

Abstract of two presentations

## **Innovative Nature-Based Solutions for Managing Cyanobacterial Blooms in Freshwater Ecosystems**

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Cyanobacterial harmful algal blooms (CyanoHABs) are an increasing global threat to freshwater security, driven by nutrient enrichment, rising temperatures and hydrological stress. These blooms release microcystins, which are persistent hepatotoxic and carcinogenic compounds. This poses serious risks to drinking water quality, ecosystem integrity, agricultural irrigation and public health. In response to the limitations of conventional treatment technologies, which are often costly and energy-intensive, this work explores the potential of nature-based solutions (NbS) to provide resilient, low-cost, and sustainable alternatives for bloom and toxin removal. The performance of Multi-Soil-Layering (MSL) ecotechnology for the treatment of cyanobacterial biomass and microcystins in eutrophic lake water is evaluated for the first time in this study. To optimise adsorption, biodegradation and nutrient removal processes, locally available substrates were used in laboratory and pilot-scale experiments. These substrates included pozzolan, sandy soil, clayey soil, charcoal, sawdust and metallic iron. The results show very high removal efficiencies, with 99–99.9% of cyanobacterial cells being removed, and 99.9% of MC-LR. Over 95% of organic matter and nutrients were also removed, and the sandy soil-based MSL system was found to be more stable and perform better over time. Microbial community analyses revealed an enrichment of key degraders, such as *Pseudomonas* and *Staphylococcus*, as well as the *mlrA* gene. This confirms the presence of active biological degradation pathways for microcystins within MSL substrates. The systems also effectively retained persistent MC variants and supported diverse, functionally relevant microbial assemblages. Overall, the findings demonstrate that MSL ecotechnology is a robust, scalable and environmentally friendly NbS capable of managing CyanoHABs and associated toxins. By combining natural materials, microbial processes and low operational requirements, MSL systems offer a promising solution for improving the quality of freshwater, protecting public health and strengthening universities' role in advancing innovation to address the challenges of water scarcity and pollution.

### **Keywords:**

Cyanobacterial blooms; Microcystins; Nature-based solutions; Multi-Soil-Layering; Freshwater treatment; Biodegradation.

**Special session : Universities as Catalysts for Water Innovation**

## **Title : Reuse of treated wastewater in agriculture as circular economy option**

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In Morocco, conventional water resources are reaching saturation, and most agricultural basins face chronic water deficits. In response, the government has shown strong political commitment to promoting alternative resources—mainly treated wastewater and brackish water—for agricultural irrigation, as highlighted in several national water and environmental strategies. Reusing treated wastewater offers multiple benefits: reducing pressure on conventional water supplies, providing a reliable year-round source, enhancing soil fertilization by supplying nutrients, and reducing fertilizer costs.

However, safe reuse requires compliance with sanitary and chemical quality standards. WHO and Moroccan guidelines define microbiological criteria to protect farmers and consumers from waterborne diseases, while FAO standards aim to preserve soils and the environment. Achieving this quality depends on appropriate wastewater treatment technologies adapted to local climatic and socio-economic conditions.

Since the 1980s, the University Cadi Ayyad—particularly the Faculty of Sciences Semlalia—has led extensive research and pilot projects on wastewater treatment and reuse. These include large-scale stabilization ponds in Marrakech high-rate algal ponds, constructed wetlands, and studies on wastewater reuse in rural areas. The research produced numerous thesis and scientific publications, guided national decision-making, supported local communities, trained professionals, and demonstrated the technical, environmental, and economic feasibility of natural, low-cost wastewater treatment systems , including for complex effluents such as olive mill wastewater and the suitability of treated waste water to be reused in successful experiences.