

## اعتماد المعالجة اللامركزية كأحدى الطرق الرائدة في تقديم حلول فعالة ومستدامة لإدارة مياه الصرف الصحي في لبنان

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### The implementation of decentralized treatment as one of the main methods for providing effective and sustainable wastewater management solutions in Lebanon

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The wastewater management and treatment sector in Lebanon faces significant and diverse challenges due to several factors, including a lack of financial and human resources, technical difficulties, the absence of integrated sewage networks in most areas, and deficiencies in operation and maintenance. These stations were originally designed to convert wastewater into safe water for use. For example, the Tripoli wastewater treatment plant, the largest in the North, which is supposed to serve one million people, is designed to treat water in three stages (primary, secondary, and tertiary) and generate power from gas and wastewater. With a capacity of 135,000 m<sup>3</sup> per day, its current operation is limited to rudimentary wastewater filtration before pumping it into the sea via 2-kilometer-long pipes. This is due to technical difficulties and an insufficient water supply to operate the plant, as it receives between 30,000 and 40,000 m<sup>3</sup> per day only because the connecting networks between the plant and the Zgharta, Koura, and Dnieh regions have not been completed.

Sewer networks and centralized treatment plants are vital integrated systems for protecting public health and the environment from pollution by removing organic and solid pollutants through physical, biological, and chemical processes to produce safe, reusable water for agriculture or industry. However, this system consumes significant amounts of energy, requires regular maintenance, incurs high costs, and generates large quantities of sludge.

Climate change, population growth, and the massive loss of biodiversity are forcing us to reconsider the current system. With increasing heat waves and altered rainfall patterns, the need for water will grow in increasingly densely populated cities. Decentralized treatment plants offer an innovative, cost-effective, and efficient solution. Decentralized wastewater treatment essentially involves collecting, treating, and reusing wastewater. These systems can then reuse the treated water for irrigation or other applications, in accordance with national environmental standards. Typically installed near the wastewater source, these systems can operate as standalone plants.

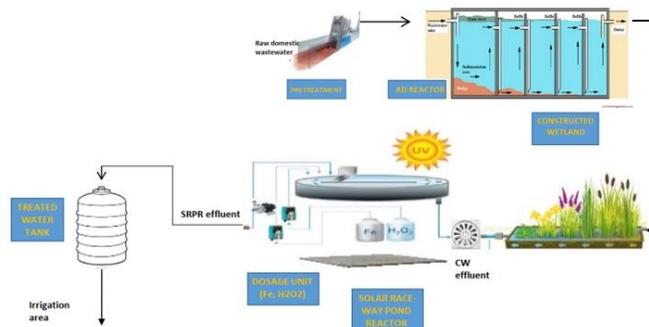


Figure 1: the scheme of Decentralized wastewater treatment plant

Decentralized wastewater treatment plants utilize Nature-based Solutions (NbS) technologies to mimic ecosystems (such as constructed wetlands) for efficient and sustainable water purification. These systems filter solids, break down organic pollutants, and remove nutrients (nitrogen/phosphorus) through microbial activity and plant uptake. Anaerobic barrier reactors (ABRs) represent the first and most innovative stage in wastewater treatment, offering a highly efficient and low-cost decentralized system that does not require electricity. The final stage is solar disinfection: Raceway Pond Reactors (RPRs) are low-cost, shallow-channel systems that are highly efficient in disinfecting and treating wastewater, particularly through solar-powered processes such as the photo-Fenton process.

These systems offer a suitable solution to address the structural challenges facing Lebanon's wastewater sector, including dilapidated infrastructure and a shortage of human and technical resources in public institutions. They provide low construction and operating costs, often relying on natural, energy-efficient technologies, thus reducing the burden on public networks and facilitating their management by water authorities and relevant ministries. Furthermore, they offer high flexibility, address the geographical challenges of remote areas, and contribute to protecting public health and the environment by preventing pollution and conserving natural resources.

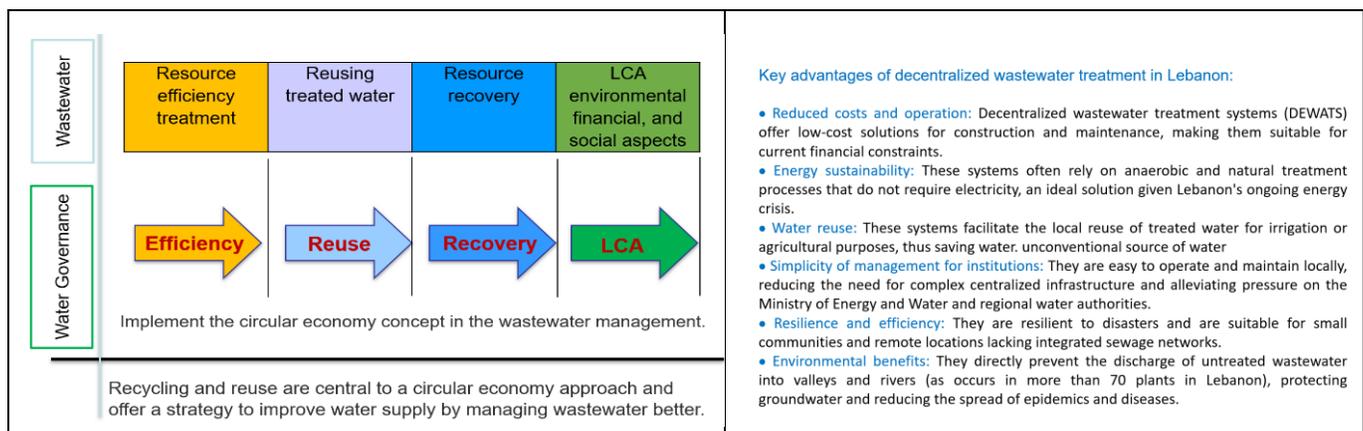


Figure 2: Greater Tripoli Basin Wastewater Networks.