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Temporal Variability of Soil Properties in the Diyawannawa Wetland, Sri Lanka

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Abstract

Wetland soils are highly dynamic and sensitive to seasonal hydrological fluctuations that influence their physical structure, nutrient dynamics, and overall ecological functioning. Understanding these temporal variations is essential for sustainable wetland management and conservation. This study investigated the temporal variability of key soil physical and chemical properties in the Diyawannawa Wetland, Sri Lanka, under varying rainfall conditions. This study examined the temporal variability of major soil physical and chemical properties in the Diyawannawa Wetland, Sri Lanka, across three rainfall-driven sampling periods including July, September, and November 2024. Bulk density, porosity, pH, electrical conductivity (EC), Organic Matter Content (OMC), total nitrogen (TN), and available phosphorus (AP) were assessed. A total of 24 soil samples per period, each with 3 replicates, were analyzed using standard laboratory procedures, and temporal differences were tested using one-way ANOVA. The results revealed that temporal variability in both physical and chemical parameters ($p<0.05$). Bulk density was lowest in November (0.70±0.22 g/cm³) and highest in September (0.97±0.30 g/cm³), indicating reduced compaction under wetter conditions. Correspondingly, soil porosity peaked in November (57.48±13.82%) and declined during drier months (43.03±14.58% in July; 41.91±17.07% in September), reflecting the influence of soil moisture on structural aggregation. Among chemical properties, soil pH was significantly lower in November (6.15±0.52) compared to July (6.39±0.61) and September (6.57±0.48), suggesting acidification driven by organic acid accumulation under anaerobic conditions. Similarly, EC showed its lowest value in November (0.06±0.01 dS/m) due to leaching of soluble ions during high rainfall, whereas higher EC values occurred in July (0.086±0.02 dS/m) and September (0.113±0.05 dS/m). Organic matter content and total nitrogen followed opposite trends, with peak values recorded in November (70.30±43.77 g/kg and 0.26%±0.09, respectively), associated with enhanced litter input, moisture retention, and reduced decomposition. In contrast, July and September exhibited significantly lower values due to limited rainfall and increased mineralization rates. Available phosphorus showed minimal temporal variation (8.22±7.25-9.81±8.65 mg/kg) and was not significantly affected by rainfall fluctuations ($p>0.05$), implying that phosphorus availability is more controlled by soil redox and adsorption–desorption processes than by direct hydrological input. Overall, the findings highlight the strong influence of rainfall-driven hydrological variability on wetland soil structure and nutrient dynamics, emphasizing the need for seasonal monitoring to support adaptive management of the Diyawannawa Wetland and similar tropical ecosystems.

Keywords: *Diyawannawa wetland, Soil properties, Temporal variability, Hydrological fluctuations, Nutrient dynamics*