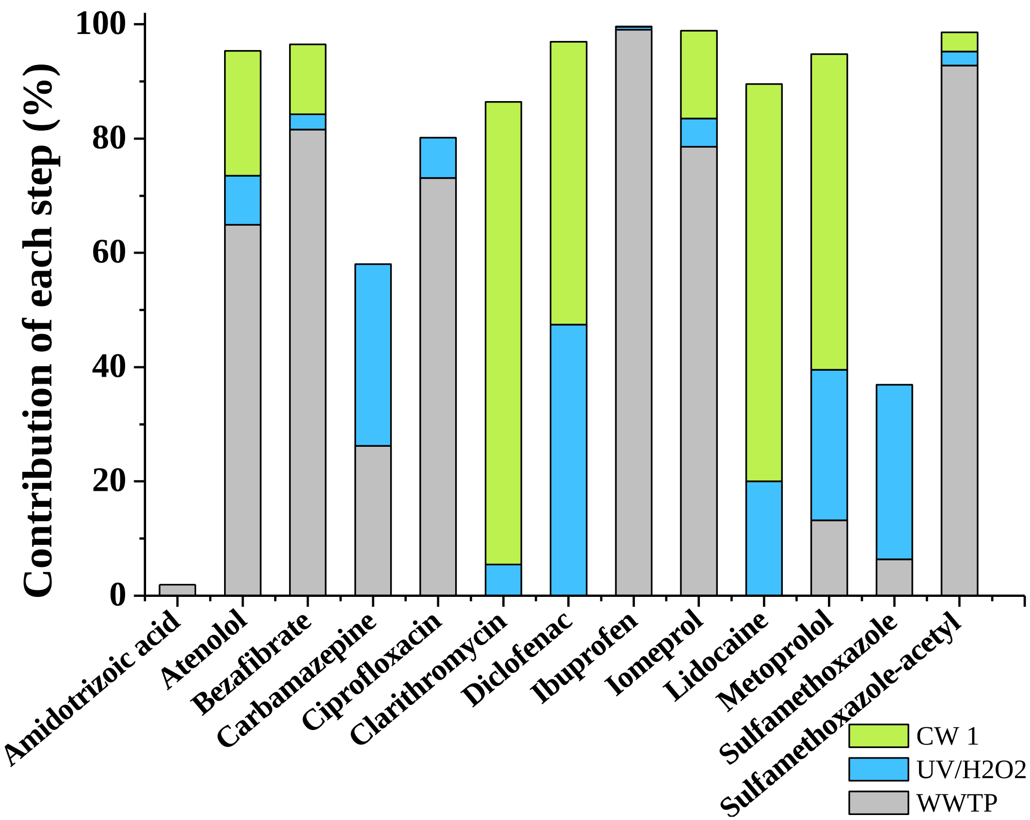
CW had again the main role to reach 80% of removal

Increasing molar ration of the chelating agent enhanced significantly photo-Fenton efficiency. The complex was more stable and allows to maintain iron in solution and available for the reaction thus more OH radicals were generated.

- **Amidotrizoic acid** no removal
- **Claritromicyn and Diclofenac** were mainly removed by PF
- CW were crucial for the removal of **Lidocaine**

Micropollutants removal

Line 2 - UV/H2O2 + Constructed wetlands



Without iron the removal efficiency is higher than with citric acid 1:1 but lower than with 1:2.
This confirmed that 1:1 was not stable and precipitation of iron hindered the process.

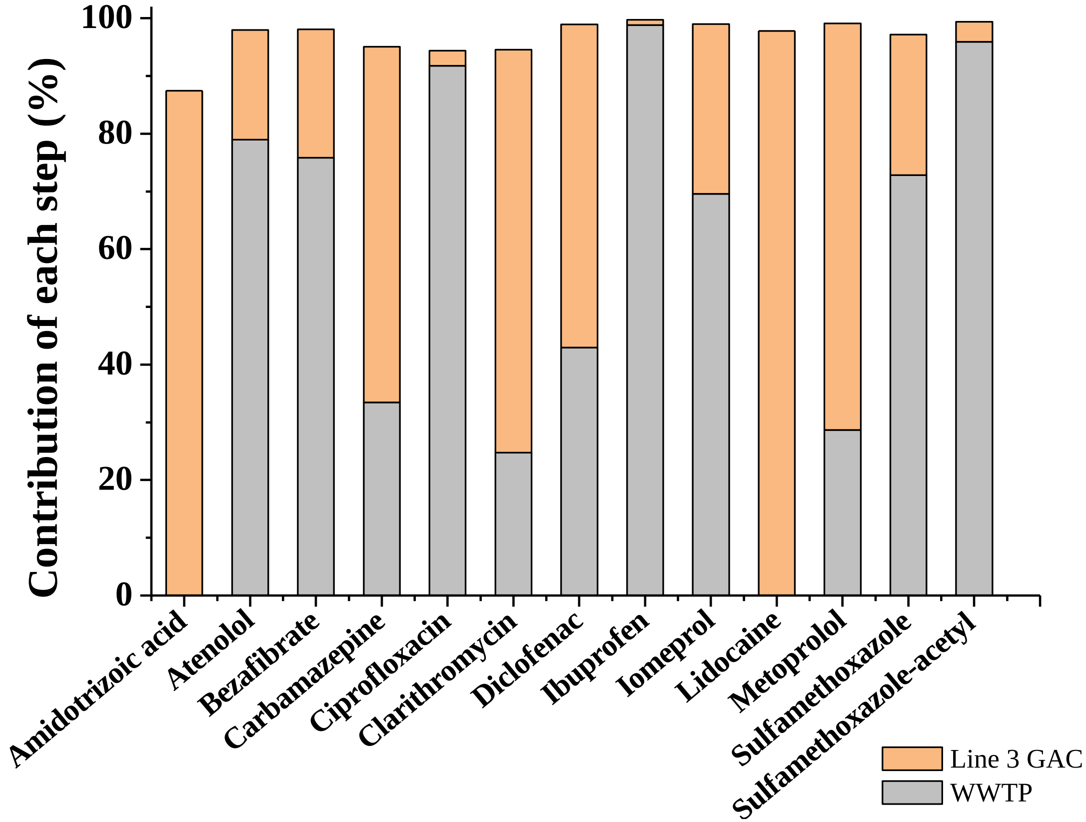
- **Amidotrizoic acid** slight removal by UV/H2O2 that might allow removal by CW

Again, CW had the main role.

To remark: Effluent contained a high amount of bicarbonates (>120 mg/L) which are scavengers of OH radicals!
A possibility to increase efficiency could be to reduce them by adding acid.

Micropollutants removal

Line 3 – Granular activated carbon

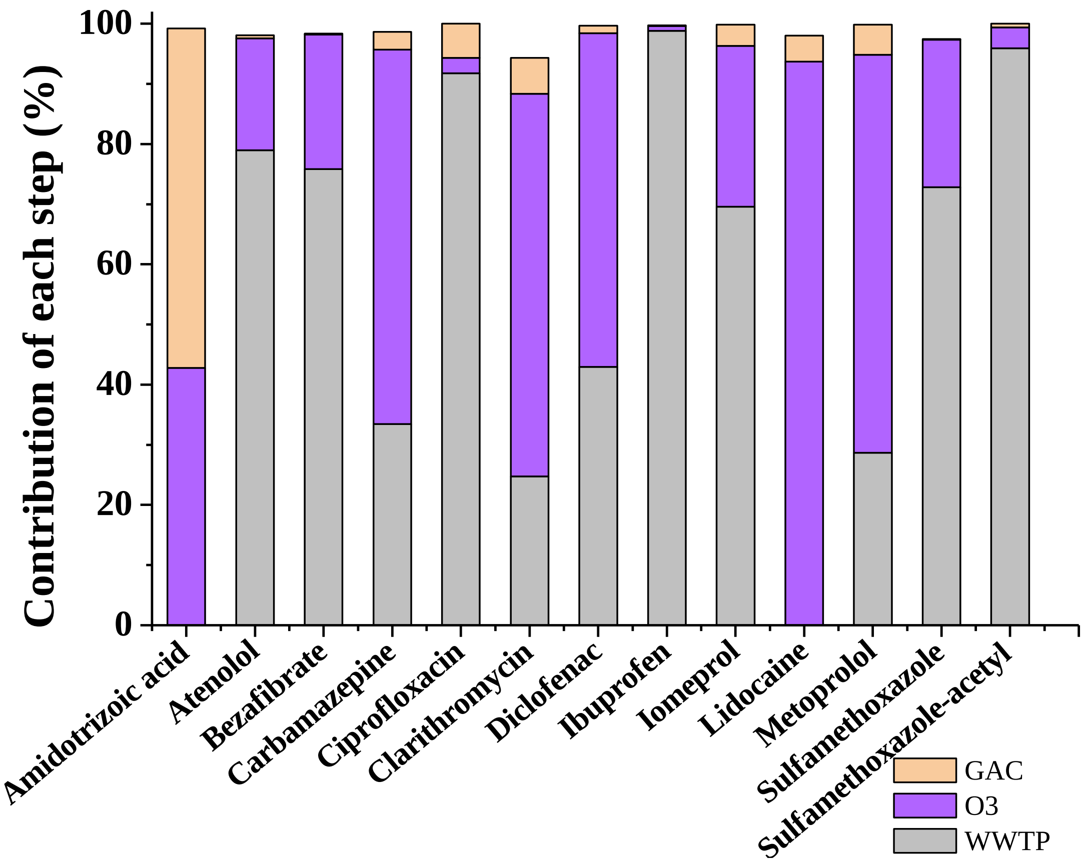


Most of the compounds reached 100% removal with the application of GAC

- **Amidotrizoic acid** is removed more than the 80%

Micropollutants removal

Line 4 – Ozone + Granular activated carbon



Most of the compounds reached 100% removal. Application of O_3 as first step pose a huge advantage since it is the main process. Lifetime of GAC extended.

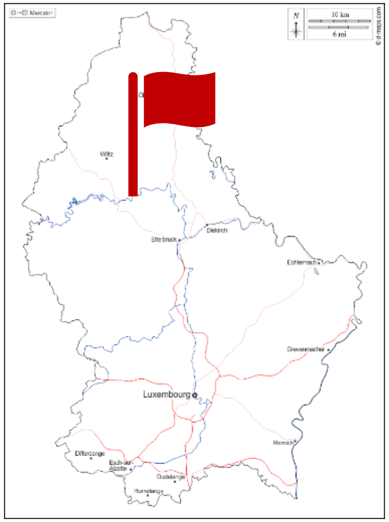
- **Amidotrizoic acid** Fully removed with the combination

CoMinGreat: Conclusions

- Common treatments as GAC and O3+GAC remove efficiently micropollutants for WWTP effluents
- CW supported with activated biochar proved to be suitable for the removal of micropollutants as a post-treatment step
- The upgrade of CW with an upstream oxidation technology would improve the removal of most persistent compounds having double benefits:
  - reduction of energy demand needed for the sole Photo-Fenton;
  - extended lifetime and minimized space needed for the sole wetland.
  - However photoFenton needs to be tested under favourable conditions

CoMinGreat: Future steps

New testing location Heiderscheidergrund WWTP (Luxembourg) (12000 PE)



Improvements in operation versus performance:

- Use of a sand filter in the inlet of the post-treatment step
- Reducing the carbonates to avoing OH radicals scavenging
- Testing pH 3 to reduce the fouling due to the commercial chelant and remove carbonates at the same time

Testing new biochar in a circular economy perspective (cellulose biochar with the WoW project).