

COMPARATIVE CARBON SEQUESTRATION POTENTIAL OF FRESHWATER MACROPHYTES: A NATURE-BASED APPROACH TO CLIMATE CHANGE MITIGATION

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ABSTRACT

Aquatic macrophytes are vital to freshwater ecosystems, contributing to primary productivity, nutrient cycling, and carbon sequestration. This study assessed the dry biomass and carbon content in the leaf and stem tissues of three dominant freshwater plants—*Nymphaea odorata* (Water Lily), *Eichhornia crassipes* (Water Hyacinth), and *Lemna minor* (Duckweed)—collected from the Kestopur canal, Kolkata, during April 2025. *N. odorata* exhibited a leaf biomass of $0.76 \pm 0.13 \text{ kg/m}^2$ with $35.14 \pm 0.80\%$ carbon, and stem biomass of $0.35 \pm 0.04 \text{ kg/m}^2$ with $24.70 \pm 0.53\%$ carbon. *E. crassipes*, known for rapid growth and invasiveness, showed the highest biomass with leaf and stem values of $1.34 \pm 0.38 \text{ kg/m}^2$ and $0.85 \pm 0.22 \text{ kg/m}^2$, and carbon concentrations of $30.08 \pm 0.78\%$ and $20.63 \pm 0.71\%$, respectively. *L. minor*, due to its reduced morphology, had only leaf biomass ($0.29 \pm 0.04 \text{ kg/m}^2$) with $24.16 \pm 0.44\%$ carbon. While *N. odorata* displayed the highest carbon density per unit biomass, *E. crassipes* dominated in total carbon stock due to its larger biomass, offering potential for phytoremediation and carbon storage despite its ecological risks. These findings underscore the carbon sequestration potential of freshwater macrophytes and highlight the need for integrated management, especially for invasive species.

Keywords: Freshwater macrophytes, Carbon sequestration, *Eichhornia crassipes*, *Nymphaea odorata*, *Lemna minor*

1. INTRODUCTION

Freshwater ecosystems are dynamic and highly productive, supporting biodiversity, regulating biogeochemical cycles, and acting as critical carbon sinks. Aquatic macrophytes, including floating, emergent, and submerged species, are central to these processes by contributing to primary productivity, nutrient cycling, and carbon sequestration. As climate change intensifies due to rising greenhouse gas emissions, the role of macrophytes in fixing and storing carbon has gained increasing importance within nature-based climate solutions (NbS). This study evaluates the carbon sequestration potential of three freshwater macrophytes—*Nymphaea odorata* (Water Lily), *Eichhornia crassipes* (Water Hyacinth), and *Lemna minor* (Duckweed)—collected from the Kestopur canal ($22^{\circ}35'43.8'' \text{ N}$, $88^{\circ}26'8.5'' \text{ E}$) in Kolkata, India. By analysing leaf and stem biomass separately, the study provides insights into species-specific carbon storage strategies.

N. odorata, with moderate biomass but high carbon concentration in its leaves, demonstrates significant carbon density per unit mass. In contrast, *E. crassipes* produces the highest overall biomass, allowing it to store the greatest total carbon despite a lower carbon percentage. However, its invasive nature requires controlled management to balance ecological benefits and risks. *L. minor*, though small, compensates with rapid turnover and dense mat formation, enabling continuous carbon uptake over shorter cycles.

These findings highlight variations in biomass allocation and carbon content across species, offering valuable data for ecosystem modelling and wetland restoration.