Separation and Purification Technology
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In Press, Journal Pre-proof What's this?

Biochar-based downflow Fixed-Bed adsorption systems for water Treatment: Process Optimization, Reusability, and Techno-Economic evaluation

Oussama Baaloudj [a], Fausto Langerame [a], Rocco Iunnissi [b], Gianluigi Buttiglieri [c], Daniele Del Buono [d], Samia Khadhar [e], Laura Scrano [a], Vincenzo Trotta [f g], Monica Brienza [a]



# Open Access Publication Highlights Biochar-Based Adsorption for Scalable Water Treatment

## Description

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As part of the research developed under the **PRIMA-SAFE project**, a new peer-reviewed article has been published in the high-impact journal **Separation and Purification Technology** *(Impact Factor: 9)* . The paper, titled:

> **"Biochar-based Downflow Fixed-Bed Adsorption Systems for Water Treatment: Process Optimization, Reusability, and Techno-Economic Evaluation"**,

offers fresh insight into **sustainable, low-cost technologies** for addressing one of today's most pressing environmental challenges: the treatment of contaminated water.

## A Practical and Scalable Approach to Water Purification

The study focuses on the use of **biochar**, a porous, carbon-rich material derived from biomass, as a

core component in down **flow fixed-bed adsorption systems**—a configuration widely considered suitable for both centralized and decentralized water treatment applications.

Through a combination of **experimental optimization**, **real-water testing**, and **techno-economic evaluation**, the research offers compelling evidence that biochar-based systems can provide an **efficient, eco-friendly, and affordable** solution for removing contaminants from water supplies. This makes them particularly well-suited for **resource-limited or climate-stressed regions**, such as those targeted by the PRIMA-SAFE initiative in the Mediterranean.

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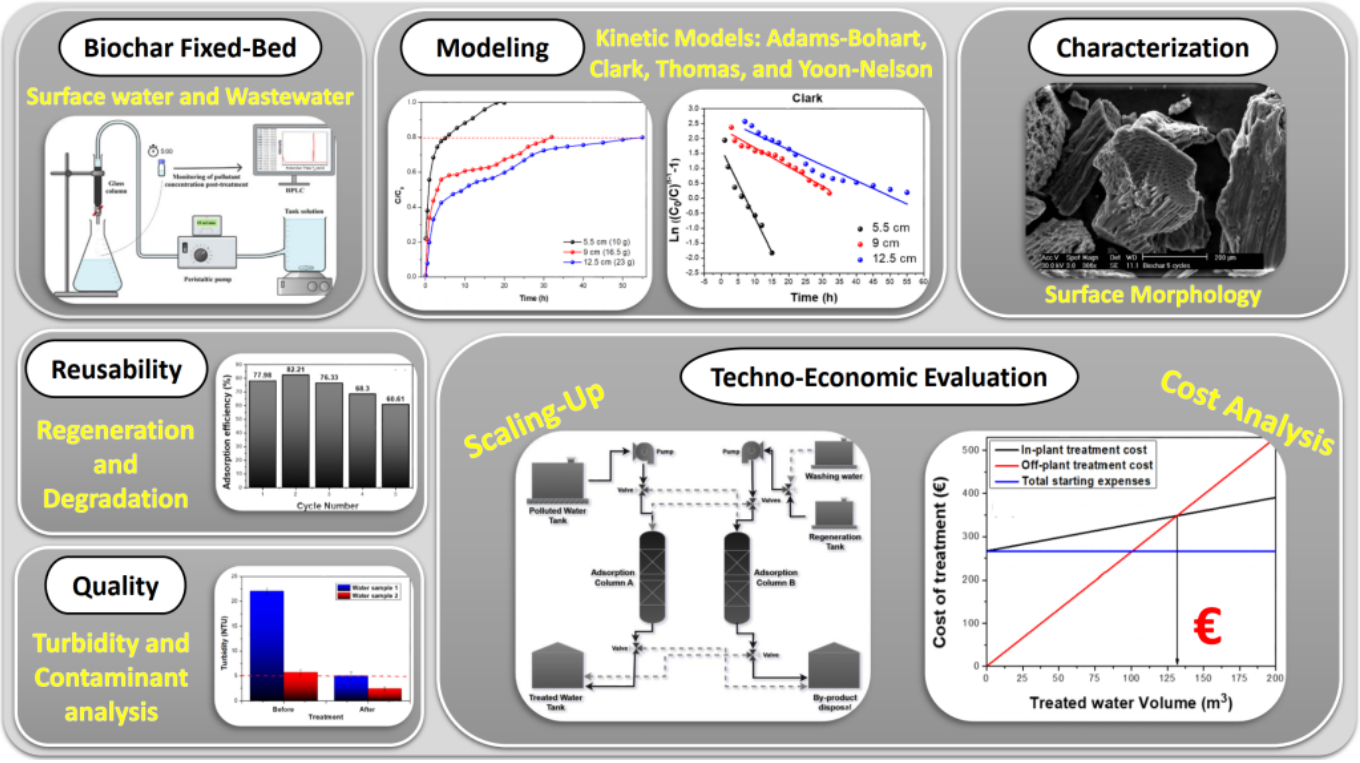
## Key Highlights from the Study




- ? **Process Optimization**: The team identified optimal operational conditions for column design and flow rate to maximize removal efficiency of **sulfamethoxazole**, a common pharmaceutical pollutant found in surface waters and wastewater effluents. The study demonstrated that under optimized conditions, high removal rates could be achieved, even at elevated contaminant concentrations.
- ? **Reusability & Regeneration**: A major strength of the system lies in its **regeneration capability** . The study showed that biochar columns could be reused through multiple adsorption-desorption cycles without significant loss of performance, reducing material consumption and waste generation over time.
- ? **Real Water Testing**: Beyond laboratory conditions, the system was successfully validated on **real water samples**, where it showed excellent results in reducing **turbidity** and removing trace pollutants. This proves the system's relevance for practical field applications.
- ? **Techno-Economic Assessment**: A detailed evaluation of operational costs confirmed that the proposed setup offers a **very low treatment cost per cubic meter**, making it not only technically

effective but also economically feasible for large-scale implementation.

## Towards Circular, Low-Impact Water Solutions

The publication underlines PRIMA-SAFE's commitment to developing technologies that balance **scientific rigor**, **affordability**, and **environmental responsibility**. In particular, this study contributes to the project's broader goals of supporting **circular economy models**, where waste biomass is upcycled into functional materials—like biochar—that can close resource loops in water treatment.

It also reinforces the role of **adsorption technologies** as a competitive option alongside more established methods like membrane filtration or advanced oxidation, especially where energy consumption or cost presents a barrier.

## Acknowledgements

This achievement would not have been possible without the collaboration of an interdisciplinary team of researchers and engineers working under the PRIMA-SAFE umbrella. Their collective expertise in **environmental engineering, material science, and process optimisation** continues to drive forward innovation in the field of water reuse and treatment.

? Access the full publication here
? Journal: *Separation and Purification Technology*

Stay tuned as PRIMA-SAFE continues to deliver impactful results at the intersection of **science, sustainability, and practical implementation**.

### Category

1. Publication

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