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The Water Management Systems in Saharan Oases and the Sustainability Challenge in the Face of Climate Change: A Case Study of the Oued-Noun Oases, Southern Morocco

Mohamed Louazani

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Resumo

Este estudo analisa os sistemas tradicionais e modernos de gestão da água nas oásis de Oued-Noun, no sul de Marrocos, avaliando o seu papel na sustentabilidade perante as crescentes pressões climáticas. Os sistemas tradicionais, como as foggaras e canais de derivação, foram soluções eficazes em ambientes áridos, mas têm sido enfraquecidos pela modernização e alterações institucionais. As recentes infraestruturas, como a barragem de Fask e os poços solares, oferecem novas oportunidades e desafios à gestão sustentável. Os resultados destacam a importância de integrar práticas tradicionais e abordagens modernas para preservar o património ambiental e cultural.

Palavras-chave: Oásis, Gestão da Água, Alterações Climáticas, Sustentabilidade, Oued-Noun.

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Abstract

This study analyzes traditional and modern water management systems in the Oued-Noun oases of southern Morocco, assessing their role in ensuring sustainability under growing climatic pressures. Traditional systems, such as foggaras and diversion canals, effectively adapted to arid conditions but have been undermined by modernization and institutional shifts. Recent developments, including the Fask Dam and solar-powered wells, present both opportunities and challenges for sustainable water governance. The findings highlight the need to reconcile traditional practices with contemporary management strategies to preserve environmental and cultural heritage.

Keywords: Oases, Water Management, Climate Change, Sustainability, Oued-Noun.

Traditional Water Management

The inhabitants of the Ouad-Noun oases have long focused on managing water scarcity, demonstrating ingenuity in creating adaptive techniques that harmonize with the local environment. This has enabled them to produce a legal and equitable framework for managing water resources for centuries, ensuring land irrigation and thus the persistence of the oases.

Traditional Water Sources

- Springs(Ain):** A primary source of groundwater, is used for agricultural activity, irrigating up to 1117 hectares (Chmourk, E-M.2011) despite recent declines in flow. Several springs are located along the banks of the Oued wagnoun and Oued Sayad, as well as their tributaries. These springs are characterized by their consistent flow and ease of use, although their discharge rates vary. They are primarily utilized for irrigating agricultural lands. Among them are “Ain Agadir Mkourn” in the Tagmout Oasis, “Ain Tofagho” in the Tinzert Oasis, “Ain Tajnant” and “Oued Wagnoun” in the Tighmert Oasis, as well as “Ain Bouizakarne” and “Ain Tagant.
- khetaras:** An effective method for exploiting groundwater, using underground channels to minimize evaporation. The Guelmim basin has around 216 foggaras, with varying flows, from as high as 44 liters per second to as low as 1.5 liters per second. (Oasis Preservation and Development Program for the Southern Provinces POS .2009)

Structurally, a khetara is divided into three main parts:

1. The Supply Zone: Known locally as «**Ras El Khetara**» this area includes the first and deepest wells, which contain the springs that feed the khetara system.

2. The Water Channel: These are the underground passages that carry water from the supply zone downstream. This section is divided into specific intervals called «Qantara,» which refer to the distance between two consecutive wells, usually no more than 40 meters apart.
3. Distribution Channels: This network ensures the efficient delivery and allocation of water. It includes a main central canal (Targa) connected to secondary canals (Asaro), which then branch into smaller tertiary canals (Aginan). It’s important to note that the canals are often named after the beneficiaries, such as the tribe, community, or family they serve, or the specific irrigated area they supply. (Oudada M, Azdi F. 2018)

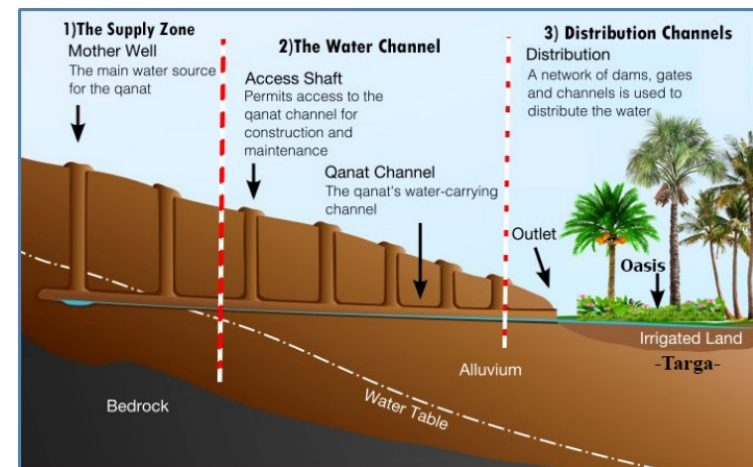


Figure 2. Simplified Diagram of khetaras

- Diversion Dams and Can :** Constructed to capture floodwater and distribute it through a network of canals for traditional farming. (Al-Sharkawi A. 2005).

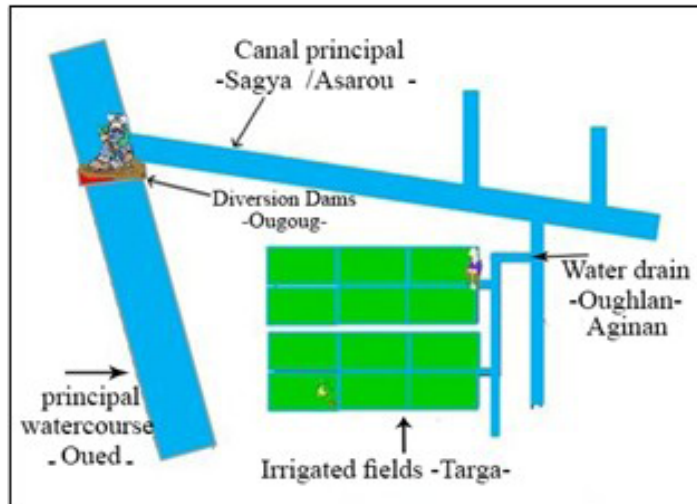


Figure 3. Simplified Diagram of a Canal
Source: (Ouhajou, L.1996) (modified)



Figure 4. The Diversion Dam at Taghijit Oasis
Source: Cliché Personal 2019

Customary Water Regulation

- **Turn System:** A system based on alternating water distribution according to individual contributions to infrastructure.
- **Community Institution:** A traditional body that organizes irrigation operations and manages water-related disputes.
- **Customary Penalties:** Applied to violators to ensure compliance with water management rules, either material or in-kind, like community service such as cleaning canals or removing contaminants from water reservoirs. (El-Talib Mahand A.2016)



Figure 5. Technique for Water Distribution (Tanast)

Discussion

Modern Transformations in Water Management: The introduction of modern techniques in water resource management has been among the most significant changes:

- **Modern Dams**

Fask Dam: As part of the new development plan for the southern regions, launched in February 2016 in Dakhla, the

Fask Dam, located downstream of the Sayad Basin, is set to become the largest and most important water facility in the Guelmim Basin and the southern regions. This strategic project, with a total budget of 1.5 billion dirhams in partnership with Qatar, is expected to significantly enhance water reserves in the medium and long term.

The Fask Dam is located 30 km east of Guelmim and 8 km east of the Fask community center. It is being constructed on the Oued Sayad over a 48-month period (2017–2021). With a capacity of 79 million cubic meters, the dam will manage a water reserve of 19 million cubic meters, protect water resources in the region, and reduce water waste from the floods of several wadis that flow into the Tofilit Ait Hammad plain (Fask community). This plain is one of the richest agricultural areas in the region. The dam will also irrigate the agricultural perimeter downstream, including the Guelmim plain, supply drinking water to urban and rural centers in the region, enhance the groundwater table, and protect against flood risks.

Following recent rainfall in the Guelmim Oued-Noun Basin, the Fask Dam reservoir received approximately 10.5 million cubic meters of water by 6:00 PM on Sunday, September 8, 2024, increasing its storage rate to 12.65%. This project is also expected to boost the tourism and employment sectors, particularly for youth, providing a strong economic dynamic to the region. (Ministry of Equipment and Water of Morocco, 2024)



Figure 6. Location of the Fask Dam
Source: Noufel El Majdoubi, 2024

- **Collective and Individual Well:**

Based on the data from the figure 10, farmers have worked tirelessly to find new water sources for irrigating agricultural plots within the oases after the springs dried up. Many oases in the Guelmim Oued-Noun Basin have experienced the depletion of springs and foggaras that once supplied water to these areas. These traditional sources have now been replaced by modern wells, which have been drilled by local authorities and water user associations in the oases of the Guelmim Basin.

Each canal now has its own well, managed by an association responsible for its operation and maintenance. This represents a shift in irrigation and water management systems, as the traditional canal networks have been preserved while the wells have been equipped with solar energy. Water is rented to farmers at a fixed rate, depending on their capacity, which generates significant financial resources for the associations.

These funds are used for investments, exploring new methods to ensure the sustainability of water resources, and managing canal repairs and periodic cleaning.

Below are examples of canal layouts in some oases, as well as a map showing the distribution of these new wells, which are now used for oasis irrigation after the foggaras dried up.



Figure 7/8. New Wells at Taghijit Oasis, Ain El Ansar with Solar Energy at Ifrane
Source: Mohamed LOUAZANI, 2023



Figure 9. Well and Reservoir Equipped Oasis
Source: Mohamed LOUAZANI, 2023

Solutions and Recommendations for Water Resource Sustainability

Given the profound changes in water resource exploitation in the oases and the resulting environmental degradation, there is a need for serious consideration of organizing water use based on scientific principles that focus on optimizing available resources while ensuring their sustainability:

- Raising awareness among farmers about the importance of adopting drip irrigation within the oases to conserve and rationalize water use.
- Working on legislating the production of market crops that consume significant water resources and are not native to the area.
- Intensifying agricultural research to develop techniques for conserving water resources.
- Organizing the exploitation of groundwater with an emphasis on collective management.
- Creating an accurate database on successful water management projects.
- Granting licenses for the purpose of drilling new wells for the benefit of water user associations for agricultural purposes.
- Revaluing cultural heritage with an emphasis on collective water management.
- Supporting and encouraging self-initiated projects by some farmers to preserve natural heritage, with framing, training, and providing technical assistance.
- Coordinating efforts and programs among stakeholders concerned with the development of oasis areas.

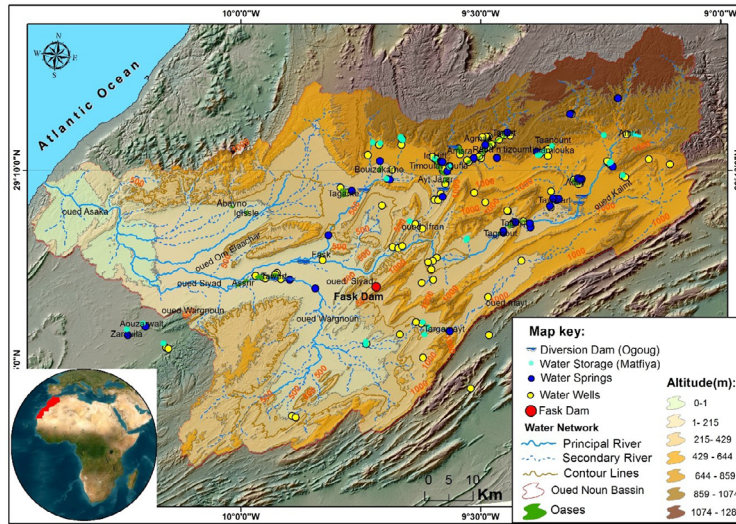


Figure 10. Distribution of New Wells within the Oases
Source: Field Visit, 2023

Conclusion

The oases of the Guelmim Oued-Noun Basin face growing challenges due to water scarcity and socio-environmental changes. While traditional water management systems have declined, the introduction of modern techniques such as dams and solar-powered wells offers promising solutions. However, the sustainability of water resources depends on coordinated efforts among stakeholders, increased awareness of sustainable practices, and the revival of solidarity and collective management values.

In 2020, several Moroccan oases, including those in the city of Errachidia, saw their foggaras recognized as UNESCO World Heritage Sites, acknowledging them as tangible cultural heritage. This recognition serves as an incentive for other Moroccan oases to register their water-related heritage with UNESCO. Foggaras

play multiple roles, such as reducing water evaporation and limiting rural migration, as local communities are reluctant to abandon their lands as long as these systems remain functional.

There is a need to explore new ways of living without compromising ancestral heritage, combining traditional foggaras with modern irrigation methods. While both systems have their merits, the traditional foggaras were more sustainable, whereas modern techniques often lead to overexploitation of water resources, resulting in declining water reserves.

Government policies providing aid to farmers have had a noticeable impact on the region. However, given the challenges of declining groundwater levels and the depletion of springs and foggaras, farmers may face difficulties in sustaining these benefits without long-term policies that promote more efficient and resilient water use practices.

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