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Estimation of Soil Carbon Stocks of Urban Freshwater Wetlands in the Colombo Ramsar Wetland City and their Potential Role in Climate Change Mitigation

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Abstract

Wetlands hold significant potential for climate change mitigation due to their high capacity to sequester atmospheric carbon dioxide (CO_2). Colombo, Sri Lanka was recently declared as one of the eighteen global Ramsar wetland cities. The current study represents the first attempt to quantify soil organic carbon (SOC) stocks held by the urban freshwater wetlands in Colombo. The study focused on the extensive urban wetland ecosystems of Kolonnawa wetland and Thalawathugoda wetland park. SOC stocks were determined using three parameters: depth of soil, bulk density, and SOC concentration. Loss on ignition method was used in quantifying SOC concentrations. Average SOC stocks, up to a depth of 60 cm at Kolonnawa wetland and Thalawathugoda wetland park were estimated at 504 ± 14 t C/ha and 550 ± 23 t C/ha, respectively. Furthermore, the total SOC stock at Kolonnawa wetland and Thalawathugoda wetland park were estimated at 198,408 ± 5564 t CO_2eq and 66,313 ± 2764 t CO_2eq, respectively. When considering global estimates, it was found that freshwater wetlands in Colombo hold a higher SOC stock than tropical wet forests and tropical dry forests. The current study highlights the importance of urban ecosystems in mitigating the ever increasing concentrations of atmospheric CO_2 .

Keywords Soil organic carbon stock · Tropical urban wetlands · Histosols

Introduction

The occurrence of climate change at an unprecedented scale is indicated by many studies and global assessments. Human-induced warming reached approximately 1 °C above pre-industrial levels in 2017, increasing at approximately 0.2 °C per decade (Allen et al. 2018). Climate change mitigation has become critical as human induced changes continue to result in unpredictable consequences around the globe. The potential to slow down climate change via the sequestration of carbon in soil has been investigated mostly during the past two decades, especially in the agricultural and forest ecosystems (Follett 2001; Lal 2004; Paustian et al. 1997; Lal 2008; Powlson et al. 2011).

The extent of world's wetlands is estimated to be about 5–8% of the total land surface of earth (Mitsch et al. 2013). Despite this low representation as a percentage of area on land, wetlands among all terrestrial ecosystems have the best capacity of any ecosystem to sequester and retain carbon through long term burial (Stern et al. 2007). Soils have a significant capacity to sequester carbon. Out of the total storage of carbon in earth's soils (i.e. ~1400–2500 Pg C; Pg = 10^{12} kg) 20–30% carbon is stored in wetlands (Lal 2008). In fact, global soil carbon sequestration rates of coastal wetlands (210 g/cm^2/yr) and freshwater wetlands (20–30 g/cm^2/yr) are higher than those of terrestrial forests (10 g/cm^2/yr) (Chmura et al. 2003; Clark and York 2005).

Terrestrial plants remove CO_2 from the atmosphere via photosynthetic uptake and some of this is rapidly released back by respiration. However, in wetlands much of this CO_2 is incorporated into the organic carbon of the soil where its

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