(130)

Hydrological Drivers of Vegetation Zonation in a Sri Lankan Riverine Mangrove

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Abstract

Riverine mangrove ecosystems are strongly influenced by hydrological conditions, particularly tidal fluctuations and seasonal water-level variations. Factors such as groundwater depth, surface water dynamics, and tidal activity shape vegetation structure and zonation. However, in Sri Lanka, studies that examine these ecohydrological drivers remain relatively new. To address this gap, the present study was conducted in the Malgasowitadeniya Conservation Forest, a riverine mangrove ecosystem located in Ittapana South, Kalutara District, Sri Lanka. The objective was to assess how fluctuations in groundwater and surface water levels influence vegetation zonation from the riverbank to inland. From September 2024 to April 2025, groundwater and surface water levels were measured at ten fixed sampling points along three transect lines (each~430 m) using custom-made monitoring setups. Measurements were taken four times per month, aligned with lunar phases to capture tidal influences across wet and dry seasons. Additionally, short-duration tidal and overflow experiments were also conducted to examine immediate hydrological responses. A vegetation survey was conducted along the middle transect, documenting species composition and structural attributes (height, Diameter at Breast Height (DBH), canopy width, and canopy shape). Results showed no significant difference in groundwater depth between wet and dry seasons or between tidal phases across transects. Groundwater depth remained shallow and relatively uniform along Transects 1 and 2, but increased inland along Transect 3. Vegetation displayed clear zonation: true mangrove species (*Bruguiera sexangula* and *Rhizophora mucronata*) dominated the river edge, mangrove associates (*Cerbera odollum*) in the mid-zone, and invasive species (*Annona glabra* and *Dillenia suffruticosa*) prevailed inland. Structural attributes were greater closer to the river and declined landward. Although zonation patterns did not statistically correlate with groundwater depth, field-based observations and spatial mapping suggest that the hydrological gradient plays an important role in shaping vegetation structure and distribution. These findings provide baseline evidence of ecohydrological controls on riverine mangrove vegetation in Sri Lanka. The study highlights the need for systematic restoration strategies, strengthened protective regulations, and site-specific restoration standards to safeguard riverine mangrove ecosystems facing hydrological and land-use pressures.

Keywords: *Groundwater dynamics, Vegetation zonation, Riverine mangrove, Ecohydrology, Sri Lanka*