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CARBON SEQUESTRATION POTENTIAL IN CONSTRUCTED WETLANDS: A MINI-REVIEW

Adetunji Ojediran[1,2,3]; Sofia Pereira[2]; Paulo Rosa-Santos[1,3]; Cristina S. C. Calheiros[1]

1. CIIMAR/CIMAR LA, Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Terminal de Cruzeiros do Porto de Leixões, 4450-208 Matosinhos, Portugal; aojediran@ciimar.up.pt; ccalheiros@ciimar.up.pt
2. Universidade Católica Portuguesa, CBQF Centro de Biotecnologia e Química Fina Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho, 1327, 4169 005 Porto, Portugal ; sapereira@ucp.pt
3. Department of Civil and Georesources Engineering, Faculty of Engineering, University of Porto, Portugal; pjrsantos@fe.up.pt

BACKGROUND

Wetlands are "high-carbon ecosystems," covering only 5–8% of the Earth's land surface yet storing 20–30% of terrestrial carbon [1]. **Constructed wetlands (CWs)**, originally designed for wastewater treatment, also provide carbon sequestration alongside biodiversity support, flood regulation, and landscape enhancement [2].
Studies show high carbon sequestration rates (CSR) during the first 0–15 years of CWs, followed by a plateau, with average carbon storage of 3.58 ± 2.21 kg C m^{-2} (~0.12 kg C m^{-2} yr^{-1}), 92% of which is organic carbon, and mid-term rates are enhanced by macrophytes growth, among other factors [3].
Figure 1 schematically illustrates plant-mediated carbon sequestration and the main carbon cycling processes in wetland ecosystems. With rising anthropogenic GHG emissions, advancing real-scale evaluations and long-term monitoring is essential to confirm CWs as a practical nature-based solution (NBS) for carbon neutrality strategies and climate change mitigation.

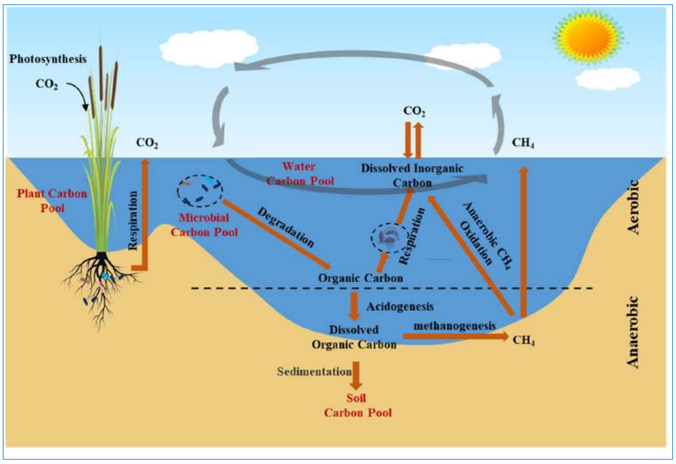

Fig. 1. Schematic of a CW carbon cycle:
plants fix CO_2 → carbon flows through ecosystem (arrows) [1].

AIM

The aim of this review is to synthesize current evidence (2021–2025) on how CWs contribute to **carbon sequestration** and to evaluate their potential as a **NBS** in climate neutrality strategies.

METHODOLOGY

Bibliographic review

1. Scope and Keywords
- "constructed wetlands"
- "carbon sequestration"
- "carbon storage"

2. Data source
Clarivate
Web of Science
ScienceDirect

3. Screening and Selection
- Publication years: 2021-2025
- Document Types: Article, Review, Letter, Editorial, & Early Access

RESULTS AND DISCUSSION

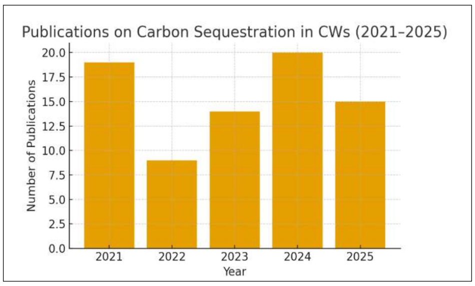

Fig. 2. Number of publications per year.

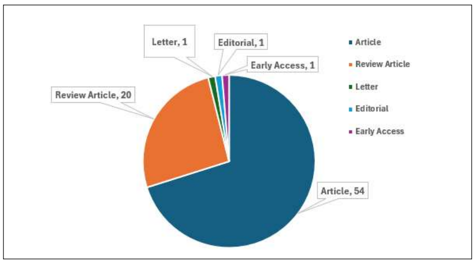

Fig. 3. Type of publications.

Publication Trends

- Peak in **2024 (20 papers)**, followed by 2021 (19 papers) **Fig. 2**
- Research interest is **steadily growing** (2021–2025)
- Majority = **Articles (54, 70%)**, Reviews (20, 26%) **Fig. 3**

Key Review Findings

- CWs show **high median CSR**, higher than many natural wetlands.
- Sequestration plateaus after ~15 yrs with composition: ~92% of C = organic; inorganic C ~8%
- Nutrient-rich influents → boost plant productivity, but also increase **GHG emissions (CO_2,** CH_4, N_2O**)**.
- Major drivers: **air temperature; annual rainfall; influent quality-COD, TN; macrophyte type; and water level regimes**.
- CW's ability to store carbon diminishes over time. Long-term real scale study required.

CONCLUSIONS

CWs are a NBS that combine wastewater treatment with ecological services, notably **carbon sequestration**. The surge of research (77 papers, 2021–2025) highlights their rising global importance and multifunctionality. Advancing **real-scale evaluations and long-term studies** will be essential to confirm their role as a **practical NBS for carbon neutrality strategies.**

References

[1]: https://doi.org/10.1016/j.envres.2025.120890
[2]: http://dx.doi.org/10.1016/j.ecoleng.2015.03.001
[3]: https://doi.org/10.1016/j.ecoleng.2024.107435

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