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Effects of Two Distinct Monsoon Seasons on the Water Quality of a Tropical Crater Lake

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Abstract : The paucity of long-term measurements and monitoring of accurate water quality parameter profiles is evident for small and deep tropical lakes in Southeast Asia. This leads to a poor understanding of the stratification and mixing dynamics of these lakes in the region. The water quality dynamics of Sampaloc Lake, a tropical crater lake (104 ha, 27 m deep) in the Philippines, were investigated to understand how monsoon-driven conditions impact water quality and ecological health. Located in an urban area with approximately 10% of its surface area allocated to aquaculture, the lake is subject to distinct seasonal changes associated with the Northeast (NE) and Southwest (SW) monsoons. NE Monsoon typically occurs from October to April, while SW monsoon from May to September. These monsoons influence the lake's water temperature, dissolved oxygen (DO), chlorophyll-α (chl-α), phycocyanin (PC), and turbidity, leading to significant seasonal variability. Monthly field observations of water quality parameters were made from October 2022 to September 2023 using a multi-parameter probe, YSI ProDSS, together with the collection of meteorological data during the same period. During the NE monsoon, cooler air temperatures and winds with sustained speeds caused surface water temperatures to drop from 30.9 ºC in October to 25.5 ºC in January, resulting in the weakening of stratification and eventually in lake turnover. This turnover redistributed nutrients from hypolimnetic layers to surface layers, increasing chl-α and PC levels (14-41 and 0-2 µg/L) throughout the water column. The fish kill was also observed during the lake's turnover event as a result of the mixing of hypoxic hypolimnetic waters. Turbidity levels (0-3 NTU) were generally low but showed mid-column peaks in October, which was linked to thermocline-related effects, while low values in November followed heavy rainfall dilution and mixing effects. Conversely, the SW monsoon showed increased surface temperatures (28-30 ºC), shallow thermocline formations (3-11 m), and lower surface chl-α and PC levels (2-8 and 0-0.5 µg/L, respectively), likely due to limited nutrient mixing and more stable stratification. Turbidity was notably higher also in July (11-15 NTU) due to intense rainfall and reduced light penetration, which minimized photosynthetic activity. The SW monsoon also coincided with the typhoon season in the study area, resulting in partial upwelling of nutrients during strong storm events. These findings emphasize the need for continued monitoring of Sampaloc Lake's seasonal water quality patterns, as monsoon-driven changes are crucial to maintaining its ecological balance and sustainability.

Keywords : seasonal water quality dynamics, Philippine tropical lake, monsoon-driven conditions, stratification and mixing
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