



# Sustainable Water Remediation and Natural Product Extraction from Macroalgae through ICT Technologies: A Pilot Study in Port of Alicante (Spain)

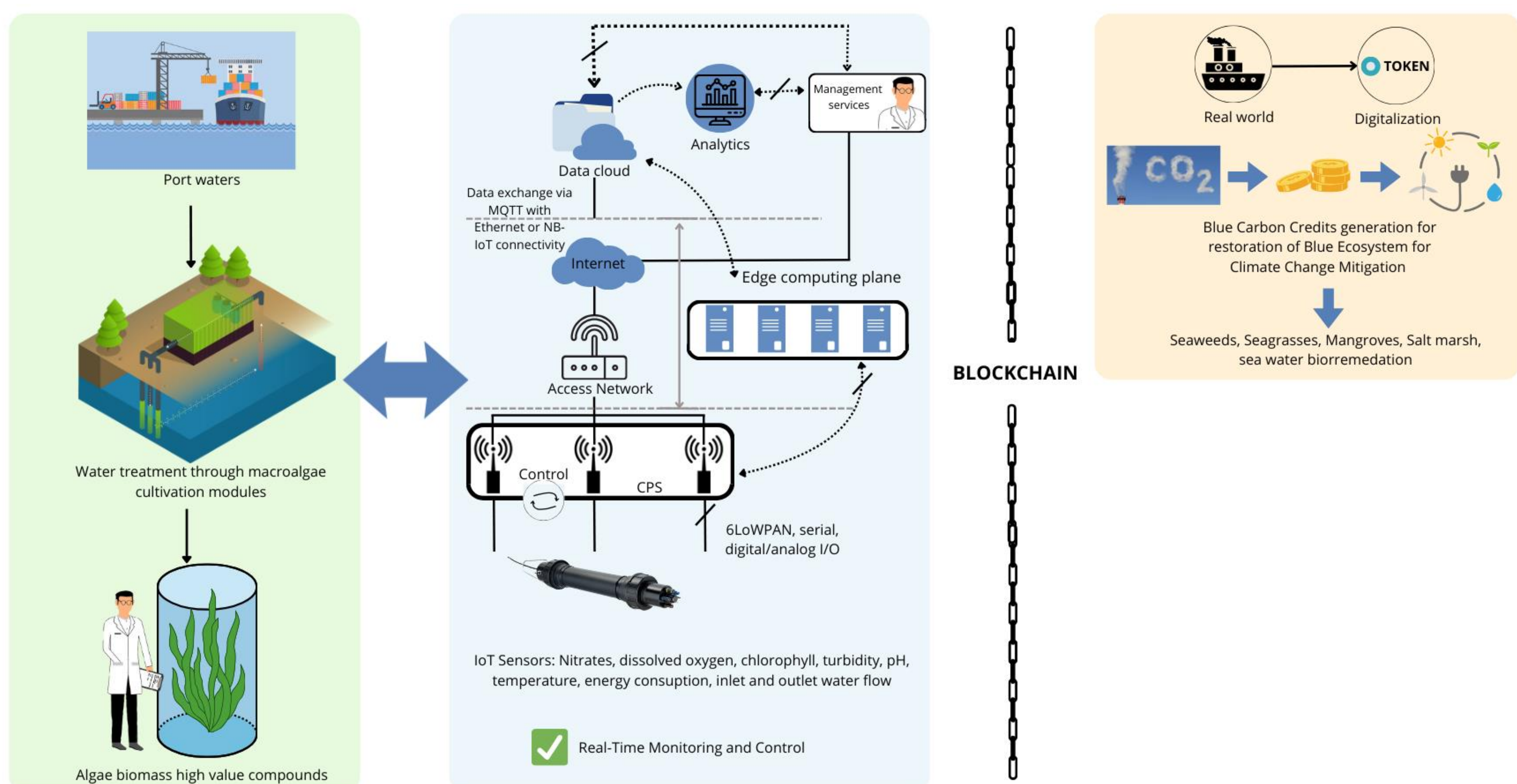
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**Introduction:** Removing heavy metals and excess nutrients from port waters is a major environmental challenge requiring innovative solutions. However, macroalgae like *Ulva sp.* offer an effective nature-based solution for water bioremediation and ecological improvement. At the same time, these algae can also serve as a sustainable source of valuable bioactive compounds. Moreover, integrating ICT technologies allows real-time monitoring and system optimization, increasing efficiency and scalability in the process. In parallel, extracted natural products, such as antioxidants or pigments, create opportunities in the circular bioeconomy. However, large-scale deployment remains limited due to regulatory, technical, and market challenges.

**Pilot Description:** This pilot study investigates the combined potential of *Ulva sp.* macroalgae cultivation, water bioremediation and the extraction of natural bioactive compounds, supported by IoT and ICT technologies. Conducted at the Port of Alicante, the project aims to demonstrate how integrated algal systems can improve water quality, reduce environmental impact and generate commercially valuable outputs. The initiative is the result of a collaboration between University of Murcia, Mediterranean Algae and the Port of Alicante, and it focuses on a highly active maritime zone, offering ideal conditions for testing scalability and replicability in other port settings. The study emphasizes not only environmental remediation but also the identification, extraction and valorization of compounds from macroalgae for use in cosmetics, animal feed and other sectors.

**Pilot Design:** The pilot uses a closed system with 2000-litre tanks to cultivate *Ulva sp.* macroalgae, which remove nutrients and pollutants from seawater. Real-time IoT monitoring and ICT analysis optimise system performance and efficiency. Blockchain-based tools track CO<sub>2</sub> uptake to generate certified Blue carbon credits in line with Spanish regulations. Finally, harvested biomass is investigated to obtain high-value compounds and secondary products.



**Expected Outcomes:** Set up a pilot demonstration site as a tool to foster the integration of macroalgae and digitisation processes in the integrated water cycle. Applied to water bioremediation and new natural products extraction to (1) identify the potential of native algae species, (2) explore new products based on macroalgae, (3) promote a circular economy and carbon credits use in bioremediation, and (4) develop a protocol for their use elsewhere.

