

# Pharmaceutical pollution of water resources in Nakivubo wetlands and Lake Victoria, Kampala, Uganda

*Sahar Dalahmeh, Emma Björnberg, Anna-Klara Elenström, Charles B. Niwagaba, Allan John Komakech*

## Abstract

This study investigated the occurrence and removal in wastewater and water bodies in Nakivubo wetland area and Inner Murchison Bay, Lake Victoria, of common prescription and non-prescription pharmaceutically-active substances (PhACs) sold in Kampala city, Uganda. A questionnaire was sent to 20 pharmacies in Kampala, to identify the most commonly sold PhACs in the city. During two sampling campaigns, samples were collected from Bugolobi wastewater treatment plant (WWTP) influent and effluent and surface water samples from Nakivubo channel, Nakivubo wetland and Inner Murchison Bay. The concentrations of 28 PhACs, organic matter, solids and nutrients in water samples were analysed. Ciprofloxacin (antibiotic), cetirizine (anti-allergy), metformin (anti-diabetes), metronidazole (antibiotic) and omeprazole (gastric therapy) were reported by pharmacies to be the PhACs most commonly sold in the study area. Chemical analysis of water samples revealed that trimethoprim (antibiotic) and sulfamethoxazole (antibiotic) were the dominant PhACs in water from all sites except Lake Victoria. Other PhACs such as atenolol (anti-hypertensive), carbamazepine (anti-epileptic) and diclofenac (anti-inflammatory) were also found at all study sites except Lake Victoria.  $\sum$ PhACs in effluent from Bugolobi WWTP (13000–37,600 ng L<sup>-1</sup>) was higher than in the corresponding influent (4000–28,000 ng L<sup>-1</sup>), indicating poor removal of PhACs within the WWTP.  $\sum$ PhACs decreased by a factor of 2–6 between Bugolobi WWTP effluent and Nakivubo channel (5700 ng L<sup>-1</sup>), due to dilution and sorption to channel sediment, and by a factor of 1–3 between the Nakivubo channel and Nakivubo wetland (3900–5400 ng L<sup>-1</sup>), due to sorption to sediment and uptake by plants in the wetland. No detectable levels of PhACs were found in water from Lake Victoria. Overall, this investigation demonstrated that PhACs in wastewater enter Nakivubo water system. Thus, Bugolobi WWTP needs to be upgraded to improve PhACs removal from wastewater. Considering the high occurrence of antibiotics in the water system in Kampala, development and spread of antimicrobial resistance within the area should also be investigated.

**Keywords:** Kampala, Lake Victoria, Nakivubo wetland area, Pharmaceutical pollution, Sulfamethoxazole, Trimethoprim, Wastewater