Effects of enhanced removal of micropollutants on Antibiotic Resistance

First results of a monitoring campaign

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WHO-message

Antibiotic resistance is a rapidly evolving health issue extending far beyond the human health sector. Awareness of the seriousness of the situation and the need for urgent action is required at the highest political level, globally and at country level. A cross sectoral approach is required for effective action at global and national levels.

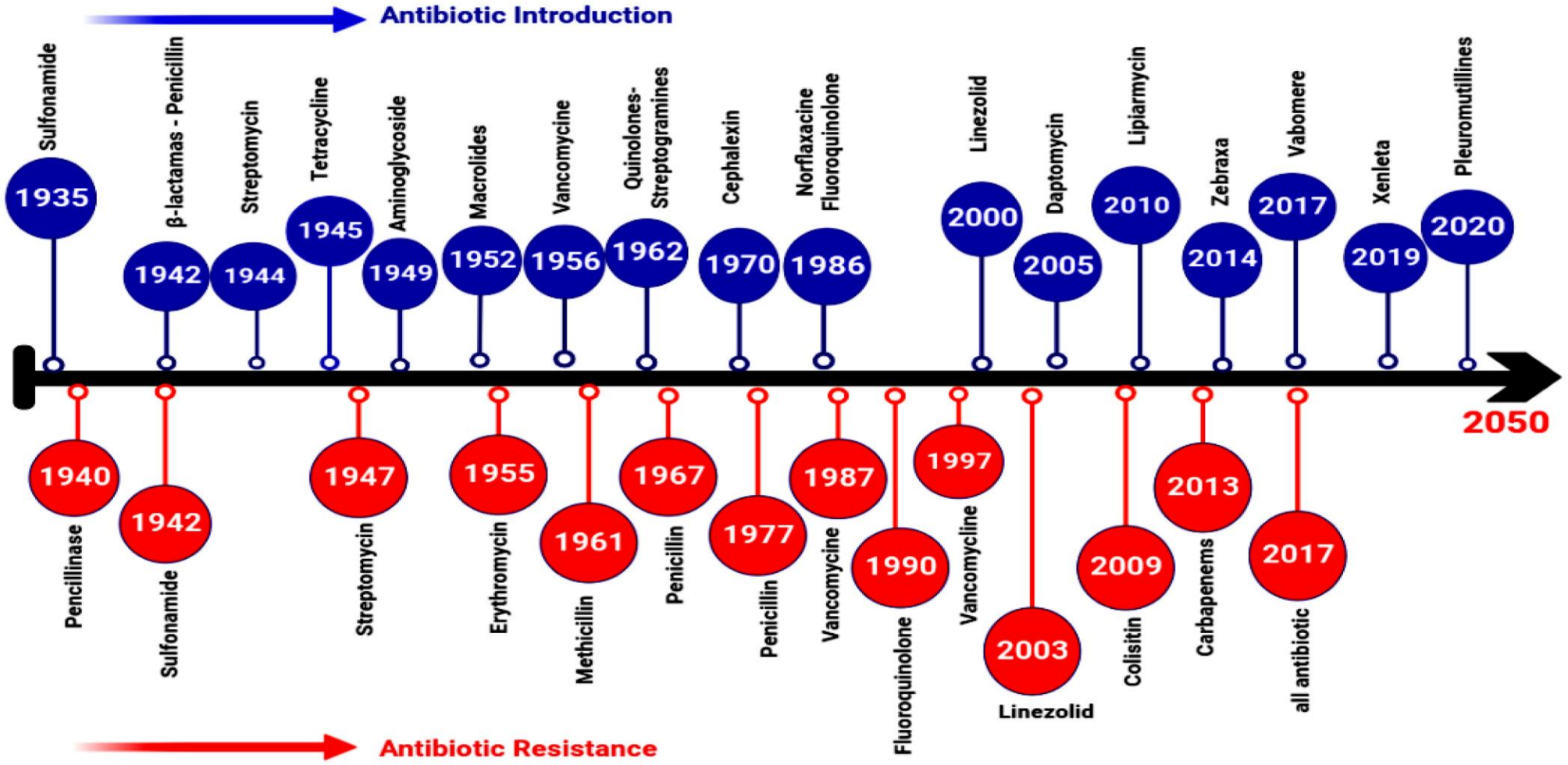
“The misuse of penicillin could lead to the propagation of mutant forms of bacteria that would resist the new miracle drug”
- Alexander Fleming

Antibiotic/antimicrobial resistance (AMR)

- Antibiotics present in humans and animals
- Relation between use of antibiotics and development of resistance

- Antibiotic residues and AMR also present in our environment through:
  - Effluent of wwtp’s
  - Sewer overflows
  - Animal manure

Antimicrobial resistance (AMR)



Helmy, Y.A. et al. *Antibiotics* **2023**, *12*, 274. https://doi.org/10.3390/antibiotics12020274

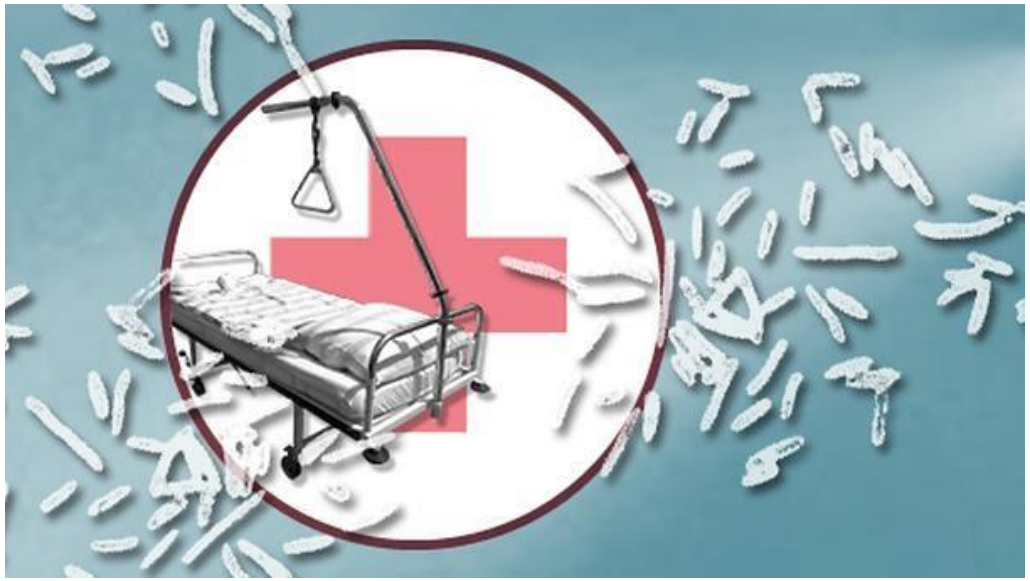
Antibiotic resistant bacteria and genes

Antibiotic resistant bacteria:

- Less or not sensitive to antibiotics
- Natural or acquired resistance
- No discrimination on their ‘looks’

Multiresistant bacteria

- Resistance against several antibiotics



Antibiotic resistance genes:

- Transfer of genes between microorganisms

Antibiotic resistant bacteria and genes

ESBL (Extended Spectrum Beta-lactas) producing bacteria

- Mainly intestinal bacteria, like *E. coli and Klebsiella*
- Harmless in the intestine of healthy humans
- Severe infections in patients
- Resistant to beta-lactam antibiotics and mostly also to other antibiotics
- Global increase of ESBL

Goal

To increase knowledge about:

- The removal of AMR and antibiotic resistance genes by advanced water treatment techniques
- The presence of AMR and genes in WWTP effluents
- Is *Escherichia coli* an indicator for the removal of ESBL and/or antibiotic resistance genes in these systems

Set-up of research

- 13 WWTPs, 13 techniques
  (PACAS, upflow GAK, ozon+GAK, PAC-O3, ozon+filter, NF+UV, BODAC, GAK-O2, AdOx, Dex-filter, ozon, BO3-B, NF+UV)
- Analysis on ESBL (AMR), antibiotic resistance genes and *E. coli*
- 2-4 samples per technique
- Inflow, outflow and after each step.

Limited numbers of samples per technique

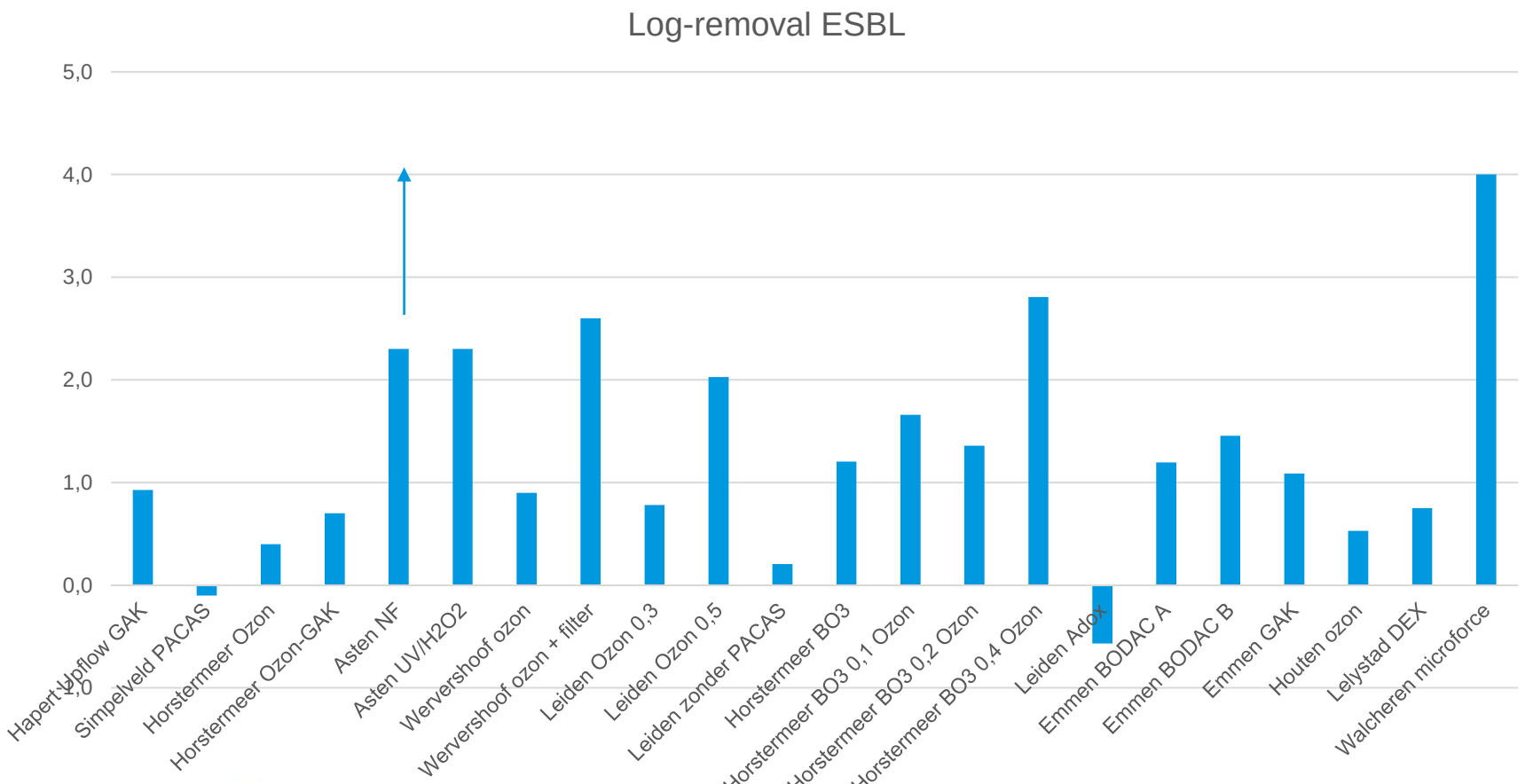
→prelimanary results

→Results are not generic

First results

- 13 WWTPs, 13 techniques
  (PACAS, upflow GAK, ozon+GAK, PAC-O3, ozon+filter, NF+UV, BODAC, GAK-O2, AdOx, Dex-filter, ozon, BO3-B, NF+UV)
- All: Analysis done on ESBL and *E. coli*
- 6 WWTP's: analysis done on antibiotic resistance genes

Log-removal ESBL



ESBL results

- ESBL present in all WWTP-effluents

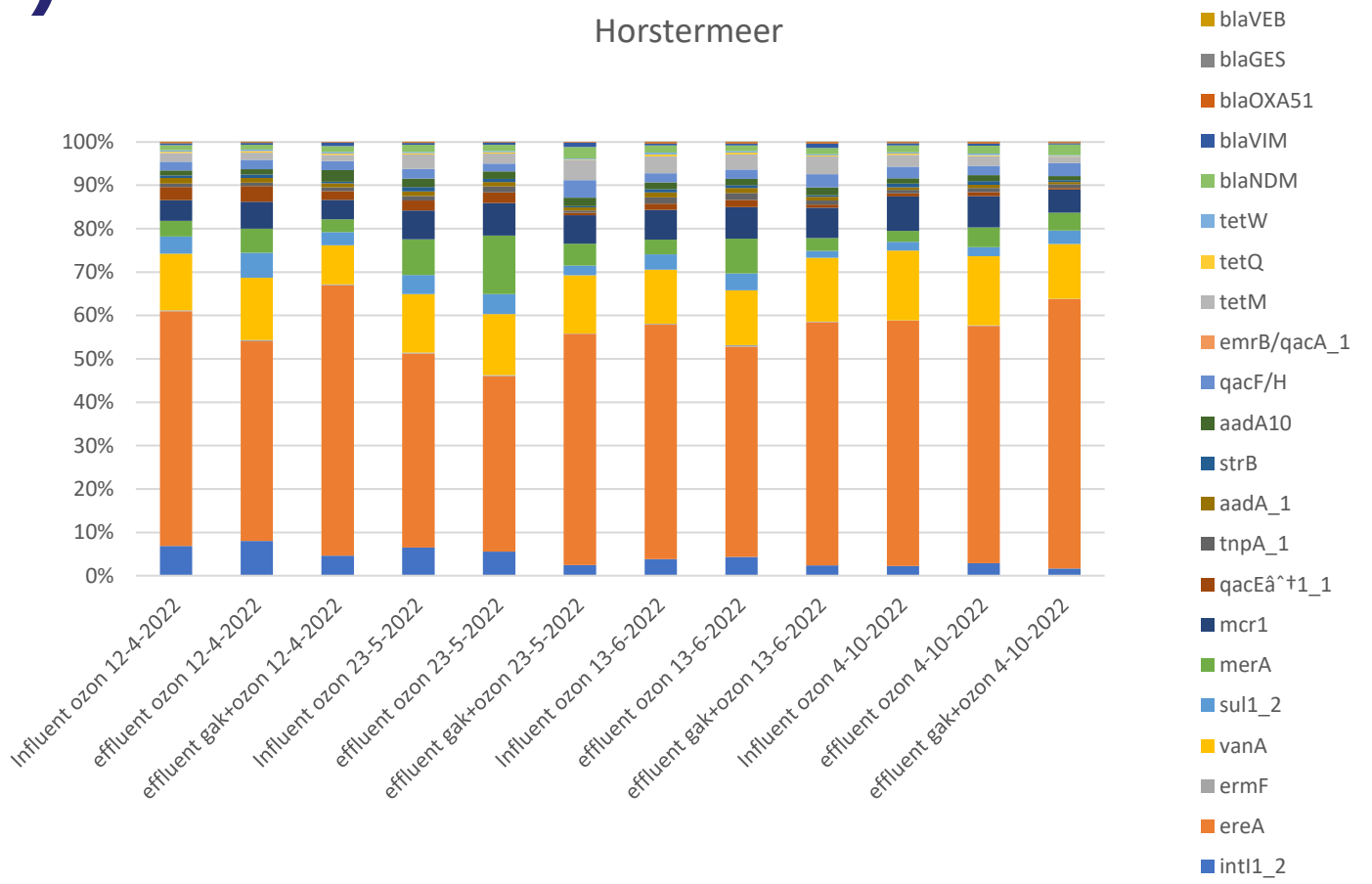
Summary:

- Activated carbon: ineffective / no removal
- Ozon: mostly relative low removal (0,5 – 3,5 log)
- NF: highly effective >4 log-removal
- UV: unknown, > 1-log removal
- Combination Ozon+Filter relatively effective (2,5 – 3,0)
- DEX-filter: low removal (0,5-1)
- Microforce: highly effective: 4 log-removal

Genes (resistomap)

Results from 5 of 6 WWTP's

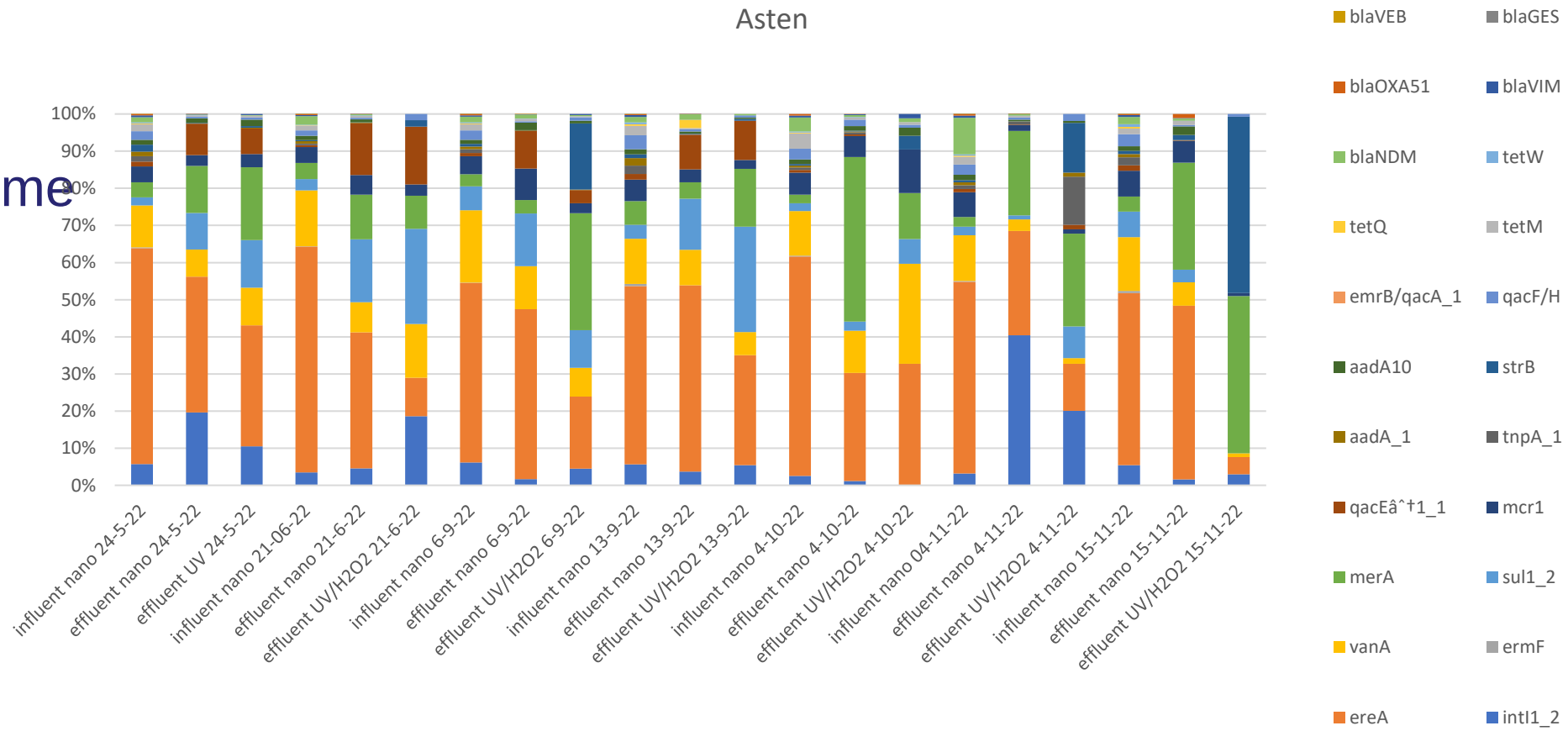
- Upflow-GAK
- PACAS
- Ozon-GAK
- Ozon +filter
- Ozon + Pacas



Genes (resistomap)

NF and NF/UV

- Shift in genes
- Removal of some genes



E. Coli vs ESBL

Hypothesis:

Removal of E. coli is a good prediction for the removal of ESBl-bacteria

- Higher amounts of *E. coli* present in wastewater (~2 log)
- After treatment the relation between ESBL and E. coli remains 2 log

→ Based on these results is E. coli an indicator for log-removal of ESBL

Expectation techniques

- Activated carbon: not effective on bacteria and genes
- Ozon: Expected to have effect on bacteria and genes
- Nanofiltration: Highly effective for bacteria and genes (dependent on pore-size)
- UV: Effective, dependent on dose
- Dex and Microforce: ?

Take home messages

- Ozon effective for bacteria at high dosage.
- Activated carbon techniques do not remove antibiotic resistant bacteria and genes
- Nanofiltration in combination with UV, as well as seems effective

Outlook

- All pilots and demo’s have been sampled
- Results for genes for the last techniques to be expected
- Further processing of data
- Overall report in Q1 2024

Thank you for your attention!

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stowa

Rijkswaterstaat
Ministry of Infrastructure and Water Management

Tackling Micropollutants in Wastewater
Results of the Dutch Innovation and Implementation Program

November 8 and 9 2023
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