

Life cycle assessment of floating wetland islands for crop production

Valentina Carrillo^{1,2}; Sofia Pereira²; Carlos A. Afonso³; Cristina S. C. Calheiros¹

1. CIIMAR/CIMAR LA, Centro Interdisciplinar de Investigação Marinha e Ambiental, Universidade do Porto, Matosinhos, Portugal; vcarrillo@ciimar.up.pt; ccalheiros@ciimar.up.pt
2. Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Porto, Portugal; sapereira@ucp.pt
3. Centro de Investigação e Tecnologia das Ciências Agro-Ambientais e Biológicas (CITAB), Universidade de Trás-os-Montes e Alto Douro (UTAD), Vila Real, Portugal; cafonso@utad.pt

Background

Floating wetland islands (FWI) are innovative, nature-based solutions (NbS) for water management and ecological restoration, rooted in circular economy and sustainable development [1,2]. Briefly, they consist of aquatic plants, a floating platform and an anchoring system. Plant shoots grow above the water surface, while their roots extend directly into the water column [3]. Figure 1 shows the growth of a FWI system from its installation, stabilization and development, highlighting its functioning as a biofilter capable of absorbing nutrients such as nitrogen and phosphorus. Previous studies have shown the potential of using non-traditional plants as hydroponic crops for human consumption, taking advantage of the nutrients present in the water and optimizing the use of space (see Table 1). Commonly, fast-growing wetland emergent plants are used in FWI systems, although they are not marketable.



Figure 1. Implementation, establishment and development of floating wetland island (FWI). Source: [1]

Table 1. Summary of previous studies for crop production at floating wetland island (FWI).

Location	Scale	Water type	Plant or crop	Platform	Biomass (kg/m ²)	Reference
USA	Mesocosm	Tap water + liquid fertilizer	<i>Ocimum basilicum</i> (sweet basil)	Beemats™	0.046	[4]
			<i>Beta vulgaris</i> (Swiss chard)		0.039	
Italy	Greenhouse	Seawater + liquid fertilizer	<i>Spinacia oleracea</i> (spinach)	Polypropylene tank	0.05-0.06	[5]
Bangladesh	Full	Water pond	<i>Capsicum annuum</i> L. (chili pepper)	PVC pipes, net and bamboo sticks	3.2	[6]
China	Full	Fishpond wastewater	<i>Oryza sativa</i> L. (rice)	Ceramic	13.27	[7]

Aim

- This study aims to evaluate the feasibility of crop production in FWI using a hydroponic system, estimating the potential yield per square meter.
- Additionally, a life cycle assessment (LCA) will be performed to quantify the environmental impact and ensure resource efficiency in this innovative agricultural approach.

Life cycle assessment

LCA is applied to FWI to analyze their environmental impact from manufacture to disposal. This cradle-to-grave approach takes into account the limits and scope of the system. LCA quantifies the environmental benefits associated with water treatment and crop production. Figure 2 shows a LCA schematic, which identifies the key stages of a product's life cycle, from the extraction of raw materials to its final disposal.

Expected results

The feasibility of hydroponic crop production in FWI is evaluated by analyzing yield per square meter, plant health and establishment, with the objective of optimizing the sustainability and efficiency of the system according to the proposed approach.

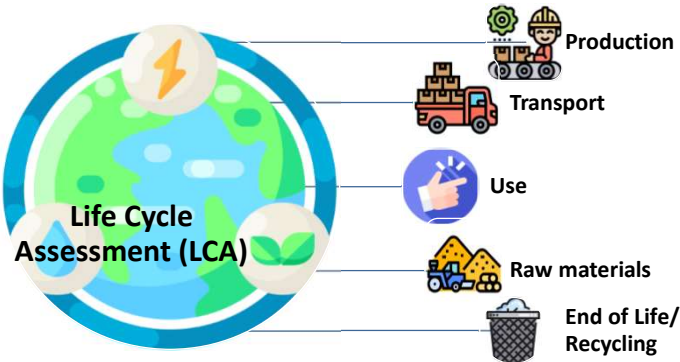


Figure 2. Life Cycle Assessment (LCA) scheme, which makes it possible to identify and evaluate all the stages involved in the life cycle of a product.

References

- [1]: <https://doi.org/10.1016/j.ecoleng.2025.107598>
- [2]: <https://doi.org/10.1007/s11273-025-10042-7>
- [3]: https://doi.org/10.1007/978-3-031-31289-2_13
- [4]: <https://doi.org/10.1016/j.ecoleng.2025.107546>
- [5]: <https://doi.org/10.1016/j.scienta.2019.05.067>
- [6]: <https://doi.org/10.1080/15427528.2024.2425602>
- [7]: <https://doi.org/10.1016/j.ecoleng.2018.10.001>

Acknowledgements

VC is thankful to ANID/POSTDOCTORADO BECAS CHILE /2024- 74240040 grants. Authors are thankful to the National Funds from FCT-Fundação para Ciência e Tecnologia within the scope of projects UIDB/04423/2020, UIDP/04423/2020, LA/P/0101/2020 and UIDB/50016/2020 projects