



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

**The removal efficiency of pharmaceutical residues from three wastewater treatment plants in Saudi Arabia and their potential for pollution of groundwater**

**Dr. Obaid Aziz Alharbi**

*19 January 2023, 09:35 CET*



## Introduction

---

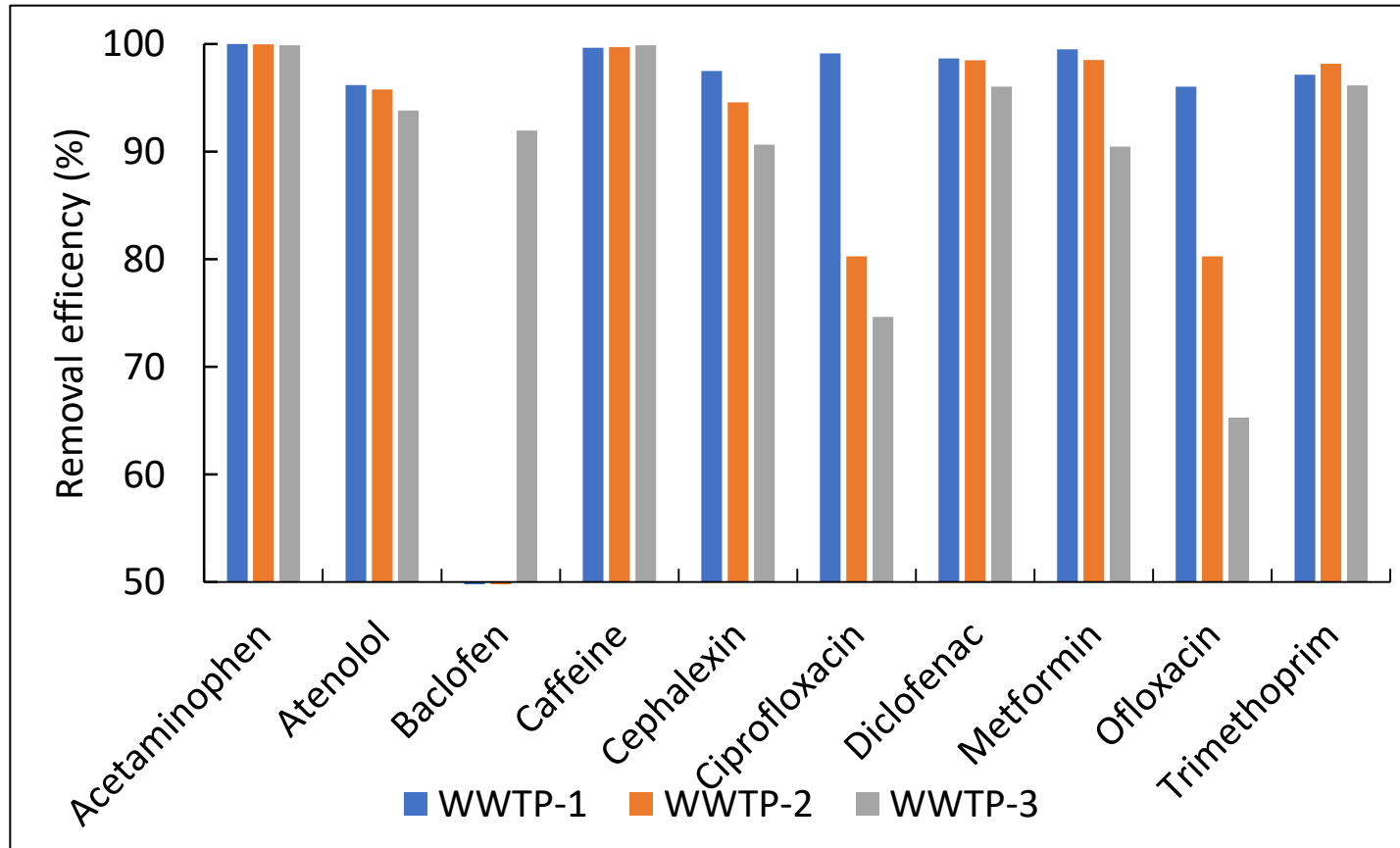
- Pharmaceutical compounds are being reported in groundwater, e.g., in a 1120 locations in 46 States across the USA (Bexfield *et al.*, 2019)
- Saudi Arabia has very low rainfall and because of the scarcity of fresh water, wastewater is used for irrigation and artificial recharge of groundwater.
- Protecting scarce water resources from potential pollution by pharmaceuticals in Saudi Arabia is essential.
- This study examined the potential for wastewater from three wastewater treatment plants in Riyadh, Saudi Arabia, to contaminate groundwater with pharmaceutical residues

## Methodology

---

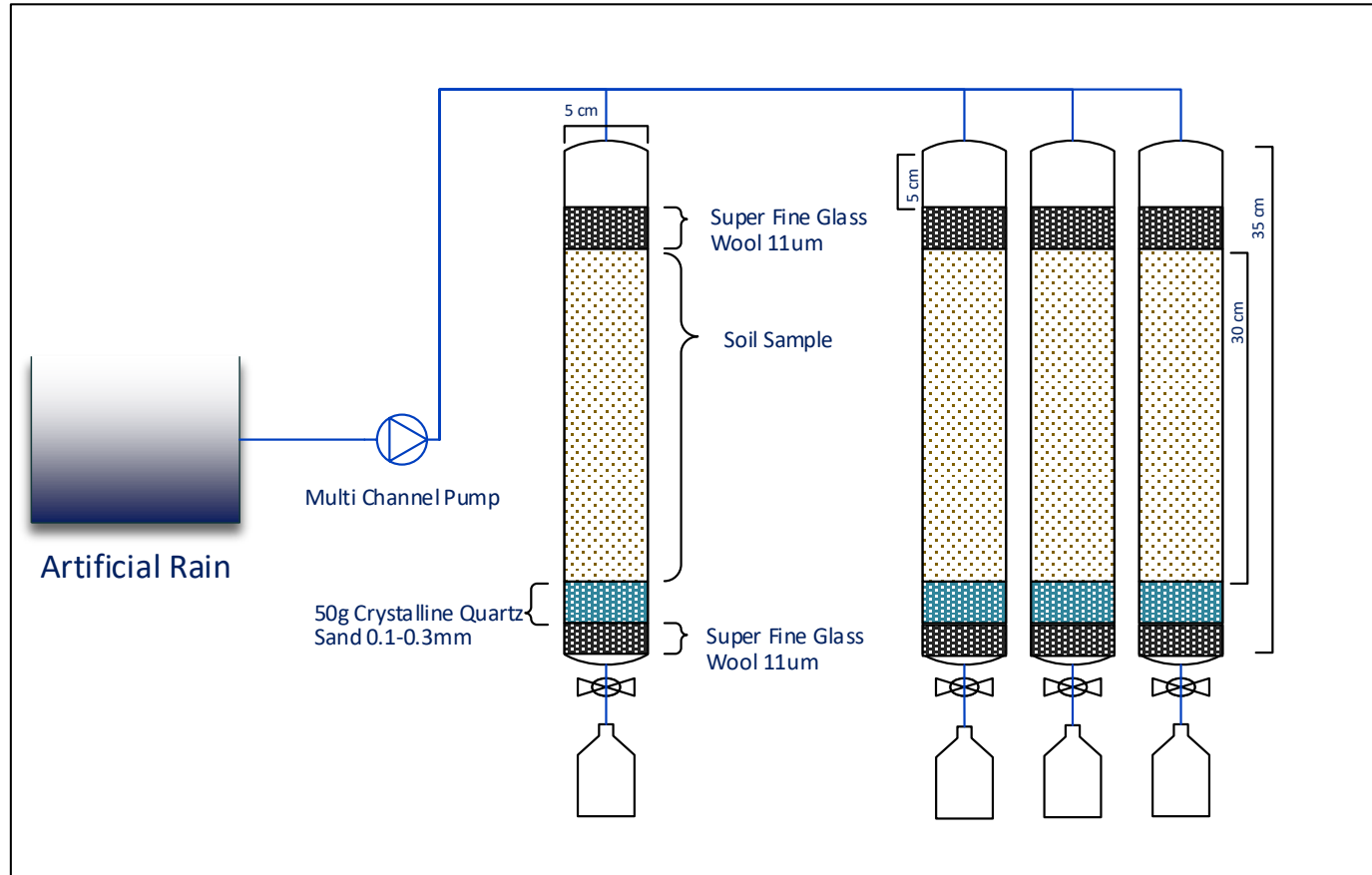
- ❖ Samples were collected from the influent and effluent of the three WWTPs after chlorination stage.
- ❖ Two WWTPs used oxidation ditch treatment and one used trickling filters.
- ❖ 144 samples were collected monthly over 12 months.
- ❖ 16 compounds selected for analysis and 11 and 5 were detected in the influent and effluent, respectively.
- ❖ Percolation through the soil by selected compounds tested in the laboratory (OECD protocol).

## Average removal efficiency (%) of pharmaceuticals in studied WWTPs



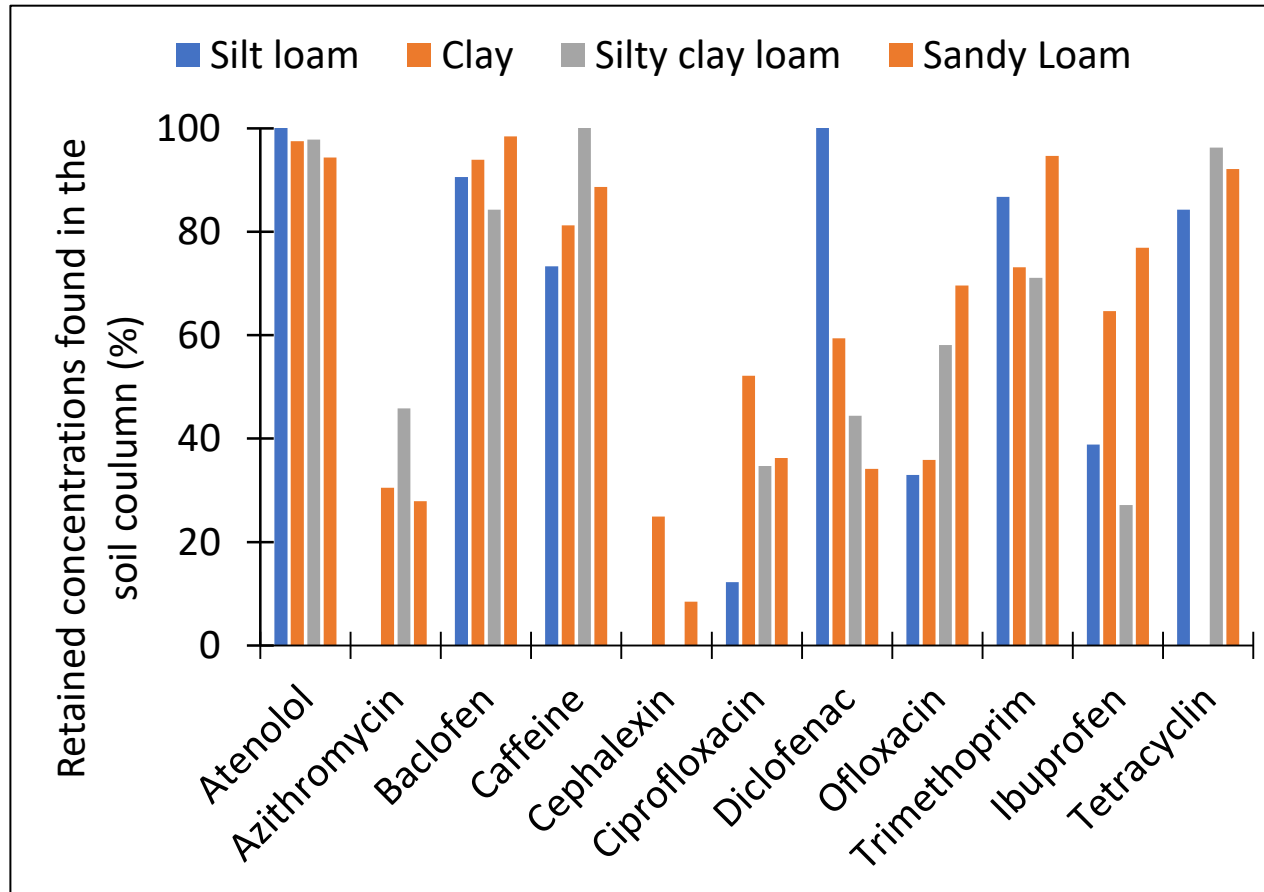
- The average removal efficiency was high ( $\geq 75\%$ ).
- Oxidation ditches and sand filters had slightly higher removal efficiencies than the trickling filter and sand filter.
- Removal efficiency of the *antibiotic compounds*, cephalixin, ciprofloxacin, ofloxacin and trimethoprim, ranged from 65.29% (ofloxacin, WWTP-3) to 99.13% (ciprofloxacin, WWTP-1).

## Testing the leaching behaviour of selected pharmaceuticals through different soils



- Columns were spiked with solutions of 16 different compounds.
- Applied concentrations were higher than detected in the WWTP effluent samples to ensure recovery.
- $\text{CaCl}_2$  solution was applied as artificial rain for 48 hours.
- Compounds analyzed in leachate and soil of column segments.

## Potential for groundwater contamination



- Most of the compound had a high affinity for soil particles and accumulated in the top 5 cm.
- Most compounds were detected at recovery percentages between 12% and 100%.
- Only two compounds (caffeine and cephalalexin) were detected in the leachate, at very low concentrations.
- Previously unstudied compound, baclofen, was mostly recovered in the top 10 cm of the columns.

## Conclusions

---

- ❖ The likelihood of groundwater contamination by the selected pharmaceuticals in wastewater discharged from the three WWTPs would be low due to:-
  - High removal efficiency in the WWTPs, and
  - Low percolation through soil
  - Provided the groundwater is protected by an adequate soil layer.
- ❖ The reuse of effluent for irrigation and groundwater recharge is unlikely to cause environmental risk.

---

Thank you to my supervisors and collaborators: Dr Deborah Chapman, Dr Ed Jarvis, Dr. Aikaterini Galani, Prof. Nikolaos S. Thomaidis, Dr. Maria-Christina Nika.

To King Abdulaziz City for Science and Technology (KACST) for funding the research.

and

Thank you for listening