Nextwater 2025 @ 22nd Oct 2025

# Recent advances of stormwater treatment systems in heavy metal and organic chemical removal


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**Project #3048**

Review of stormwater quality to support the development of evidence-based stormwater recycling guidelines


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# Stormwater runoff

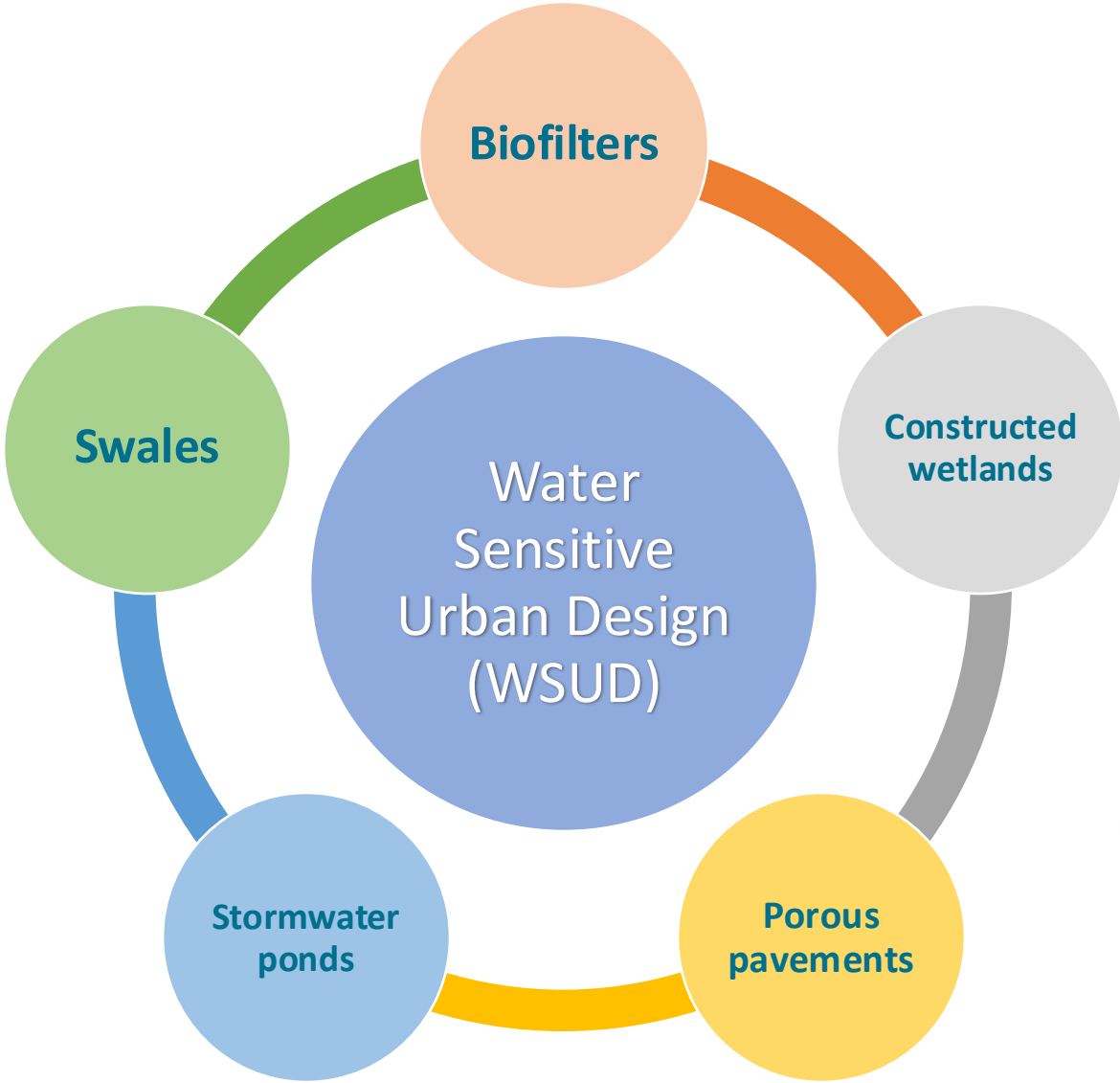
## Emerging contaminants

### Heavy metals

### Organic chemicals

Source: https://www.globalwatergroup.com.au/our-blog/primary-secondary-and-tertiary-treatment-of-stormwater

# Stormwater treatment




Source: https://news.cityofsydney.nsw.gov.au/articles/explainer-what-is-a-raingarden; https://www.landscapeperformance.org/case-study-briefs/sydney-park-water-re-use-project; https://glooloop.com.au/decorative-permeable-paving/; https://www.extremestorms.com.au/overnight-storms-intensify-flooding-western-sydney-sunday-6-march-2022/

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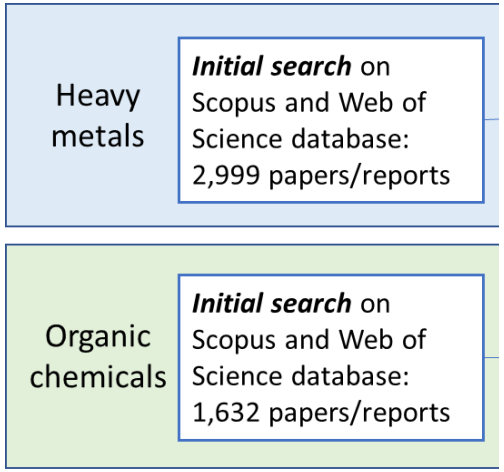
# Systematic literature review

## Database source from: **Scopus and Web of Science**

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# Overview of collected data

| Technology | No. of papers | No. of pollutants | No. of sites (designs) |
|---|---|---|---|
| **Heavy metals** | | | |
| Biofilters | 68 | 22 | 454 |
| Constructed wetlands | 44 | 20 | 54 |
| Porous pavements | 23 | 18 | 52 |
| Stormwater ponds | 21 | 19 | 47 |
| Swales | 7 | 5 | 23 |
| **Sub-total** | **163** | **25** | **630** |
| **Organic chemicals** | | | |
| Biofilters | 32 | 168 | 67 |
| Constructed wetlands | 10 | 43 | 15 |
| Porous pavements | 3 | 8 | 5 |
| Stormwater Pond | 4 | 11 | 5 |
| Swales | 8 | 41 | 19 |
| Advanced technologies | 10 | 19 | 10 |
| **Sub-total** | **67** | **181** | **121** |

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# Data analysis

Statistical Summary

Impact of system design

Impact of operational parameters

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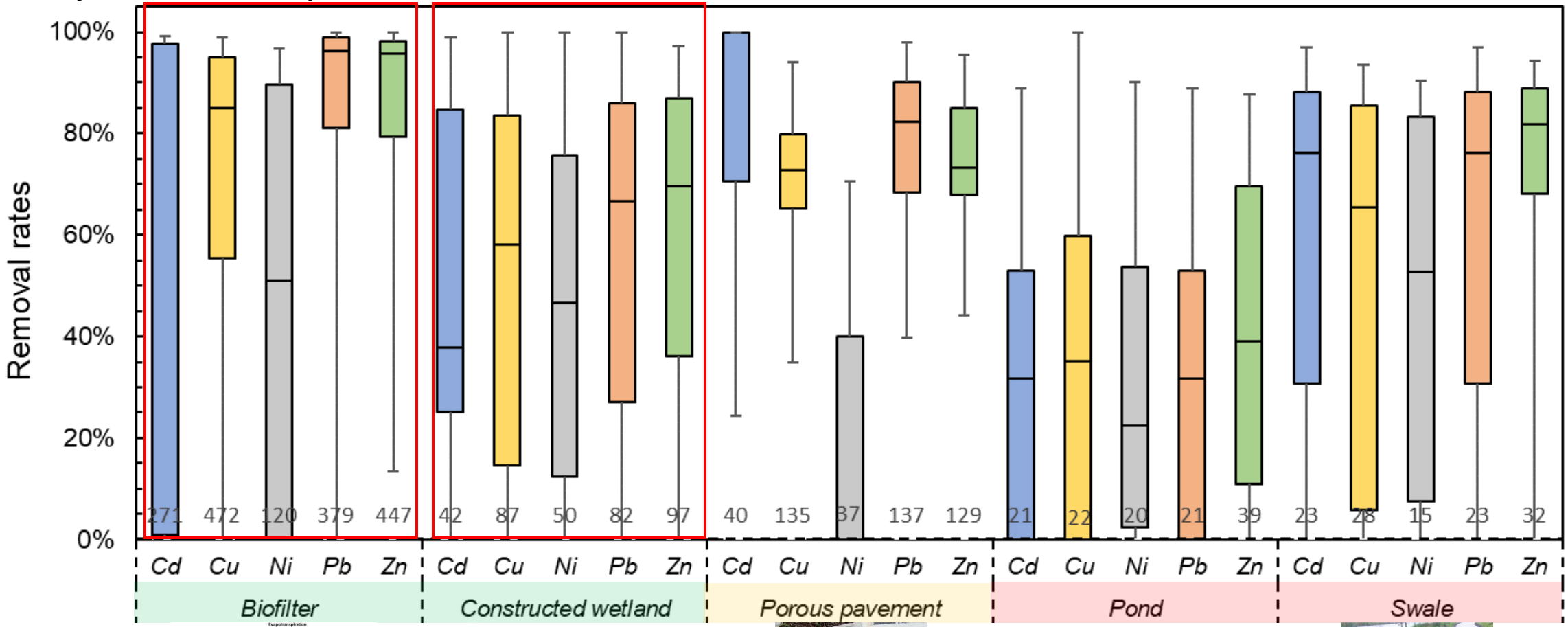
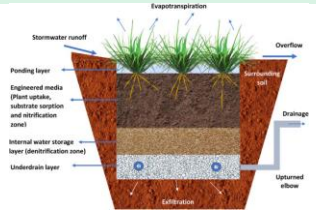
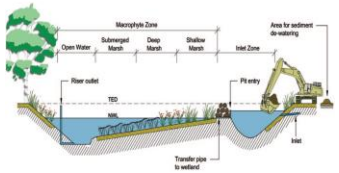
# Comparison technologies

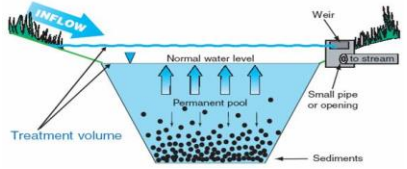
## Nature-based systems

**Heavy metals as example**



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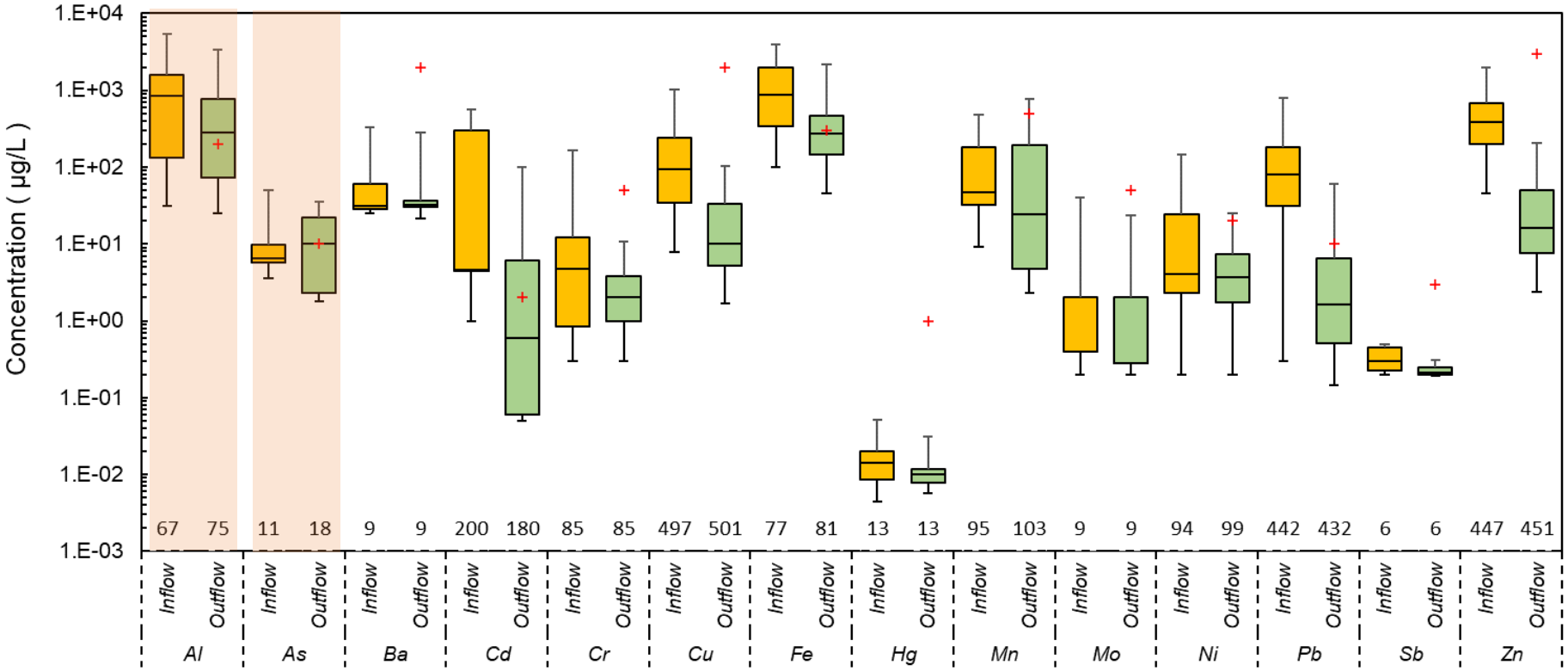
# Biofilters

## Overview of treatment performance

### Heavy metals

"+" represents ADWG values




*Inflow and outflow concentrations boxplots of the metals*

**Less concern:**

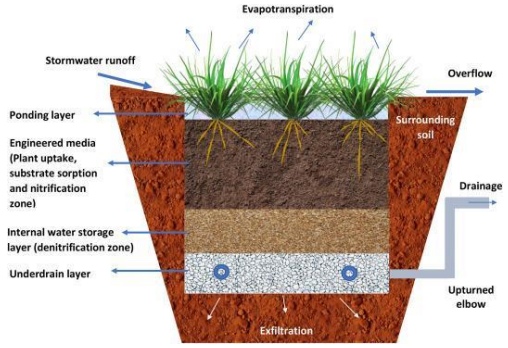
- Ba, Cr, Cu, Hg, Mo, Sb, Zn

**Moderate concern**

- Cd, Fe, Mn, Ni, Pb

**High concern**

- Al (*aesthetic*), As

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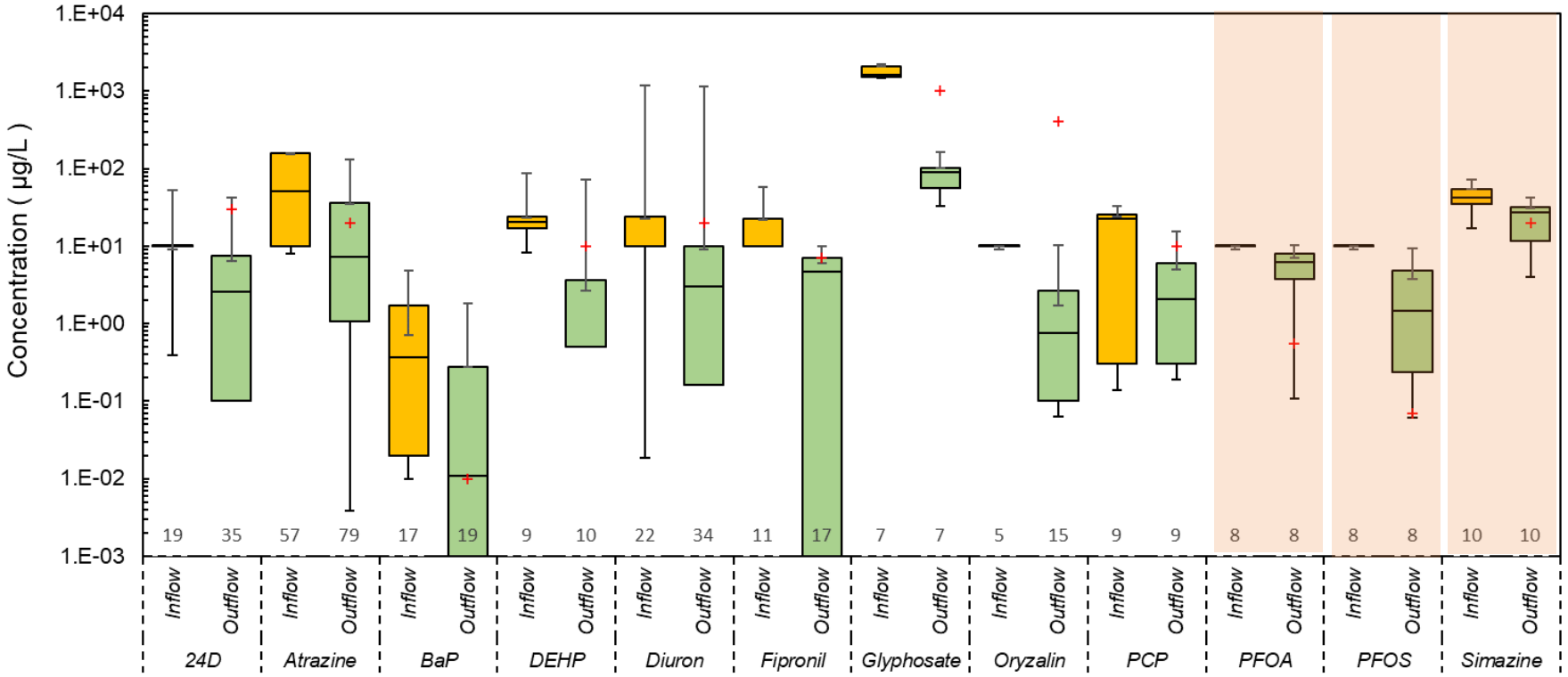
# Biofilters

## Overview of treatment performance

### Organic chemicals

"+" represents ADWG values




*Inflow and outflow concentrations boxplots of the organic chemicals*

**Less concern:**

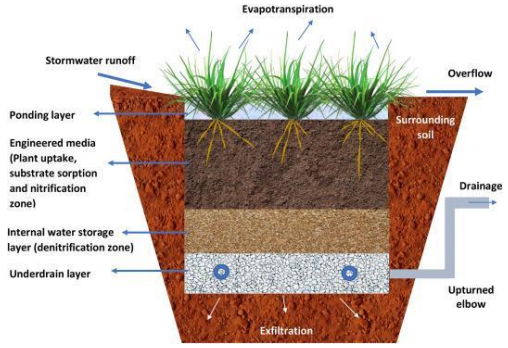
- Glyphosate and oryzalin

**Moderate concern**

- 2,4-D, atrazine, BaP, diuron, fipronil, PCP and DEHP

**High concern**

- Simazine, PFOA and PFOS

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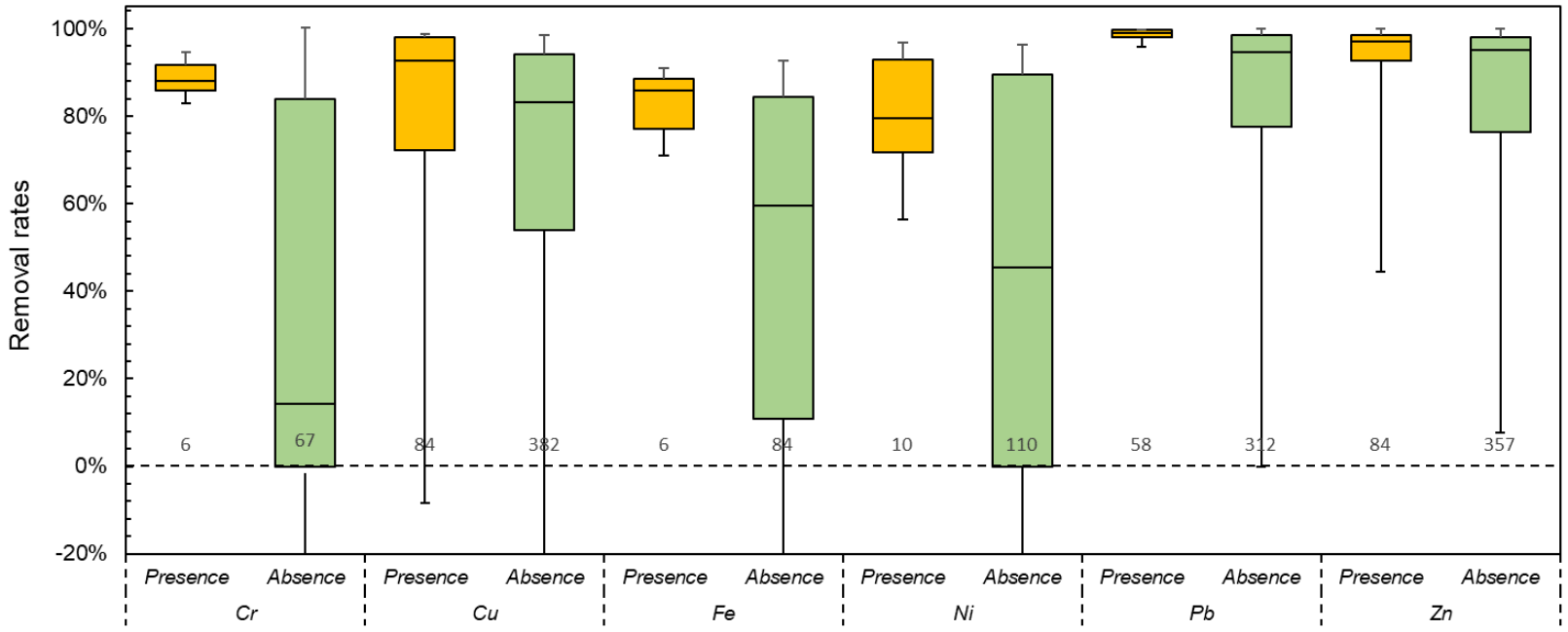
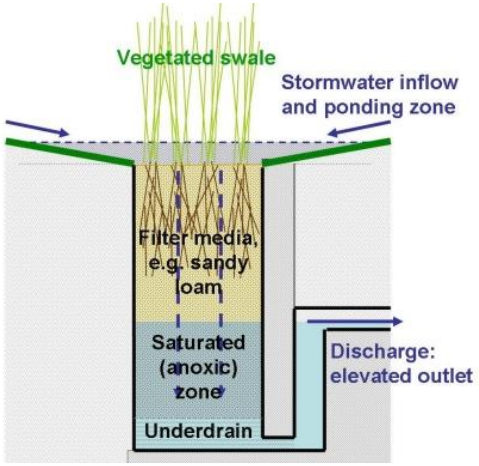
# Biofilters

## Submerged zone (SZ) presence

**Heavy metals as example**




- A **clear positive impact** observed for both metals and organic chemicals
  - higher removal
  - less variability




**'Y'** – presence of SZ; **'N'** – absence of SZ

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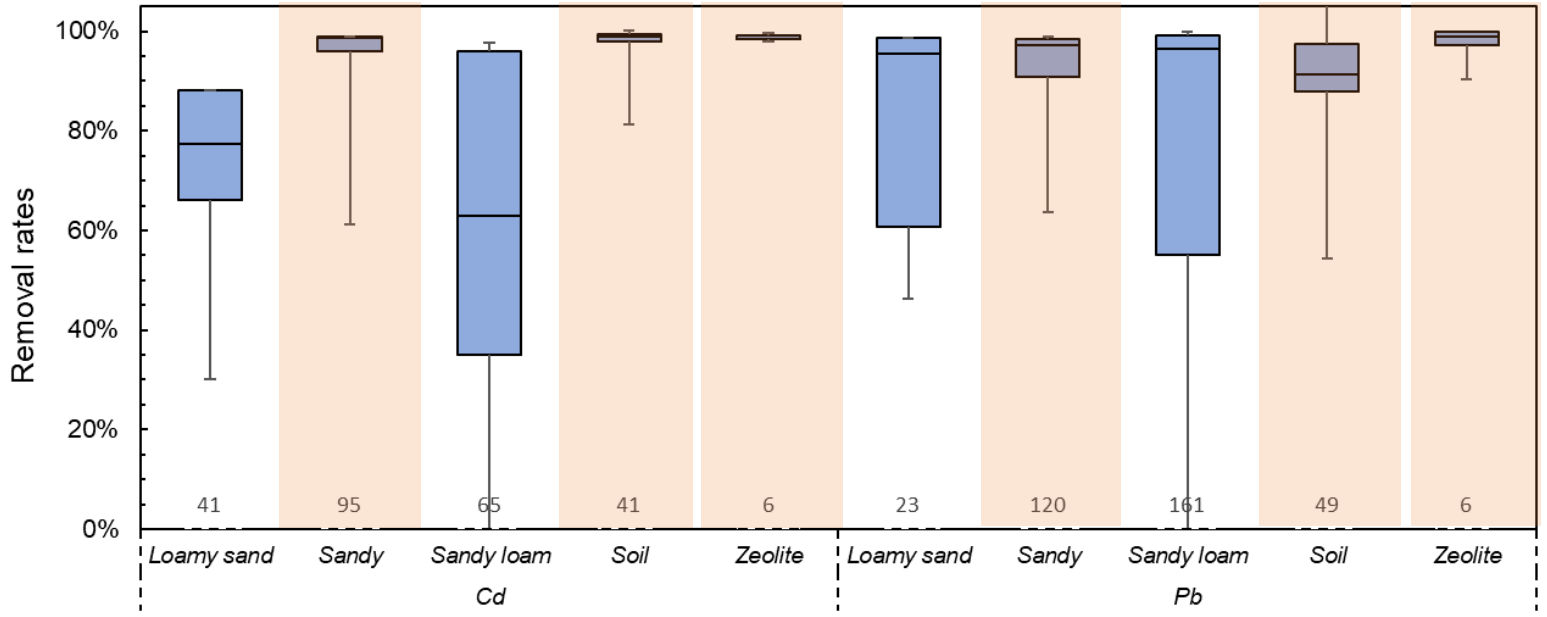
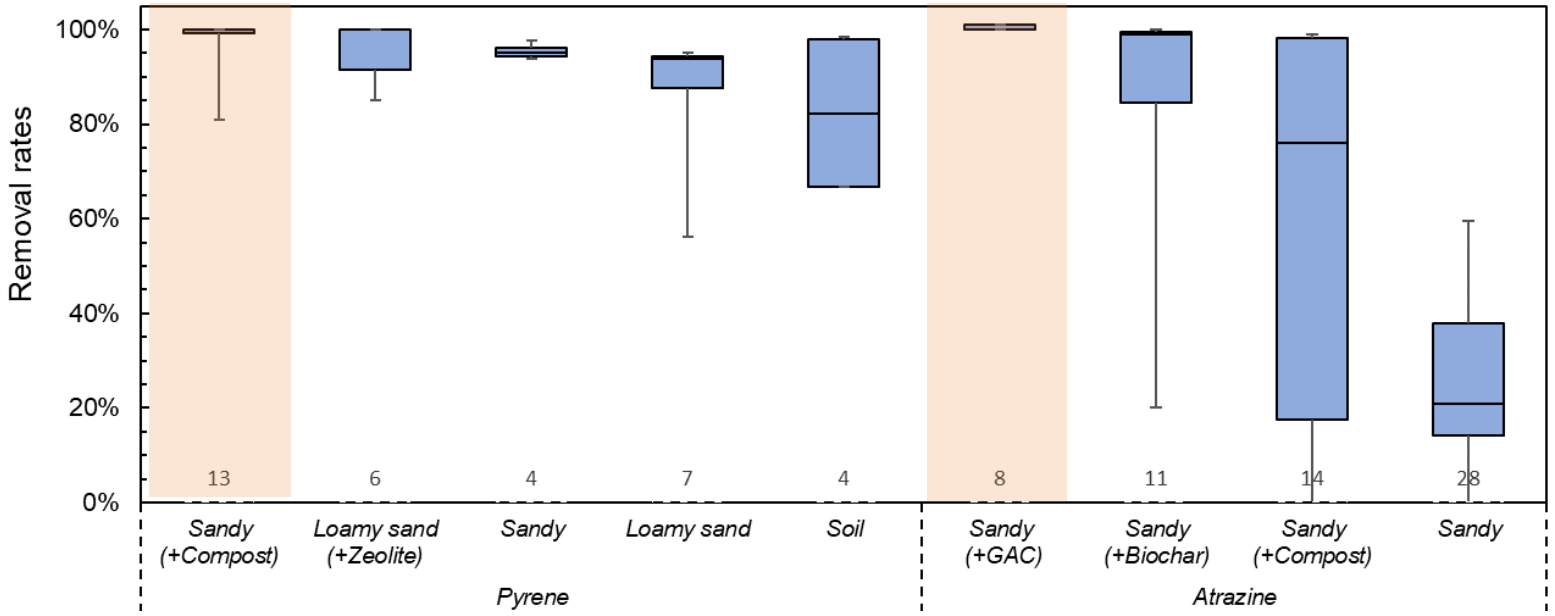
# Biofilters

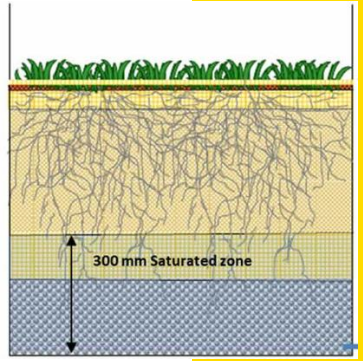
## Media type impact

**Heavy metals**




**Organic chemicals**

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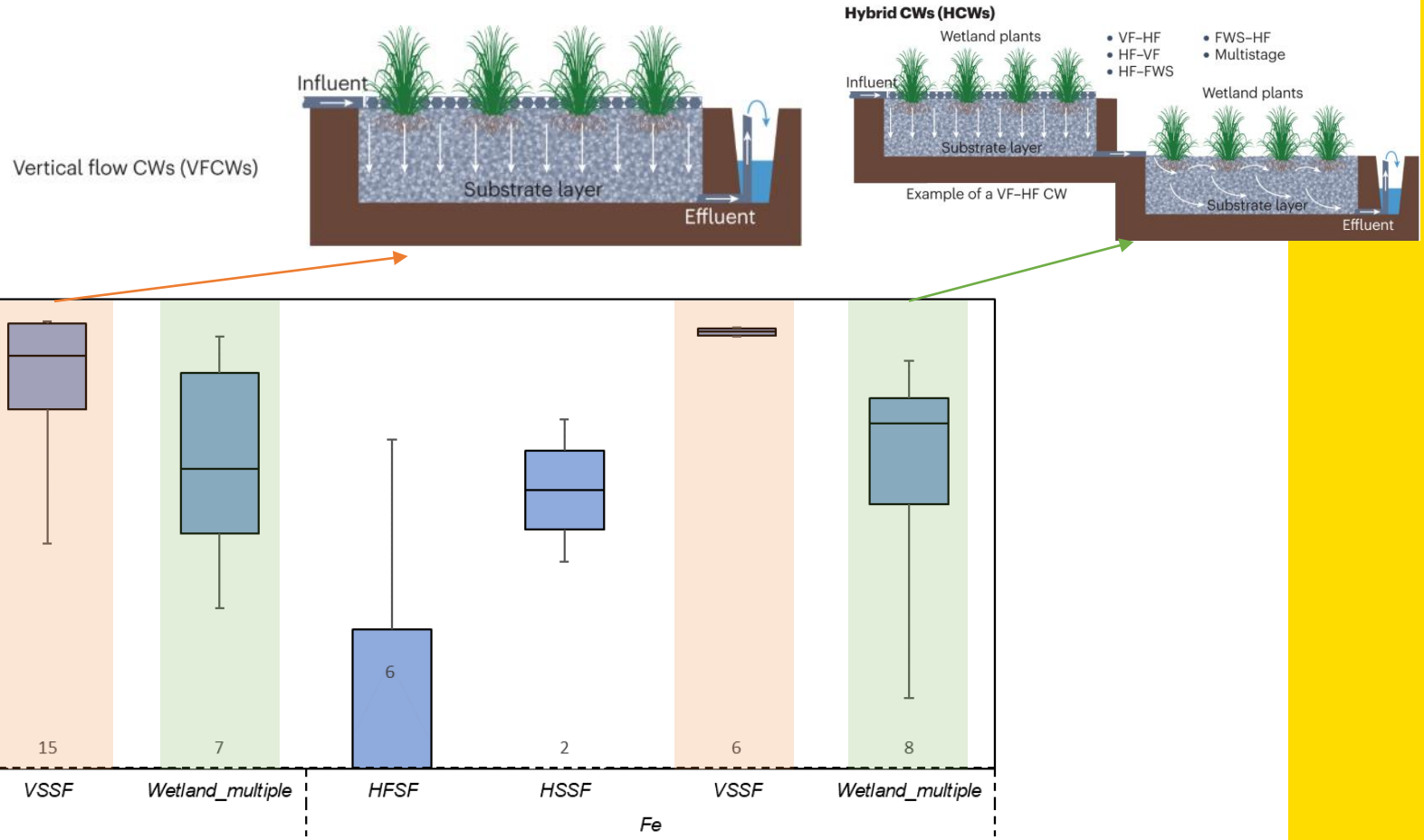
# Constructed wetland

## Wetland design impact

### Heavy metals




*Note: HFSF- Horizontal free surface flow wetlands; HSSF- Horizontal subsurface flow wetlands; VSSF- vertical subsurface flow wetlands; Wetland_multiple- wetlands applied in series

- **Better performance:**
  - VSSF: vertical subsurface flow wetlands
  - Wetland multiple: different-design wetland in series
- **Variable and lower performance:**
  - Horizontal surface/subsurface flow wetlands

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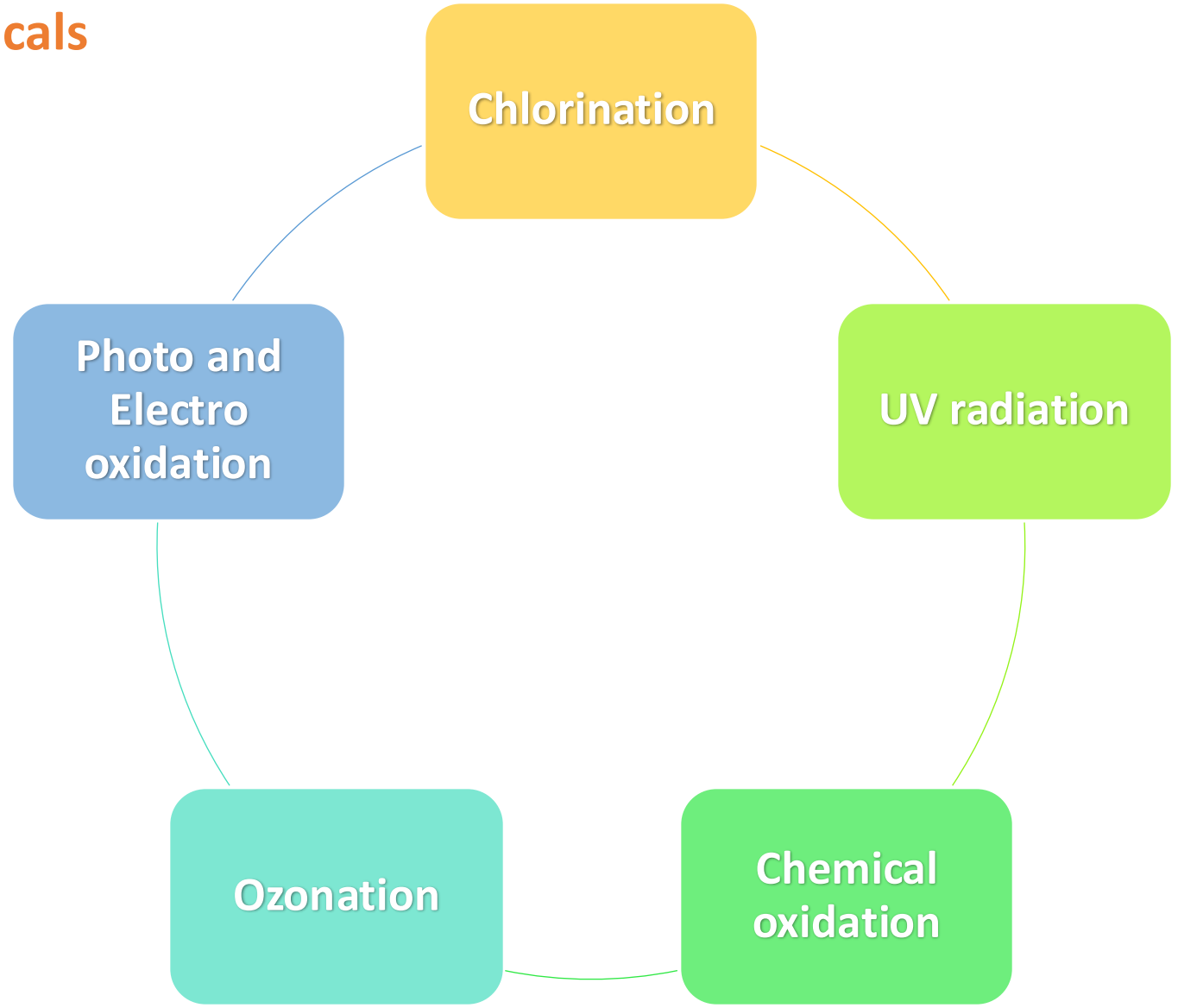
# Advanced technologies

## Mainly target on organic chemicals

- **Excellent performance** (over 80% removal within mins)
- Mostly within **laboratory scale**
- Great potential as **post-treatment options** in stormwater harvesting

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# Take-home message

- ❑ Biofilter→ #1; Constructed wetlands→ #2
- ❑ Porous pavement, swale and pond → Based on local conditions
- ❑ Design parameters impact system performance
- ❑ Advanced technologies → Promising approach as post-treatment in stormwater harvesting

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Review of trace organic chemicals in urban stormwater: Concentrations, distributions, risks, and drivers

Kefeng Zhang [a,*], Zhaozhi Zheng [a], Lena Mutzner [b], Baiqian Shi [c], David McCarthy [c,d], Pierre Le-Clech [e], Stuart Khan [f], Tim D. Fletcher [g], Marty Hancock [h], Ana Deletic [d]

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Organic micropollutant removal in stormwater: a review of treatment performance

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# Thank you for your listening

## Any questions?

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