Blue Papers 2024 (Vol. 3 No. 2), pp. 176–85
10.58981/bluepapers.2024.2.14
Received 05.08.2024; Receved in revised form 26.08.2024; Accepted 20.10.2024

Learning from the Hydraulic Heritage of Figuig, Morocco

Ouafa Messous
Ecole Nationale d'Architecture de Rabat (National School of Architecture of Rabat)

In the face of water scarcity and climate change, the Figuig Oasis exemplifies resilience through the integration of culture, heritage and sustainable development. This arid region has preserved ancient water management practices that have sustained life for millennia, offering a model for achieving the United Nations' Sustainable Development Goals (SDGs). Figuig's significance lies in the potential to harmonize traditional and modern water governance systems, optimizing its hydraulic organization as a living cultural heritage to ensure the sustainability of ecosystems in desert environments amid growing water scarcity.

Keywords: *resilient water management, oasis irrigation systems, water scarcity, water governance*

< Fig. 1 Figuig Oasis: lifeblood of a fragile ecosystem in the arid desert (Source: Ouafa Messous).

Figuig: Resilient Oasis at the Edge of the Desert

Figuig (fig. 1), located in the eastern region of Morocco, 841 km from the capital Rabat and 373 km from Oujda, the regional capital, lies deep within the desert. The city is characterized by significant temperature fluctuations, ranging from 0°C in winter to 45°C in summer, with an average annual rainfall of only 150 mm. Historically, prior to the geopolitical and macroeconomic upheavals of the twentieth century (fig. 2), Figuig served as a strategic commercial hub along desert trade routes, connecting eastern Morocco with the sub-Saharan regions of West Africa (Vallat 2014). Today, Figuig's local economy is strongly dependent on its oasis and date palm groves. The ecological, economic and social balances in this context are exceedingly fragile and important, posing critical challenges to the sustainability of the region.

The example of the Figuig Oasis is particularly noteworthy due to the survival of its millennia-old traditional hydraulic system (El Fassi 2015), as well as the resilience of its traditional system of governance, which is based on communal management. The fundamental principle of this is that water use must be equitable and meet essential needs (basic domestic use) balanced with productive needs (agriculture).

The case of Figuig calls for careful consideration of governance models in extreme situations, whether they arise from water scarcity

^ Fig. 2 Section of the oasis destroyed in the early twentieth century due to a conflict between villages, triggered by a water management dispute. Ongoing urbanization in the distance (Source: Ouafa Messous, 2019).

or from social, economic or even geopolitical tensions. To prioritize the survival of the oasis and its ecosystem, both traditional and modern hydraulic systems should converge toward this goal, starting with the rationalization and optimization of water use by all possible means.

Traditional Water Management in Figuig: Subtleties of a Resilient Hydraulic System

Water management in Figuig is intricately linked to the social structure of the oasis. The inhabitants, distributed among the various *ksour* (traditional villages), collaborate to maintain the irrigation network and regulate water distribution. In the past, each *ksar* (village) had its own specific rules governing water distribution.

The *raïfi* or *aiguiadiers* (water guardians) responsible for allocating *kbarrouba* (units of time) and *tigbirte* (units of volume) (Lahlou 2017), historically have played a crucial role in balancing water rights, taking into account seasonal variations and the specific needs of each agricultural plot. Each *kbarrouba* corresponds to 45 minutes during which a specific amount of water is allocated to a plot. This time is then converted into a water volume within storage basins, allowing for flexibility and optimization in water usage. This system has not only proven effective for the survival of the palm grove but also strengthened social ties and community cohesion.

The hydraulic network in the Figuig Oasis is designed to optimize and maximize water usage. Water is sourced from various springs within the oasis, and at junction points, distributors channel the water into primary basins of various *douars* (small clusters of human settlements). From these basins, a network of *seggias* (surface channels) runs throughout the palm grove, delivering water by gravity to the plots needing irrigation. Water is also conveyed via aqueducts when the rugged terrain necessitates it. Besides the natural springs, water is brought into the oasis from external sources through *khattarates* (underground conduits) or *foggaras* (underground galleries capturing runoff) (Smith 2015). This system also includes *ahfires* (rainwater capture pits), where underground cisterns are constructed. The most remarkable feature of this hydraulic system is the use of geothermal energy to maintain water at an optimal temperature year-round, facilitated by the construction of *bahbouha* (subterranean crevices) used for both public and private baths.

^ Fig. 3 The landscape in (left) and outside (right) the Figuig Oasis (Source: Ouafa Messous, 2019).

The optimization of water usage is also evident in agricultural production methods, which maximize the use of space and water, ensuring productivity in an arid environment. The stratification of crops into three levels – date palms, fruit trees and low-growing plants – creates a microclimate that reduces evaporation and protects the lower crops from extreme weather conditions (Harrouchi 2010).

The scarcity of water resources has led to the development of a hydraulic system that makes use of all possible water resources, rationalizes consumption and intensifies usage. Thus, each water resource is used and reused at different stages based on its sacred purity and level of cleanliness: purified water isused for religious tasks like ablutions and is then repurposed for less sacred uses, such as cleaning or irrigation, depending on its condition.

The Geopolitical Challenges of Water Management in Figuig

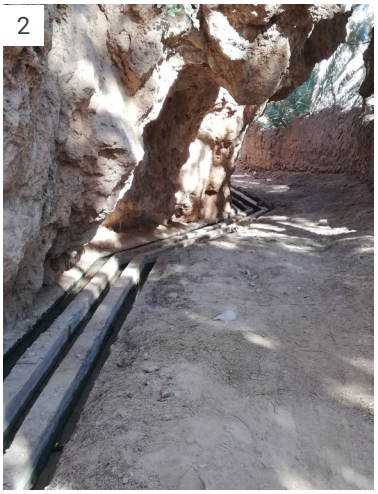
In Figuig, water management, along with the preservation of its traditional network, has reached critical limits, unveiling a set of complex new challenges. One is a duality of local governance: The coexistence of the traditional system and modern approaches to water management reveals a stark contrast in governance, with no carefully considered or gradual transition between the two systems. On the one hand, the local population advocates for the preservation of their hydraulic heritage – despite its vulnerabilities, such as unequal distribution (Amrani 2020), inter-village tensions (Benchekroun 2018) and individual pumping practices. Water was allocated based on agricultural needs and household size to ensure food security. Conflicts arose when access, previously governed by communal rules, shifted to favor status and power, leading to the rise of individualistic practices at the community's expense. On the other hand, the administration promotes standardization to facilitate the control of water as a national resource. This dichotomy has led to escalating political and social tensions. The primary challenge, both locally and regionally, lies in modernizing traditional social structures, institutionalizing them and potentially transforming them into "Public Interest Social Structures." Preserving this heritage also requires upgrading its governance mechanisms, as well as exploring solutions to optimize water use as a vital resource.

Another challenge has been the exacerbation of border tensions. The border between Morocco and Algeria is not merely a political demarcation but also a hydrological divide. The aquifers and springs that supply Figuig are shared between the two countries, making water management even more delicate (Harrouchi 2010). Bilateral water agreements often fall short in preventing disputes, and the political tensions between the two nations further complicate cooperation (Benchekroun 2018). The coordination of water policies is frequently hindered by broader geopolitical considerations, which further complicates the implementation of sustainable solutions (El-Fassi 2015). In this context, water, initially a local concern, has become a national issue, exacerbating already strained relations, even among villages within the same oasis.

> Fig. 4 The hydraulic system in the Figuig Oasis includes many components:

1. Sources supplying the oasis with water; 2. *Seggias* (surface channels; also shown in image 5); 3–4. Storage basins; 5. Hydraulic distribution structures, such as aqueducts (see image 6) or underground canals called *fougga-rates* (see image 9); 6. Aqueducts; 7. *Ahfire*, hollow areas with underground cisterns used to store rainwater for later use; 8. *Bahbouha*, subterranean crevices used for baths; 9. Underground canals (Source: Ouafa Messous, 2019).


1


2


3


4


5


6


7


8


9

Managing the Transition: Challenges and Tensions in Water Governance in Figuig

The late 1990s witnessed the establishment of Agricultural Water Users Associations (AUEAs) as a state initiative and as part of structural adjustment plans. These associations were tasked with representing irrigators to public administrations and organizing water management, with the aim of improving the efficiency and sustainability of irrigation systems (FAO 2019).

The transition to this new form of governance was not without tensions. AUEAs often found themselves in competition with traditional water management structures, particularly the informal arrangements between irrigators and *aiguiadiers*. In some instances, AUEAs were perceived as a way for the state to interfere in local affairs, challenging ancestral practices and institutions.

The construction of a dam near Figuig in 2010, though not yet fully operational, has accelerated the broader socioeconomic and socio-spatial transformations that have been unfolding since the early twentieth century, reshaping the oasis's traditional landscape and its relationship with water despite its conservative character.This project has strengthened the role of AUEAs, which will be responsible for distributing this "new water," but it has also raised concerns about equitable distribution and the impact on traditional practices (Smith 2015). Discussions surrounding the dam's water management have highlighted the challenges of updating water management information and integrating new users (Ministère de l'Agriculture et de la Pêche Maritime 2020).

Conclusion

In the context of water scarcity, the emergence of social, economic and political tensions underscores the urgency of finding new solutions and objectively reassessing the current situation. The example of the Figuig Oasis illustrates that the traditional water management system, which has continually adapted to challenges, deserves to continue evolving. Its integration with modern technologies, such as dew collection for localized irrigation (Hasila 2020; Yang 2024), could further strengthen this system.

The case of Figuig suggests a modern, sustainable framework: Water consumption should be based on actual needs rather than financial capacity, ensuring efficient use of resources and minimizing waste. From this perspective, viewing water as a resource for shared management projects, rather than through the lens of exclusive use, can replace inherent tensions with a societal approach that emphasizes shared benefits – a "win-win" strategy.

Finally, it is important to highlight the triptych – community goals, accepted governance and optimized solutions – demonstrated by the Figuig case. This model encourages intensified water use while clarifying both societal objectives and the principles of sustainable water management. Water use should be tiered within homes, with water being reused based on its cleanliness for tasks like cleaning and irrigation before it is sent to neighborhood and city treatment stations, maximizing efficiency and minimizing waste.

Policy Recommendations

- In adapting to climate change, water management authorities should ensure balanced sustainable development by integrating traditional and modern practices. By enhancing local communities and their governance, geopolitical risks can be reduced.

Acknowledgment
This contribution was peer-reviewed. It was edited by members of the editorial team of the UNESCO Chair Water, Ports and Historic Cities: Carola Hein.

References

Amrani, Souad. 2020. "La Transition de la gouvernance de l'eau à Figuig." In *Gestion Durable des Ressources en Afrique du Nord*, edited by Hicham El Khattabi, 200–20. Tunis: African Studies Publishing.

El-Fassi, Mohamed. 2015. *Figuig: Oasis résiliente aux confins du désert.* Casablanca: Éditions du Maghreb.

Food and Agriculture Organization of the United Nations (FAO). 2019. *Gestion de l'eau en zones arides: Étude de cas de Figuig*. Rome: FAO.

Harrouchi, Nabil. 2010. *Gestion de l'eau et défis environnementaux au Maroc*. Rabat: Université Mohammed V Press.

Jarimi, Hasili, Richard Powell and Saffa Riffat. 2020. "Examen des méthodes durables de collecte des eaux atmosphériques." *Revue internationale des technologies à faible émission de carbone* 15, no. 2: 253–76. https://doi.org/10.1093/ijlct/ctz072.

Lahlou, Youssef. 2017. "Les pratiques traditionnelles de l'irrigation à Figuig." Master's thesis, Université de Casablanca.

Ministère de l'Agriculture et de la Pêche Maritime. 2020. *Rapport sur la gestion de l'eau dans les oasis du Maroc*. Rabat: Ministère de l'Agriculture.

Smith, John. 2015. "Water Management in Moroccan Oases: The Case of Figuig." *Journal of Desert Studies* 15, no. 3: 245–60.

Vallat, Jean-Pierre. 2014. *Le patrimoine Marocain: Figuig, une oasis au cœur des cultures*. Paris: L'Harmattan.

Yang, Kaiije, Tingtin Pan, Nadia Ferhat, Alejandra I. Felix, Rebekah E. Waller, Pei-Ying Hong, Johannes S. Vrouwenvelder, Qiaoqiang Gan and Yu Han. 2024. "A Solar-Driven Atmospheric Water Extractor for Off-Grid Freshwater Generation and Irrigation." *Nature Communications* 15, no. 6260. https://doi.org/10.1038/s41467-024-50715-0.

Dr Ouafa Messous is a lecturer and researcher at the National School of Architecture in Rabat, Morocco. She holds a PhD in urban planning, governance and territories from the National Institute of Urban Planning and Development in Rabat. With expertise in heritage architecture and urban planning, she also earned an advanced diploma in heritage architecture from the École des Hautes Études de Chaillot and a degree in urban and regional planning from Hassan II University. Dr Messous has held various leadership roles at the Ministry of Housing, Urban Planning and Spatial Development and has contributed to numerous urban development master plans across Morocco. Her research and publications focus on water management in oases, urban resilience and the transition to sustainable urban governance.

Contact: o.messous@enarabat.ac.ma, messous.ouafa@gmail.com