UNESCO-IWRA ONLINE CONFERENCE
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3RD IN THE IWRA ONLINE CONFERENCE SERIES

Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment

Soil aquifer treatment application to improve the chemical quality and increase the quantity of groundwater

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Abstract Session 4 - Theme 2 "Emerging pollutants and groundwater

11:00h CET, 18 January 2023

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Programme hydrologique intergouvernemental

IWRA International Water Resources Association

Groundwater status

Groundwater at risk

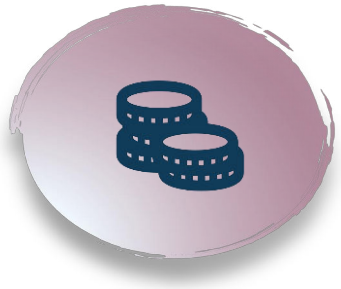
Groundwater resources are threatened globally

Increasing demand

Public water supply, industry, and agriculture expected to increase and, consequently, also water demand

Pollution

Depending on the source water used for aquifer recharge (*e.g.* river water, urban stormwater, or treated wastewater) a large variety of contaminants may be present



Cost

Wastewater treatment and reclamation technologies

Monitoring

There is an urgent need to strengthen data collection protocols to know the current real state of groundwater bodies

How to improve the status of groundwater

Aquifer Recharge

Managed recharge of water to aquifers (MAR) is an option to augment groundwater resources in a targeted and safe manner and mitigate water scarcity

Pollution Attenuation

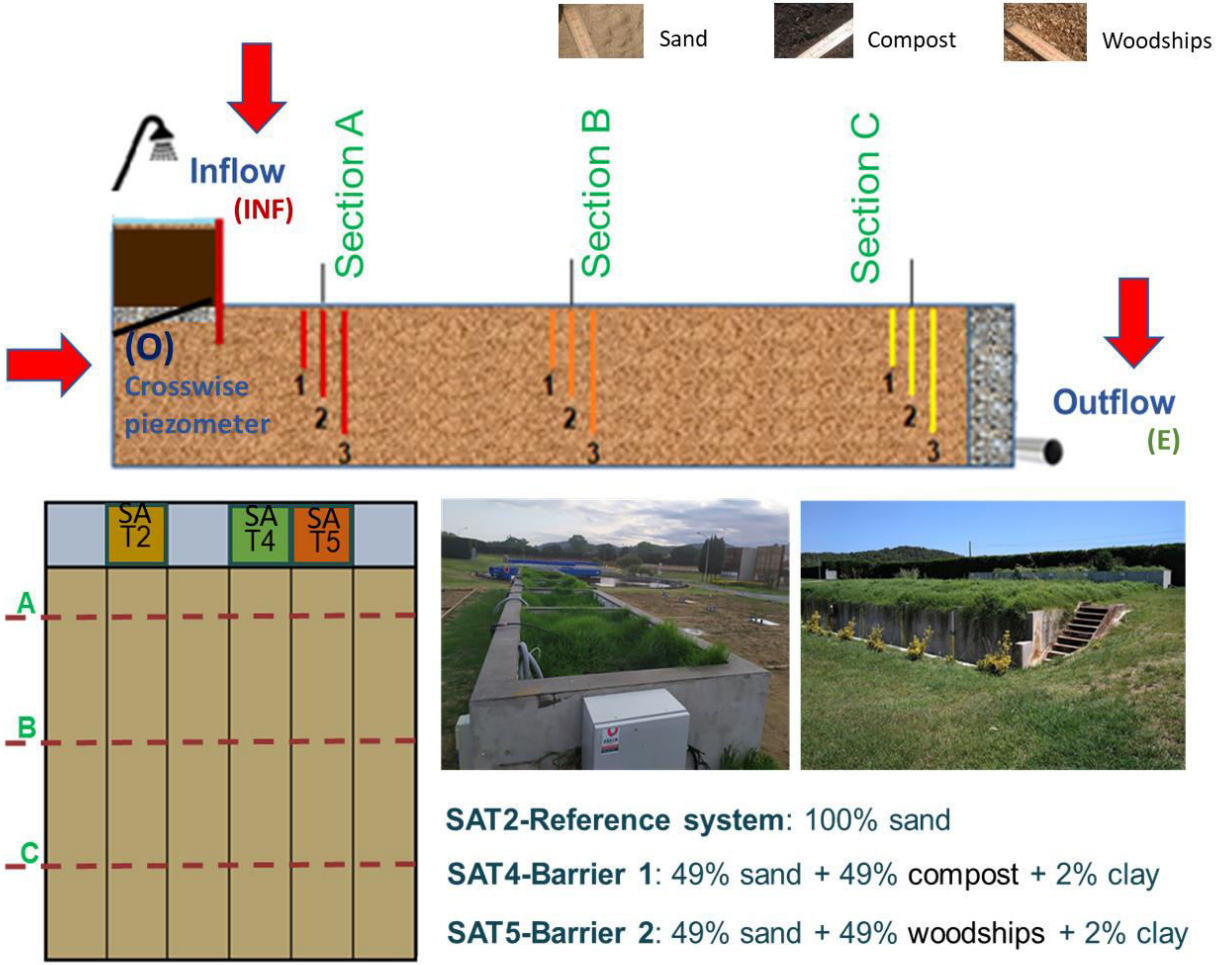
MAR implemented with reactive barriers to improving the pollutant natural attenuation of soil-aquifer systems protecting groundwater resources from contamination

Water Reuse

The improved groundwater quality can allow its subsequent recovery to produce drinking water and for agricultural irrigation

Pilot SAT system

- WWTP Palamós (Girona, Spain)



SAT2-Reference system: 100% sand

SAT4-Barrier 1: 49% sand + 49% compost + 2% clay

SAT5-Barrier 2: 49% sand + 49% woodships + 2% clay

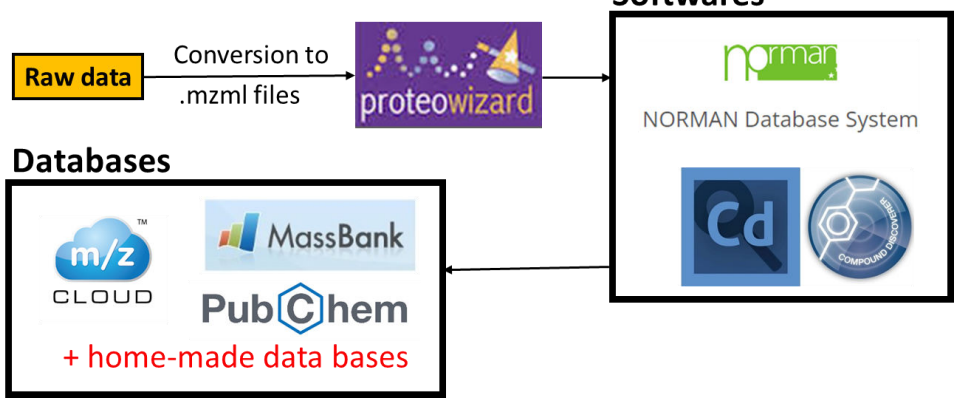
CECs suspect screening and semi-quantification

CECs - Suspect and semiquantitative screening

Liquid chromatography-high resolution mass spectrometry (LC-HRMS (Orbitrap-MS)

Thermo Q Exactive HF-X LC/MS

Workflow

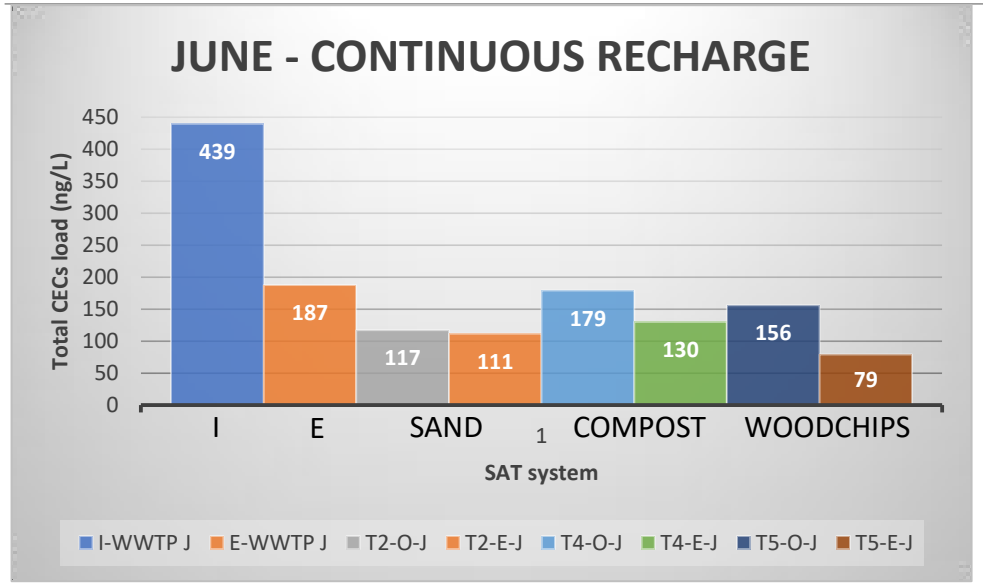


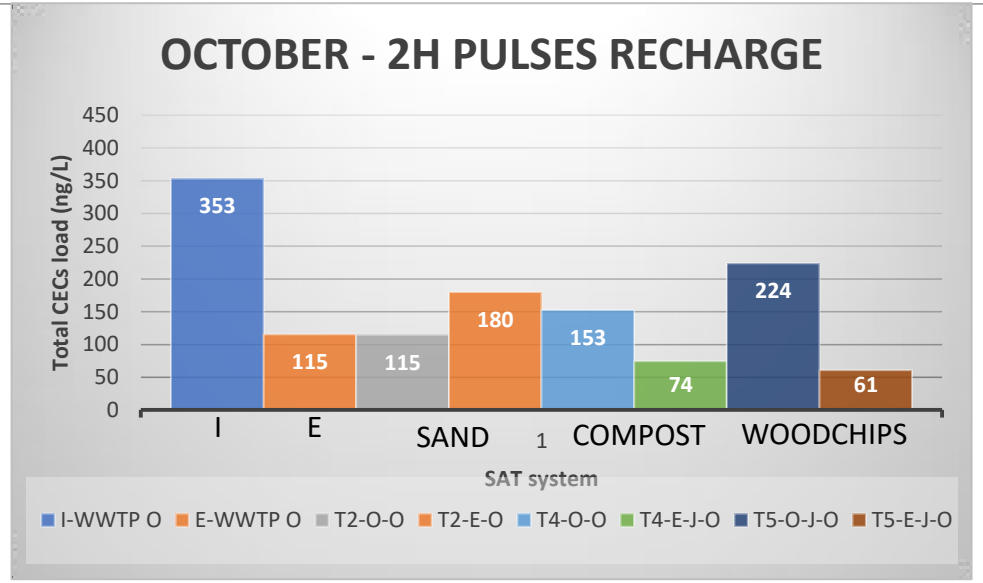
Number of chemicals identified: 124 chemicals, parents and metabolites

Nature: pharmaceuticals, plastic additives, food-related chemicals, UV filters, pesticides, stimulants, illicit drugs,…

CEC	Nature	Cluster	Predicted PNEC (ng/L)	Observed concentration OCT20 (ng/L)	Observed concentration JUN20 (ng/L)
1-Amino-2-methylanthraquinone	Additive	C	-	-	
Melamine	Additive	C	360000,00	0,11	1,49
1H-benzotriazole (BTri)	Additive	C	5910,00	9,15	10,45
Fenofibric acid	Anticholesterol	C	-	-	-
Gemfibrozil	Anticholesterol	C	500,00	0,14	0,64
Phendimetrazine	Anticholesterol	C	47200,00	1,05	1,44
Carbamazepine	Anticonvulsant	C	50,00	1,25	1,72
Lamotrigine	Anticonvulsant	C	10000,00	1,51	2,85
Venlafaxine	Antidepressant	C	38,00	0,26	0,61
Irbesartan	Antidiabetic	C	704000,00	1,09	0,32
Diclofenac	Antiinflamatory	C	50,00	0,06	-
Ketoprofen	Antiinflamatory	C	2150,00	0,53	1,38
Propylphenazone	Antiinflamatory	C	800,00	0,45	0,50
Fluconazole	Antimicrobial	C	-	-	-
Olmesartan	Hypertension	C	-	-	-
Valsartan	Hypertension	C	560000,00	4,67	-
Diuron	Insecticide	C	70,00	0,56	0,63
Clopidogrel carboxylic acid	Metabolite	C	-	-	-
10,11-dihydroxycarbamazepine	Metabolite	C	1910,00	0,68	0,26
4-acetamidoantipyrine	Metabolite	C	100000,00	12,23	7,82
4-formylaminoantipyrine	Metabolite	C	1000000,00	2,78	3,46
O-desmethyl venlafaxine	Metabolite	C	42000,00	2,97	3,81
O-desmethyltramadol	Metabolite	C	9120,00	0,42	2,90
Ritalinic acid	Metabolite	C	-	-	-
4-Methyl-1H-benzotriazole (4-Ttri)	Metabolite	C	8000,00	9,00	10,44
Caffeine	Stimulant	C	1200,00	0,25	<LOD
Ensulizole	UV_filter	C	100000,00	3,00	0,34

Results (I)





Higher contaminants load in **June – anthropogenic origin**: Cocaine, Methadone, Nicotine, Sulpiride,...

Compound-dependant reductions for many CECs.

Overall removal : Sand < Compost < **Woodchips**

Differential removal of CECs depending on the recharge approach: Continuous < **Pulse**

Results (II)

Sand in continuous removes CECs in 37%, but under pulses does not reduce them.

Selective removal:

- 1H-benzotriazole, 4-Methyl-1H-benzotriazole, Dimethyl-benzotriazole, Imiodacloprid...: **Increased in sand, but decreased in both compost and woodchips** (higher extent) reactive barriers.
- Hydroxycarbamazepine, 10,11-dihydroxycarbamazepine, Carbamazepine-10,11-epoxy, Carbamazepine ..: **Only reduced in both compost and woodchips** (higher extent) reactive barriers.
- Lorazepam, Diclofenac, Diuron,... : only reduced in **woodchips** reactive barrier.
- Valsartan acid, Clarithromycin, PPG n10,...: only reduced in **compost** reactive barrier.

Conclusions

The reduction of CECs, demonstrates that the implementation of **SAT holds a great potential to attenuate the toxic effects-risk associated to WWTP effluent**s, allowing their safer potential use in **aquifer recharg**e schemes.

The degradation observed suggests that **reactive barriers composed of a mixture of diverse materials would be effective in degrading pollutants with a wide range of physicochemical** properties in one treatment.

A functional **SAT system** with the capacity to reduce CECs from recharge water would be perceived as a **natural-based cost-effective approach to face current issues** related to aquifer recharge, in connection with the **circular economy, groundwater** and **water reuse** policies.

Acknoledgements

Agència Catalana de l'Aigua

RESTORA

Managed aquifer recharge and use of organic subsurface treatment to accelerate water renaturation

https://restora.h2ogeo.upc.edu

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http://www.maradentro-jpi.eu

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Thank you!

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