

PREPARATION OF PAPER SUBMISSION TO REUSE EUROMED 2024

Sustainable Wastewater Management and Reuse in Moroccan Oasis Regions: A Case Study of the Massire Project

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ABSTRACT

This paper examines the challenges of wastewater management and reuse in Moroccan oasis regions, highlighting the urgent need for sustainable practices in the face of climate change and water scarcity. The study focuses on a pilot project implemented under the Massire Project, a low-cost wastewater treatment and reuse system at a tourist facility in Tinghir, Morocco. This initiative demonstrates the potential of decentralized, eco-friendly solutions to address environmental degradation, support local economies, and promote community well-being in vulnerable oasis ecosystems.

Keywords: Moroccan oases, wastewater treatment, wastewater reuse, decentralized systems, multi-stakeholder approach, Massire Project.

Introduction

Oasis regions in Morocco face significant environmental challenges due to climate change and water scarcity. The discharge of untreated wastewater from urban areas, dispersed settlements, and tourist infrastructure contributes to the deterioration of water and soil quality, threatening biodiversity and community health. This paper examines the implementation of sustainable wastewater management practices in Moroccan oases, with a focus on the Massire Project's innovative approach ([Massire, 2019](#)) to wastewater treatment and reuse.

Background

Moroccan oasis regions have experienced significant economic and population growth in recent years. This growth has led to the construction of numerous individual homes along roads and within oases, as well as the establishment of various tourist facilities, often in isolated areas. The unplanned nature of this development has made it difficult to implement collective sanitation systems. As a result, wastewater from these habitations and tourist units is generally untreated and discharged into dry wells or directly into the natural environment, which has severe impacts on water and soil quality, human health, ecosystem integrity, and even the tourism appeal of these regions.

Additionally, conventional wastewater treatment methods in oasis regions often prove inadequate due to a combination of factors, including limited infrastructure, high costs associated with implementing and maintaining traditional treatment systems (GIZ, 2020), and a lack of technical expertise required to operate and maintain complex facilities (Sasse, 1998). Furthermore, many conventional treatment methods are insufficiently adapted to local conditions, such as extreme temperatures and water scarcity (Tilley, 2014)

The Massire Project: A Case Study in Sustainable Wastewater Management

- **Project Overview:** The Massire project implemented a low-cost wastewater treatment and reuse system in a tourist facility in a Moroccan oasis region. The initiative aimed to demonstrate the feasibility and benefits of decentralized, eco-friendly wastewater management solutions. By focusing on a tourist facility, the project addressed one of the significant sources of wastewater in these regions while showcasing the potential for sustainable practices in the tourism sector.
- **Multi-Stakeholder Approach:** The implementation of the pilot project involved a concerted effort from various stakeholders, including neighborhood associations, hotel managers, administrative services responsible for water quality and agriculture, and private companies involved in installing the experimental devices. This collaborative approach allowed for the development of a shared vision of challenges and solutions, supported by scientific studies on wastewater treatment and reuse.
- **Case Study (Tourist Facility in Tinghir, Morocco):** The pilot system was installed in a tourist hotel located far from urban agglomerations. The hotel offers 60 beds and various water-using facilities (rooms, restaurant, swimming pool, etc.). Water is mainly sourced from groundwater pumping, with consumption varying by month and peaking during the high seasons of April and November. Prior to the project, the unit was not connected to a collective water supply network, and wastewater treatment was done via an old agricultural digester converted into a septic tank. This autonomous sanitation system directed wastewater to an open-surface pit for additional settling before being used to irrigate olive trees. However, sludge accumulation caused unpleasant odors and insect proliferation. At the tourist facility in Tinghir, an Anaerobic Baffled Reactor was installed (Tilly, 2014). This low-cost technology can be easily produced in oasis areas and operates without oxygen (GIZ,2019). The reactor is divided into several compartments, allowing for efficient degradation of organic matter by microorganisms (Sasse,1998). Initial measurements confirmed satisfactory quality of the treated wastewater, which is used to irrigate a 2,500 m² agricultural plot (El Meknassi et al., 2024).

Discussion

- **Benefits of Decentralized Wastewater Management in Oasis Regions:** the implementation of decentralized wastewater treatment and reuse systems in oasis regions offers multiple benefits. Primarily, it contributes to the conservation of freshwater resources, which is crucial in water-scarce environments. By providing an alternative water source for agriculture, it reduces the pressure on limited groundwater reserves. The reduction of environmental pollution is another significant advantage, as proper treatment prevents the contamination of soil and water resources. Furthermore, the availability of treated wastewater supports local agriculture and enhances food security, enabling the cultivation of crops even in periods of water scarcity. There is also potential for economic development through resource recovery, such as the use of nutrient-rich treated water for fertilization. Lastly, these decentralized systems demonstrate improved adaptability to local conditions and needs, offering tailored solutions for the unique challenges faced by oasis communities.
- **Challenges and Considerations:** Cultural acceptance and community engagement are crucial factors, as there may be resistance or skepticism towards the use of treated wastewater. Overcoming these barriers requires comprehensive education and awareness programs. Technical capacity building is another important consideration, as local communities need the skills and knowledge to operate and maintain treatment systems effectively. The development of appropriate regulatory frameworks and standards is essential to ensure the safe and sustainable implementation of wastewater reuse practices. Additionally, establishing sustainable financing mechanisms is critical for the long-term viability of these initiatives, particularly in economically challenged regions. Continuous monitoring and evaluation of system performance are also necessary to ensure ongoing effectiveness and to make improvements as needed.

- Integrated Approach for Scaling Up: to support the widespread deployment of decentralized sanitation and wastewater reuse systems in oasis regions, an integrated, multi-stakeholder approach is recommended. This approach involves improving regulatory frameworks to promote efficient sanitation and water reuse in oasis environments. Establishing viable financing models is crucial to facilitate access to necessary funds for implementation and maintenance. Capacity building programs for municipal technicians in sustainable sanitation practices are essential to ensure proper operation and management of these systems. Organizing information and awareness campaigns for potential users and local institutions helps to build public support and understanding. Continuing research on various technological, management, and governance alternatives is necessary to refine and improve solutions over time. Finally, instituting robust monitoring and evaluation mechanisms is critical to measure the impact and effectiveness of treatment and reuse systems, allowing for continuous improvement and adaptation to changing conditions in oasis regions

Conclusion

The Massire project demonstrates the potential of innovative, decentralized wastewater management solutions to address environmental challenges in Moroccan oasis regions. By implementing low-cost treatment systems and promoting wastewater reuse, oasis communities can mitigate water scarcity, reduce pollution, and support local economies. The success of this pilot project highlights the importance of multi-stakeholder collaboration and the need for context-specific solutions in vulnerable ecosystems.

The creation of living laboratories “livig labs”¹ is proposed as a way forward, fostering collaboration between researchers, technicians, farmers, and decision-makers in developing sustainable water management practices for oasis regions. These initiatives can serve as models for sustainable water management in other vulnerable ecosystems facing similar challenges, contributing to the resilience and sustainability of rural and oasis communities.

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¹ Living Labs are open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact (<https://enoll.org/about-us/what-are-living-labs/>)

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