Carbon budget of an urban stormwater pond: importance of riparian vegetation

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Stormwater ponds (SWPs) within urban areas are rapidly growing as a runoff and nutrient control measure and act as reactive zones for carbon and nutrient cycling. While SWPs are known to emit significant amounts of carbon dioxide (CO2) and methane (CH4) while also sequestering organic and inorganic carbon. Understanding the net effect of urban SWPs on carbon cycling is therefore far from straightforward. Here, we present the carbon budget of a SWP in the greater metropolitan area of Toronto, Canada to evaluate whether the SWP acts a net source or sink of CO¬2. The budget calculations included the dissolved and particulate carbon fluxes at the inflow and outflow points of the pond, plus the particulate carbon burial fluxes associated with the sediments accumulating in the pond. The CO2 flux required to close the carbon budget was compared with the CO2 efflux from the pond water column. According to the carbon budget, the SWP sequesters about 29×103 moles of CO2 per year. The water chemistry data, however, imply that the SWP emits around 57×103 moles of CO2 annually. This contrasting result, therefore, indicates a missing carbon influx into the pond, which we identify as organic carbon (OC) produced through photosynthetic CO2 fixation by the riparian vegetation. Part of this OC is eroded into the pond, and its subsequent mineralization generates the missing CO2. We estimate that around 86×103 moles of riparian OC must be mineralized to CO2 to balance the SWP's carbon budget. Altogether, when including the riparian vegetation, the SWP system acts as a net CO2 sink, although it emits CO2. Furthermore, the emitted CO2 is primarily contributed by the mineralization of OC from the riparian vegetation, rather than catchment-exported OC. Our work highlights the importance of considering OC production by the vegetation closely surrounding SWPs and the transfer of this OC into the pond and its subsequent mineralization. Our results also caution against only relying on floating flux chamber measurements when assessing the overall effect of SWPs on pond-atmosphere CO2 exchanges.
Keywords: CO2 flux, carbon budget and stormwater pond.