Tropical Wetlands as Nature-Based Solutions to Remove Pollutants from Stormwater Discharge and Wastewater Effluent in Urban Environments

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Natural wetlands are critical water quality regulators, especially in developing tropical countries. However, varying loads of stormwater discharge and wastewater effluent can severely compromise their self-purification capacity. This study investigated the impact of seasons and vegetation types on the retention of pollutants in tropical wetlands.

The Lubigi wetland is a large urban wetland in Kampala, the largest city of Uganda in Africa. We studied whether stormwater discharge and wastewater effluent from a nearby stormwater channel and a sewage treatment plant in the western part of the city get cleaned as they flow through the wetland. Throughout the year, the Lubigi wetland experienced high loads of dissolved and particulate nutrients from the Nsooba main channel and the Lubigi sewage treatment plant. Despite high pollution loads, the wetland removed ammonium-nitrogen, orthophosphate, and solids in both dry and wet seasons. Regardless of the significant pollution, the wetland removed ammonium-nitrogen, orthophosphate, and particulate nutrients during both seasons, achieving removal rates ranging from 50-60% for orthophosphate but only 20-40% for ammonium-nitrogen. Interestingly, the wetland mostly released nitrate and nitrite. This was likely due to the breakdown of organic matter and run-off from farming during the rainy season. Notably, nitrate and nitrite were mainly released during water passage through the wetland, most likely due to the mineralization of organic nitrogen and agricultural run-off during rainy events in the wet season. Overall, seasonal differences in pollutant loads and retention rates were minimal. Nutrient removal decreased as water flowed from areas with *Phragmites mauritianus* (a type of grass) to areas with *Cyperus papyrus* (a type of sedge). Median uptake rates decreased for NH_4-N, PO_4-P, and TN from -112, -3.8, and -127.6 g m^{-1} d^{-1} in the midstream reach with *Phragmites mauritianus* to +3.1, +0.04, and -2.3 g m^{-1} d^{-1} in the downstream reach with *Cyperus papyrus*, respectively. However, the sewage treatment plant's limited capacity and untreated stormwater discharge reduced the wetland's ability to clean water. The insufficient carrying capacity of the treatment plant and the release of untreated sewage into the wetland significantly impact the self-purification capacity of the Lubigi wetland and call for urgent actions to improve sewage management, restore degraded wetland areas, and increase the awareness of the various ecosystems the wetland provides for the local people. Our study highlights the need for better sewage management, restoration of degraded wetland areas, and increased awareness of the wetland's benefits to local people.