Optimization of secondary wastewater treatment with biochar-based vertical-flow wetlands

- **Aims:** Our work has focused on optimizing certain parameters such as the type of biochar, the raw materials, the preparation conditions, the position of the biochar substrate and the percentage of biochar in the substrate in order to improve treatment performance using constructed wetlands with vertical flow (VF-CWs).

Third study: Efficiency of Biochar-based VF-CW filter in Wastewater Treatment.

➢ **The main objective of this study is to test the efficiency of biochar-based VF-CW.**

Based on the previous **Newsletters 3 and 4**:

- The optimal placement for biochar is as an interlayer substrate.
- A 10% biochar ratio is ideal for column filtration systems.
- Due to the higher availability of olive pomace in Morocco, it represents a promising raw material for biochar production, especially for use in large filters such as CWs.

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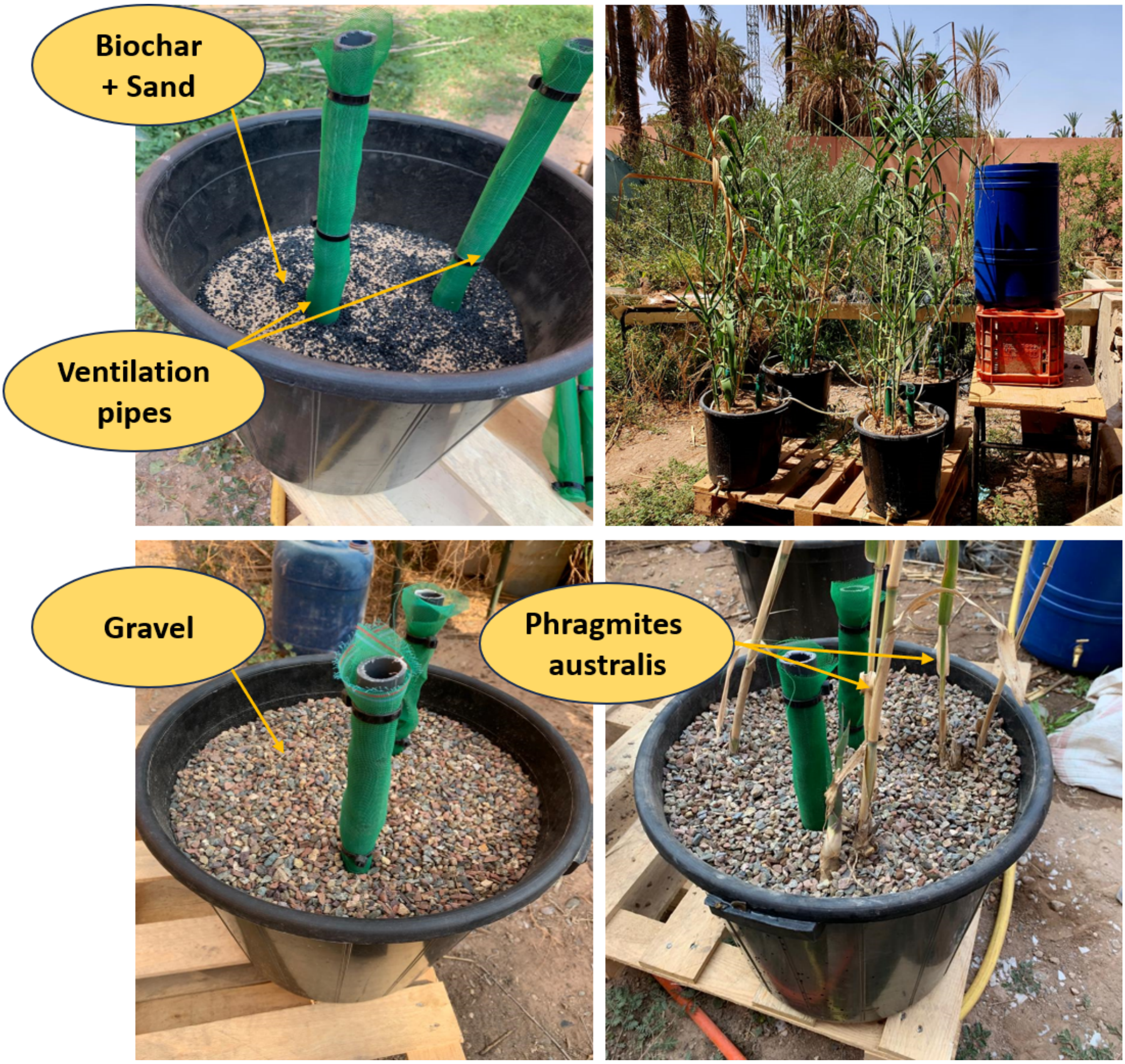

Figure 1 – View of the VF-CW experimental setup.

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- **Experimental**

The wastewater used in these experiences taken from the decanted stage of wastewater treatment plant (Marrakech, Morocco), treating mixed domestic-industrial textile wastewater.

The experimental set-up was installed at the outdoor laboratory of the biology department, Faculty of Sciences Semlalia Marrakech, University of Cadi Ayyad, Morocco.

In this study, the settled wastewater was treated using three kinds of VF-CW. These systems were designed according to different volume ratios biochar/sand (0%, 10%, and 50%) to explore the effect of biochar concentration on treatment performance. The filter bed (30 cm) is supported by two layers of 8 cm gravel: one at the top (2–6 mm diameter) and another at the bottom of the biofilter (2–8 mm diameter) as a drainage layer. The three VF-CW consists of polyvinyl chloride (PVC) with an internal diameter of 38 cm, a surface area of 0.10 m², and a total height of 4 cm each (**Figure 1**).

All CFS were operated in sequential batch filling and emptying mode (5 batches/day), with frequence of 1 day of feeding and 2 days of rest, and an organic loading rate of about 5.8 g of COD/m²/day.

Conventional parameters (i.e., pH, electrical conductivity, total suspended solids (TSS), total and dissolved chemical oxygen demand (TCOD; DCOD), TKN, NH_4^+-N, NO_2^--N, NO_3^--N, PT, PO_4^{3-}, SO42-, Ca, Mg, and total hardness (TH), as well as absorbances at 254 and 420 nm were weekly determined. In addition, the bacteriological analyses comprised fecal bacteria indicators (total coliforms (TC), fecal coliforms (FC), and fecal streptococci (FS)).

The biochar was obtained from exhausted olive pomace using a semi-pilot scale of slow pyrolysis, at a temperature of 590 °C and maintained for a residence time of 2h with a heating rate of 10 °C/min (**Newsletter 4, Figure 2**).

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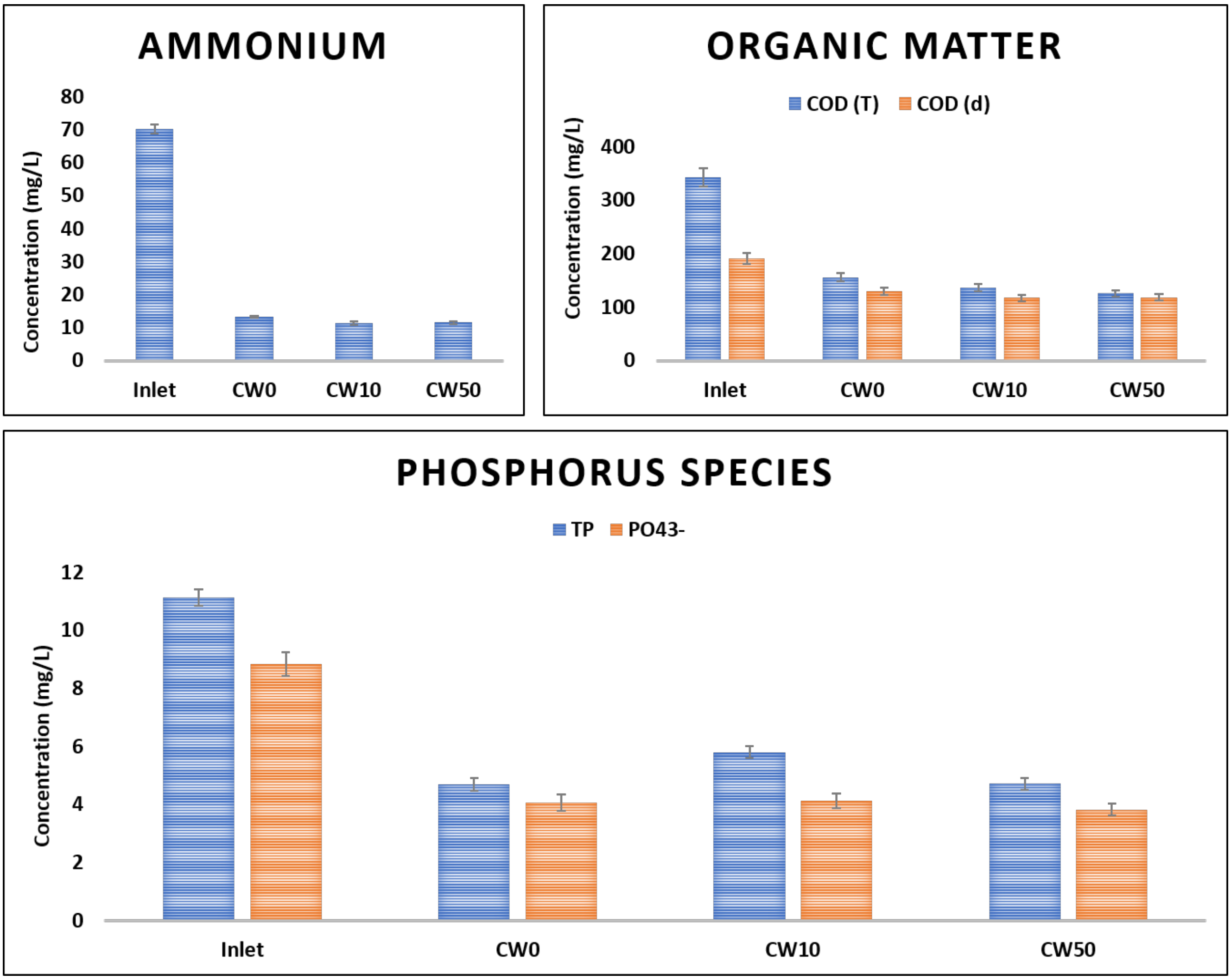

Figure 2 – Overview of the results obtained for conventional parameters

Based on this study:

- The addition of biochar to sand media showed a slight improvement in removal performance of pollutants in VF-CWs, compared to the previous studies-based column filtration systems.
- No significant difference between the VF-CWs integrated biochar, which confirmed the results of **Newsletter N°4**.
- Higher biochar additions do not always result in better treatment performance.

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