

Water and the Making of the Hydro-Social Oasis Landscape in the Touat Region during the Medieval Period: A Historical Perspective on Settlement Dynamics and Saharan Urbanism

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Abstract

This article examines the dialectical relationship between water and settlement in the region of Touat, one of the principal oasis spaces of the central Sahara within the medieval Islamic Maghreb. The study proceeds from the premise that water was not a neutral natural given, but rather a central agent in the production of social and built space through the foggara irrigation system, which allowed heterogeneous human groups to establish stable settlements in an arid environment. The analysis draws on a critical reading of descriptive geographers, on travel accounts as field testimonies, and on Ibn Khaldun's data concerning valleys, water tributaries, urbanization, and the desert economy. The study concludes that the territorial anchoring of settlement in Touat resulted from a complex interaction between hydrological geography, social organization, and trans-Saharan trade networks, warranting the notion of an integrated hydro-social space.

Keywords: Touat, foggara, oasis urbanism, medieval geography, travel literature, Ibn Khaldun, hydro-social space, central Sahara.

ملخص

يسعى هذا المقال إلى مساءلة العلاقة الجدلية بين الماء والعمران في إقليم توات، بوصفه أحد أهم الفضاءات الواحية في الصحراء الوسطى بالمغرب الإسلامي خلال العصر الوسيط. وتنطلق الدراسة من افتراض مفاده أن الماء لم يكن مجرد معطى طبيعى محايد، بل كان فاعلا مركزيا في صناعة المجال الاجتماعى والعمرانى، عبر منظومة الفقارات التي مكّنت من استقرار جماعات بشرية متعددة الأصول في بيئة قاحلة. وتعتمد الدراسة على قراءة نقدية لنصوص الجغرافيين الوصفيين، وعلى المصادر الرحلية باعتبارها شهادات ميدانية، إضافة إلى معطيات ابن خلدون حول الأودية والروافد المائية والعمران والاقتصاد الصحراوي. وتخلص الدراسة إلى أن توطين العمران في توات كان ثمرة تفاعل مركب بين الجغرافيا الهيدرولوجية والتنظيم الاجتماعى والشبكات التجارية العابرة للصحراء، بما يسمح بالحديث عن مجال هيدروسوسىال متكامل. الكلمات المفتاحية: توات، الفقارة، العمران الواحي، الجغرافيا الوسيطة، الرحلة، ابن خلدون، المجال الهيدروسوسىال، الصحراء الوسطى.

Introduction

The Touat region, located in present-day southwestern Algeria within the central Sahara, constitutes a remarkable model of oasis settlement whose emergence and development depended fundamentally on the efficient management of water resources in an environment characterized by scarce rainfall and limited surface water availability. Since the medieval period, Touat has served as a strategic node within the trans-Saharan commercial network linking the Maghreb with the Western Sudan through major caravan centers such as Sijilmasa and Ouargla. This pivotal position attracted the attention of numerous Muslim geographers, travelers, and historians, who documented its environmental, economic, and urban characteristics.

This article addresses the central question of how water, as both a scarce natural resource and a socially governed asset, contributed to the formation of Touat's urban landscape and shaped patterns of human settlement throughout the medieval period. To investigate this issue, the study adopts a cross-disciplinary reading of four categories of historical sources: first, the descriptive geographical writings of medieval scholars, particularly Ibn Ḥawqal and al-Idrīsī; second, travel narratives, including those of Ibn Baṭṭūṭa, Abū Sālim al-ʿAyyāshī, and al-Ḥasan al-Wazzān (Leo Africanus); and third, the historical and socio-economic accounts provided by ʿAbd al-Raḥmān Ibn Khaldūn concerning the valleys, water resources, settlement patterns, and economic life of Touat.

To answer the research question, the study employs a historical-analytical methodology complemented by a spatial approach to the interpretation of medieval Arabic sources. This perspective enables a reassessment of the history of Touat's oasis settlements through the concept of the **hydro-social landscape**, which highlights the dynamic interaction between water resources and social organization, thereby offering deeper insights into the processes of settlement formation and urban development in arid desert environments.

1. The Emergence of Human Settlement in the Touat Oasis System

According to both classical and modern sources, the inhabitants of the Touat region—comprising its three principal sub-regions of Tinjourarine, Central Touat, and Tidikelt—trace their origins to the Getulian (Gaetulian) tribes and their various branches, including the Laḥfāy and the Tuareg, who inhabited North Africa and the interior of the Sahara from an early period, as corroborated by archaeological evidence from the Tassili n'Ajjer and Ahaggar massifs.¹ Subsequently, the region was occupied by Sanhaja, Lamtuna, and Zenata tribes, which transformed these settlements into flourishing oasis communities serving as indispensable stations for trans-Saharan caravans. The oases supplied travelers with water and dates while functioning as strategic gathering points for caravans departing from the Maghreb toward the markets of the Western Sudan.²

During his visit to the region, Leo Africanus (al-Ḥasan ibn Muḥammad al-Wazzān) recorded in *Description of Africa* that the inhabitants of Touat belonged to the Numidian peoples, including the Zenata, Wanzīgha, Ṭawāriq (Tuareg), Lamtā (Lamtuna), and Bardāwa tribes.³ His account

highlights the ethnic diversity of the oasis communities and illustrates the complex demographic composition that characterized the central Sahara at the close of the medieval period.

These tribal groups maintained a predominantly mobile way of life, migrating seasonally in search of pasture and water while relying on scarce surface-water resources. Such environmental constraints rendered permanent settlement highly precarious but simultaneously enabled these communities to acquire an intimate knowledge of the desert landscape and the location of its hidden water resources through generations of continuous exploration and adaptation.⁴ The scarcity of water also limited agricultural production and hindered the development of stable socio-political institutions, compelling communities to move continually in search of water and grazing lands for both themselves and their livestock.⁵

This reality is vividly illustrated by Ibn Baṭṭūṭa in his account of the journey from Takadda to Touat, where he writes:

*"I set out for Touat carrying provisions sufficient for seventy nights, for there is no food to be found between Takadda and Touat."*⁶

This brief yet powerful observation underscores the immense distances separating the Saharan oases and the extreme scarcity of food and water along the route.⁷ It also emphasizes that traversing this inhospitable environment was impossible without careful logistical preparation and substantial supplies. Medieval Touat therefore emerged within a highly mobile and environmentally fragile landscape governed by seasonal movements and continual adaptation. Rather than constituting an empty wilderness, the Sahara functioned as a dynamic geographical space whose repeated exploration enabled its inhabitants to identify, map, and exploit dispersed water sources, thereby laying the environmental foundations for the subsequent establishment of permanent oasis settlements.⁸

2. The Emergence of the Foggara and the Transition to Permanent Settlement

The Foggara constitutes the backbone of oasis civilization in the Touat region of the Central Maghreb, representing an integrated hydraulic engineering system designed to extract groundwater and convey it through underground galleries operating by means of a gentle gravitational gradient.⁹ Rooted in the ancient Persian qanat tradition, this technology was far more than a simple irrigation technique; it was an effective mechanism for adapting to the harsh desert environment and for creating stable agricultural and urban landscapes capable of sustaining permanent human settlement.¹⁰

The question of how the Foggara reached the Touat region remains the subject of scholarly debate. Contemporary geographers and historians generally identify the diffusion of this hydraulic technology through the settlement of the Zenata tribes during the fourth century AH (tenth century CE) and the subsequent migration of Coptic settlers from Egypt during the late fourth and early fifth centuries AH (tenth–eleventh centuries CE). These migrants are traditionally credited with establishing some of the earliest foggaras in the oasis of Tamentit, including the renowned Hennou Foggara.¹¹

Although some historians attribute the earliest hydraulic works to ancient Coptic or Jewish communities, the prevailing scholarly interpretation maintains that the large-scale expansion and technical refinement of the Foggara system accompanied the arrival of the Zenata tribes and the migration of Coptic settlers from Egypt, who introduced accumulated eastern expertise in groundwater exploration and subterranean hydraulic engineering.¹² Local historical traditions further associate the institutional development of this hydraulic system with prominent figures such as King al-Manṣūr ibn Yūsuf al-Qurashī, who is said to have supervised the construction and organization of numerous underground water channels during the eleventh and twelfth centuries CE.¹³

The Foggara system attracted considerable attention in the writings of medieval travelers and geographers. In *Kitāb al-ʿIbar*, Ibn Khaldūn described it as "a remarkable method for deriving flowing water," emphasizing that it constituted a distinctive hydraulic technology unique to the fortified oasis settlements (*ksour*) of the Sahara and unlike those found elsewhere in the Maghreb.¹⁴ His account provides a remarkably accurate description of the excavation of vertical shafts connected by underground galleries that intercepted groundwater and conveyed it to cultivated lands solely through gravitational flow.¹⁵

Ultimately, the Foggara in Touat transcended its purely technical function to become a genuine social contract binding together the inhabitants of the oasis communities. Rights to water ownership were directly linked to the labor invested in excavation, maintenance, and collective management, thereby giving rise to an elaborate body of customary legislation regulating water rights and communal obligations. The manuscript collections preserved in the libraries of Adrar continue to safeguard extensive records of these customary regulations and the associated juridical cases (*nawāzil*), which constitute invaluable historical evidence for understanding the legal, social, and institutional organization of Touat oasis society.¹⁶

3. Engineering and Technical Characteristics of the Foggara System

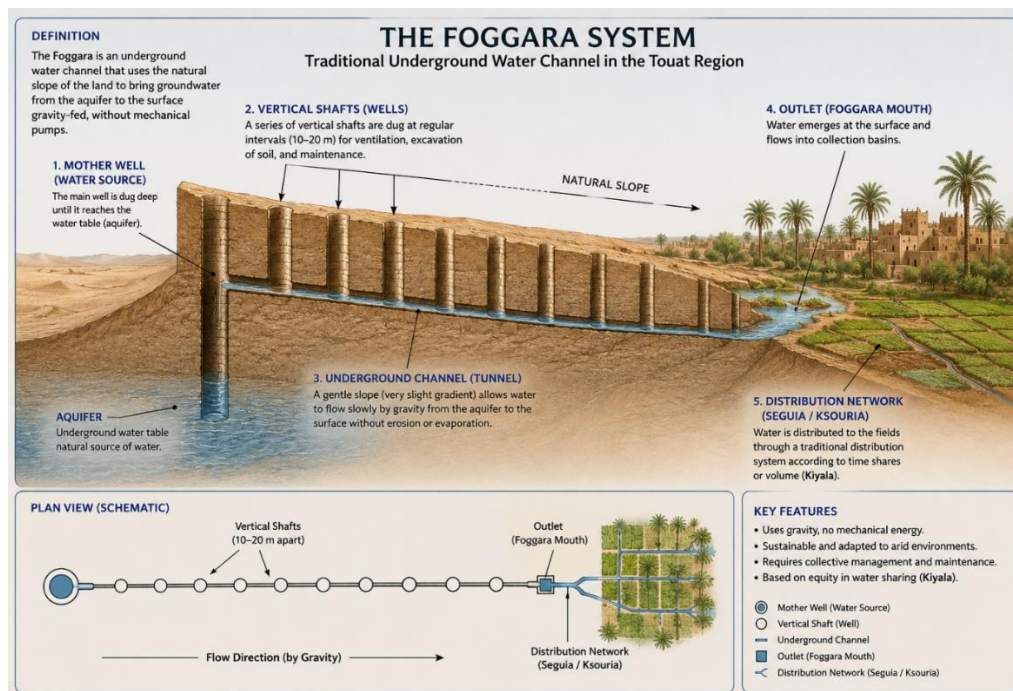
From an engineering perspective, the Foggara operates according to the principle of gravity-fed hydraulic flow, conveying groundwater from the aquifer (or groundwater reservoir) to cultivated lands without the need for mechanical energy or pumping devices.¹⁷ The structural configuration of the Foggara consists of three principal components:

Vertical Shafts. The system begins with a mother well, located at the upstream end of the Foggara and extending to a depth greater than that of the remaining shafts. Owing to its greater depth, this well intercepts the groundwater table and provides the hydraulic head required to initiate water flow.¹⁸ From this point, a series of vertical shafts are excavated at regular intervals, generally ranging from 10 to 20 meters apart.¹⁹ Each shaft is positioned at a slightly lower elevation than the preceding one, creating a gentle gradient that allows water to flow naturally through the underground galleries connecting the shafts. Water thus moves continuously from the upper sections of the system toward the lower ones until it reaches the distribution basin. In addition to their hydraulic function, these shafts provide ventilation for the

underground tunnel, facilitate maintenance operations, and enable the removal of excavated soil and accumulated sediments.²⁰

The Underground Gallery (Water Conveyance Tunnel). The underground gallery constitutes the principal conduit linking the bases of the vertical shafts. It is constructed with an extremely precise and uniform gradient that permits the slow and continuous movement of water while minimizing soil erosion and reducing water losses through evaporation.²¹ Depending on local geological conditions and the depth of the groundwater table, the gallery may be excavated at depths ranging from approximately two meters to more than ten meters below the surface. Throughout its entire course, the tunnel maintains a constant slope, ensuring an uninterrupted and regulated flow of groundwater toward the cultivated oasis lands.²²

The Foggara Outlet and Water Distribution Network. At the downstream end of the system, the conveyed groundwater emerges at the surface and is directed into a series of collection basins before entering the Qasriyyah, the traditional hydraulic distribution structure specifically designed to allocate water among shareholders.²³ Within this distribution network, water is divided with remarkable precision according to an established customary system, ensuring that each beneficiary receives his legally recognized share in accordance with inherited water rights and locally accepted regulations governing the management of the Foggara.²⁴



4. The *Kayyāla* System and the Socio-Hydraulic Organization of Water Distribution

One of the most distinctive features of the Foggara system is its integrated technical and social mechanism of water allocation, commonly known as the *Kayyāla*. Through this system, water is

distributed according to precisely defined temporal or volumetric shares among the beneficiaries. Distribution is carried out using a device known as the Qasriyyah, a stone or clay water-divider perforated with outlets of varying diameters, which regulates the flow delivered to each shareholder in proportion to his contribution to the excavation, maintenance, or ownership of the Foggara.²⁵

Water rights are measured through a sophisticated system of indigenous units, the smallest and most fundamental of which is the ḥabba ("grain"), from which progressively smaller fractional units are derived. The measurement process is supervised by a specialized official known as the Kayyāl (water measurer), who employs traditional measuring instruments and long-established practical methods. Rather than relying exclusively on abstract mathematical calculations, this allocation system is founded upon collective consensus, customary law, and generations of accumulated technical expertise, thereby ensuring fairness and maintaining social equilibrium among the shareholders.²⁶

The close integration of hydraulic engineering with social organization transformed the Foggara into a remarkably sustainable socio-ecological system that maintained environmental balance in the Touat oases for more than a millennium. Its longevity reflects not only the technical ingenuity of the system but also the effectiveness of its communal governance and customary legal institutions. Owing to its outstanding cultural and technological significance, the Foggara is today widely recognized as an important component of the world's traditional hydraulic heritage and has been acknowledged within UNESCO's Representative List of the Intangible Cultural Heritage of Humanity for safeguarding the knowledge and skills of the Kayyāls of Touat and Gourara.²⁷

From this perspective, the Foggara of Touat may be understood as an example of a community-based hydro-social governance system, in which water management is inseparable from collective decision-making and customary legal authority. The administration of the Foggara is entrusted to the Jamā'a (community council), an assembly composed of village elders and principal landowners responsible for supervising water allocation, organizing maintenance operations, resolving disputes, and ensuring adherence to inherited water customs. This collective institutional framework played a fundamental role in minimizing conflicts while reinforcing solidarity, mutual responsibility, and social cohesion within the oasis community. Consequently, water was perceived not merely as a natural resource but as the foundation of a sophisticated socio-legal order that regulated both economic production and communal life.²⁸

This institutional organization rests upon four principal structural pillars.

4.1. The *Zammām*: The Legal Register and Accounting Memory

The *Zammām* constitutes the highest legal document governing ownership rights within the Foggara system. More than a simple register of names, it provides a meticulous record of individual water entitlements, inheritance shares, and proprietary divisions. Local documentary sources indicate that the *Zammām* enjoyed legal authority comparable to that of formal contracts

and served as the principal documentary evidence in both customary and Islamic judicial proceedings concerning water rights.^{^29}

Historical records further demonstrate the close relationship between land ownership and water allocation. For example, the transfer of ownership of a single date palm within the oases of Adrar required the corresponding water entitlement to be amended in the Zammām, thereby ensuring that water rights remained inseparable from agricultural land and preventing the concentration of hydraulic wealth independently of productive property.^{^30}

4.2. The Jamā'a: Collective Administration and Specialized Technical Functions

The administration of the Foggara is entrusted to an institution known as the Jamā'a, a representative council composed of shareholders and leading landowners that functions as the governing body of the hydraulic network. Beyond its administrative responsibilities, the council appoints specialized technical personnel responsible for the daily management and regulation of water distribution.^{^31}

Among the principal officials are:

- **The Kayyāl (Water Measurer):** the technical expert responsible for calculating and allocating water shares through traditional timing techniques, employing instruments such as the water clock (*sa'at al-mā'*) or the *rahā* to regulate hydraulic flow with remarkable precision.
- **The Ḥassāb (Water Accountant):** the official charged with verifying that the actual water discharge corresponds exactly to the allocations recorded in the **Zammām**, thereby guaranteeing the integrity of the distribution system.
- **The Waqqāf (Canal Supervisor):** the inspector responsible for monitoring irrigation channels and ensuring that water reaches the *jinān* (orchards and cultivated gardens) according to the established schedule and customary regulations.^{^32}

5. Touat in Medieval Descriptive Geography: Ibn Ḥawqal and al-Idrīsī

Ibn Ḥawqal was among the earliest Muslim geographers to document the Saharan corridor linking the Maghreb with the Western Sudan. In his description of the caravan routes extending southward from Sijilmāsa, he emphasized the strategic importance of the scattered oasis settlements that served as indispensable stations where trans-Saharan caravans replenished their supplies of water and provisions before continuing their journey across the desert.^{^33} Although Ibn Ḥawqal did not devote a separate and detailed account to Touat comparable to those found in later sources, his observations constitute one of the earliest foundations of the medieval Islamic geographical conception of this Saharan region.

A more comprehensive description was provided by al-Sharīf al-Idrīsī in his *Nuzhat al-Mushtāq fī Ikhtirāq al-Āfāq* (*The Pleasure Excursion of One Who Longs to Traverse the Horizons*). His account offers a detailed portrayal of the routes crossing the Central Sahara, emphasizing the crucial role of oasis settlements in structuring patterns of mobility and human habitation. Al-Idrīsī explicitly associated the availability of water with the emergence and permanence of settlements distributed along valleys and desert depressions.^{^34} His observations reveal an early

geographical awareness of the intrinsic relationship between water availability and human occupation, demonstrating that permanent settlement in the Sahara could only develop in proximity to reliable water sources, whether seasonal wadis, perennial springs, or groundwater captured through Foggara systems.

Taken together, the writings of these descriptive geographers consistently portray Touat not as an isolated desert enclave but as an integral component of a broader geo-economic network linking the northern Maghreb with the Western Sudan across the Sahara.³⁵ This interconnected position explains the prominent attention accorded to the region in medieval geographical literature, particularly in the *Books of Routes and Kingdoms* (*Kutub al-Masālik wa al-Mamālik*), where Touat was recognized as an indispensable staging post along the trans-Saharan commercial routes transporting gold, salt, enslaved persons, and other commodities between North and sub-Saharan Africa.³⁶

6. Touat Through the Eyes of Medieval and Early Modern Travelers: Ibn Baṭṭūṭa, al-ʿAyyāshī, and Leo Africanus

Travel literature constitutes an essential complement to medieval descriptive geography, offering first-hand observations that often approach an ethnographic account of the societies and landscapes encountered. In his narrative of the journey from Sijilmāsa to the Western Sudan, Ibn Baṭṭūṭa refers to the Saharan caravan route passing through Touat, emphasizing the extreme difficulty of desert travel, the strategic importance of locating reliable water sources, and the indispensable role of experienced guides possessing intimate knowledge of the desert tracks.³⁷ His account demonstrates that access to water was the decisive factor governing both the selection of caravan routes and the timing of departures, thereby underscoring the centrality of hydraulic resources in the organization of trans-Saharan mobility.

During his visit to the ksar of Būda in 1353 CE, Ibn Baṭṭūṭa recorded one of the earliest eyewitness descriptions of Touat, praising the abundance of springs and water resources that sustained extensive palm groves.³⁸ Although his stay in the region was relatively brief and confined mainly to the oases of Būda and Tsābit, his observations were shaped by the arrival of refugees from the Banū ʿAbd al-Wād (Zayyanids), who had fled the fall of Tlemcen to the Marinid Sultan in 753 AH/1352 CE. His narrative focuses primarily on the geographical and economic dimensions of oasis life, describing local food production, agricultural practices, the consumption of locusts during periods of scarcity, and identifying several tribal groups that had settled in Touat together with the historical circumstances that prompted their migration.³⁹

While Ibn Baṭṭūṭa's references to Touat remain relatively concise, the travel account of Abū Sālim al-ʿAyyāshī, entitled *Māʾ al-Mawāʾid*, offers a far more detailed description of Touat and Gourara during the eleventh century AH (seventeenth century CE).⁴⁰ Although composed after the medieval period, this work preserves valuable observations on the enduring characteristics of oasis society. Al-ʿAyyāshī describes the spatial distribution of ksour (fortified villages), agricultural settlements, and patterns of everyday life, while highlighting the central economic importance of date palm cultivation. He also presents one of the most detailed historical accounts

of the Foggara system, identifying it as the foundation of oasis life and providing an impressive description of the precision with which water was allocated. His observations specifically refer to the Kayyāl (water measurer) and the Qasriyyah (water distribution chamber) as institutional mechanisms ensuring the equitable allocation of water rights among shareholders according to firmly established customary regulations.⁴¹

Beyond its hydraulic significance, al-‘Ayyāshī’s narrative illustrates the prosperity generated by Touat’s participation in the trans-Saharan commercial network. He notes the abundance of merchandise arriving from the Western Sudan, particularly gold and other valuable commodities, and emphasizes that the region functioned as a major provisioning center where pilgrims and commercial caravans replenished their supplies before continuing their journeys across the Sahara.⁴² Consequently, despite its later date, his travel account represents the continuation of a long descriptive tradition documenting the remarkable continuity of the oasis urban system founded upon the sustainable management of water resources.

Equally valuable is the testimony of al-Ḥasan ibn Muḥammad al-Wazzān, better known in Europe as Leo Africanus, whose *Description of Africa* records his visit to the Tinjourarine (Gourara) region in 1511 CE.⁴³ His account provides important information concerning the organization of Saharan societies and the management of water resources. He describes the oasis communities as being organized along tribal and kinship lines, with both land ownership and water rights regulated according to customary social arrangements. Leo Africanus further highlights the complex interactions between sedentary oasis inhabitants and nomadic pastoral groups occupying the surrounding desert margins.

He characterizes the region as a densely inhabited part of Numidian Sahara, containing approximately fifty fortified ksour and more than one hundred villages surrounded by extensive palm groves.⁴⁴ According to his observations, agriculture depended primarily upon groundwater extracted from wells, while the naturally poor fertility of desert soils encouraged local inhabitants to extend generous hospitality to travelers, partly because the organic waste left by visitors and their animals served as an important source of fertilizer for cultivated fields. He also portrays the inhabitants as prosperous merchants whose wealth derived largely from their commercial activities with the kingdoms of the Western Sudan.⁴⁵

Taken together, the testimonies of Ibn Baṭṭūṭa, al-‘Ayyāshī, and Leo Africanus demonstrate that human settlement throughout the three oasis clusters of the Touat region was neither static nor predetermined. Rather, it evolved through a dynamic process shaped by the continuous interaction between water availability, communal institutions governing hydraulic resources, and the fluctuating rhythms of trans-Saharan caravan trade. Their accounts collectively reveal that the sustainability and prosperity of Touat were fundamentally rooted in the close integration of environmental adaptation, hydraulic engineering, and social organization.⁴⁶

7. Ibn Khaldūn on Valleys, Water Resources, Urban Development, and the Economy of Touat

Among the sources examined in this study, 'Abd al-Raḥmān Ibn Khaldūn (d. 808 AH/1406 CE) occupies a distinctive position. Unlike the descriptive geographers or travel writers, Ibn Khaldūn approached the Sahara as both a historian and a social theorist, interpreting the relationship between natural resources and the formation of both nomadic and sedentary societies. His observations therefore transcend geographical description, offering a broader analysis of the environmental foundations of human settlement and economic life in the central Sahara.⁴⁰

In *Kitāb al-'Ibar*, while describing the geography of the Saharan regions and the territories inhabited by Berber tribes, Ibn Khaldūn refers to a major river system originating from the western mountains and extending across the desert toward Touat. He writes:

*"From this river emerges the source of a great stream flowing southward, inclining slightly eastward, until it reaches Būda and then Tamentit. In our time it is known as Qīr. Along its course stand numerous ksour (fortified villages), until it disappears into the desert sands. At the point where its waters vanish lies the oasis of Reggane, renowned for its palm groves. East of Būda, beyond the Erg, are the ksour of Tsābit, and farther east lie the ksour of Tinjourarine, extending for more than three hundred settlements along a single valley inhabited by various Zenata communities."*⁴¹

Elsewhere, while discussing the hydrography of southern Morocco and the Sahara, he further observes:

*"As for the Draa, it lies deep in the southern lands within the great valley descending from Mount Deren... Another great valley flows southward with a slight easterly inclination until it disappears into the sands south of Tinjourarine, and on its western bank lie the ksour of Touat."*⁴²

These passages reveal Ibn Khaldūn's sophisticated understanding of the intimate relationship between fluvial systems and oasis settlement. Rather than presenting the Sahara as an entirely barren landscape, he identifies valleys and ancient drainage networks as the environmental framework within which stable human communities emerged. Fertile depressions nourished by seasonal or fossil watercourses provided the physical conditions necessary for the establishment of permanent settlements within an otherwise mobile pastoral environment.⁴³

According to Ibn Khaldūn, the physical geography of the region was dominated by ḥamāda (rocky desert plateaus) and extensive sand seas, reflecting Touat's location within the African Sahara. Nevertheless, this harsh environment was intersected by several major valleys, including Wādī Saoura, Wādī Mas'ūd, and Wādī Amqīdin, along whose margins numerous *ksour* were established. Describing this landscape, he states:

"The towns and districts of this region extend across sandy plains south of the Great Western Erg and around the Tadmait Plateau. In the southern part of the Central Maghreb there is a stony land known among the Arabs as the Ḥamāda, stretching toward the land of Rīgh. Beyond it lie

*oasis settlements endowed with palm groves and a limited number of watercourses, among them Būda, Tamentit, and Tinjourarine."*⁴⁴

This description demonstrates that Ibn Khaldūn conceived Touat not as a single locality but as a vast regional system composed of multiple districts and urban centers extending across the southern Maghreb. The distribution of settlements along valley corridors reflects his recognition that the region's urban geography was fundamentally conditioned by access to water and fertile land.⁴⁵

A similar observation appears in the manuscript of Muḥammad ibn ʿUmar al-Badāwī, who remarks:

*"Touat consists of numerous ksour situated along the banks of a great valley descending from the western lands."*⁴⁶

This valley is commonly identified with the ancient Moulouya drainage system. From both historical descriptions and contemporary geomorphological evidence, Touat may therefore be understood as occupying an extensive paleohydrological basin nourished in the distant past by interconnected surface watercourses. The widespread occurrence of ḥamāda, sabkhas (salt flats), and fossil valleys across the region suggests that these ancient rivers and lakes gradually disappeared under the combined effects of climatic aridification and rising temperatures, with much of their water infiltrating underground aquifers. The remarkable freshness of Touat's groundwater may thus reflect its long-term recharge from prehistoric fluvial systems and episodic rainfall events.⁴⁷

The significance of Ibn Khaldūn's analysis lies precisely in its movement beyond purely topographical description toward an integrated interpretation of the relationships linking environment, society, and economic organization. He explicitly associates the permanence of oasis settlements with the necessity of collective cooperation in managing water resources and maintaining irrigation systems. The oasis consequently emerges not merely as an agricultural landscape but as a hydro-social space, where kinship networks, customary institutions, and collective labor converged to ensure the sustainable management of scarce water resources.⁴⁸

Ibn Khaldūn also highlights the economic importance of these oasis settlements within the trans-Saharan commercial network. He portrays them as indispensable stations linking the Maghreb with the kingdoms of the Western Sudan through the exchange of gold, agricultural produce, and other commodities. Touat therefore fulfilled a dual historical function: on the one hand, it was a productive agricultural oasis sustained by sophisticated hydraulic infrastructure; on the other, it served as a strategic commercial crossroads connecting North and sub-Saharan Africa. In this respect, the historical experience of Touat closely illustrates Ibn Khaldūn's broader theory that the regular availability and collective management of water constitute indispensable prerequisites for the flourishing of human settlement in arid environments, whereas the disruption of hydraulic resources inevitably leads to social decline, demographic contraction, and the disintegration of organized civilization.⁴⁹

8. Water and the Hydro-Social Landscape: The Foggara as a Mechanism of Settlement Formation and Oasis Urbanism

Building upon the foregoing discussion, the concept of the hydro-social landscape may be employed as an analytical framework for understanding the dynamics of human settlement in the Touat region. Within this perspective, water is not viewed merely as an external natural resource but rather as a socially constructed asset that shapes relations of ownership, hierarchy, cooperation, and collective identity. The Foggara, an underground hydraulic system that conveys groundwater through gravity-fed galleries without mechanical pumping, constituted the key technological innovation that made permanent settlement possible in an environment characterized by extremely limited rainfall.⁵⁰ The excavation, maintenance, and operation of a Foggara required long-term collective mobilization and the establishment of carefully regulated rights governing water use among families, lineages, and tribal groups. Consequently, the Foggara functioned not only as an engineering achievement but also as a tangible expression of the social organization upon which oasis life depended.⁵¹

8.1. Maintenance and Tawīza: Technical Solidarity and Collective Responsibility

The maintenance of the Foggara represented a continuous communal obligation aimed at protecting underground galleries from collapse, sand encroachment, and sediment accumulation. The legal opinions (*fatāwā*) issued by the eminent jurist Muḥammad ibn ‘Abd al-Karīm al-Maghīlī (d. 909 AH/1504 CE), together with those of other scholars from the Touat region, consistently emphasize the primacy of the public interest in safeguarding hydraulic infrastructure. Judges were therefore empowered to compel negligent shareholders to participate in maintenance activities or, where necessary, to exclude them from the partnership in order to preserve the integrity of the Foggara.⁵²

Each shareholder was required to contribute to maintenance expenses in proportion to his legal water entitlement. This obligation was justified not only by customary practice but also by principles of Islamic jurisprudence, according to which the preservation of water resources constitutes a legitimate objective of the Sharī‘a. Likewise, the juristic maxim "There shall be neither harm nor reciprocating harm" (*lā ḍarar wa lā dirār*) prohibited any negligence that might interrupt the flow of water or endanger the rights of other beneficiaries. Local juridical cases from Gourara and Tidikelt clearly demonstrate that the failure of a single participant to fulfill these responsibilities could jeopardize the functioning of the entire hydraulic network.⁵³

Within this context, the institution of Tawīza (collective voluntary labor) emerged as one of the most significant manifestations of social solidarity in Touat. Participation in Tawīza transcended distinctions of wealth, age, gender, or ownership of water rights. Whenever the Foggara was threatened by collapse or obstruction, all members of the oasis community were expected to contribute according to their abilities. Men undertook excavation and repair work, those with financial means provided material support, while women prepared food and provisions for the workforce. This collective mobilization, reinforced by strong religious values and a deeply rooted sense of communal responsibility, transformed the maintenance of the Foggara into a moral

obligation and endowed the preservation of water resources with a profound ethical and cultural significance. The remarkable resilience of Touat's hydraulic system over many centuries owes much to this institutionalized culture of cooperation and mutual assistance.⁵⁴



8.2. Customary Water Law and Its Juridical Foundations

Unlike most modern hydraulic systems, the legitimacy of the Foggara was founded primarily upon customary law (*urf*), subsequently endorsed and refined by successive generations of Mālikī jurists. Local juridical manuscripts contain detailed regulations concerning the right of pre-emption (*shuf'a*) in water ownership and the protected zone surrounding a Foggara (*ḥarīm al-foggara*), within which the excavation of new wells was prohibited in order to prevent the depletion of existing groundwater supplies.⁵⁵

These juridical texts demonstrate that questions of maintenance, ownership, and water allocation were addressed through locally developed legal opinions that adapted the principles of Islamic jurisprudence to the environmental realities of the Saharan oases. Field research conducted by Robles further suggests that these customary regulations became deeply embedded in everyday social behavior, evolving into what may appropriately be described as a moral code that discouraged any infringement upon the legitimate water rights of neighboring shareholders.⁵⁶

8.3. Regional Variations within a Shared Hydraulic Tradition

Although the fundamental principles governing the Foggara remained largely uniform throughout the Touat region, the environmental and geographical characteristics of each oasis cluster produced distinctive local adaptations. In Tamentit, the Foggara became the foundation for a densely populated center of scholarship, agriculture, and urban development. In Gourara, its organization reflected the high density of fortified ksour and the large number of shareholders participating in each hydraulic network. In Tidikelt, where groundwater resources were more fragile and settlements more dispersed, the Foggara represented an indispensable instrument for sustaining human occupation across an extensive and environmentally vulnerable landscape.⁵⁷

The local juridical corpus (*nawāzil*) constitutes an invaluable documentary source for reconstructing the historical operation of this hydraulic system. These legal texts record disputes over water rights, define the scope of judicial intervention, and illustrate the interaction between customary law and Mālikī jurisprudence. Consequently, they provide an exceptional analytical framework for understanding the institutional foundations of long-term social and economic stability within the oasis communities of Touat.⁵⁸

8.4. Oasis Urbanism and the Hydro-Social Landscape

The institutional framework surrounding the Foggara ultimately generated a distinctive form of oasis urbanism characterized by the construction of fortified ksour—compact, walled settlements organized around hydraulic axes and extensive date-palm groves. This urban morphology reflects a continuous concern for safeguarding both water resources and agricultural production within a frontier environment shared by sedentary agricultural communities and mobile pastoral populations.⁵⁹

At the same time, the trans-Saharan caravan routes significantly reinforced the process of permanent settlement by assigning the oases an additional commercial function as centers of provisioning, exchange, and redistribution. This economic role attracted diverse social groups, including merchants, artisans, scholars, and religious figures. Among the most influential commercial actors were the Ibādī merchant networks, which connected Ouargla with Touat through highly organized trans-Saharan trade routes, thereby integrating the oasis region into wider commercial and intellectual networks spanning North and sub-Saharan Africa.⁶⁰

Taken together, these observations demonstrate that the formation of the oasis landscape in Touat cannot be explained solely by environmental conditions. Rather, it emerged through the complex interaction of hydrological geography, the engineering sophistication of the Foggara system, tribal and communal institutions, customary legal traditions, and integration into trans-Saharan commercial networks. Touat therefore represents an outstanding historical example of hydro-social urbanism, illustrating how environmental adaptation, hydraulic technology, and collective social organization converged to produce a resilient and sustainable model of settlement in the central Sahara during the medieval period



This study demonstrates that water in the Touat region was far more than a natural resource to which human communities merely adapted. Throughout the medieval period, it functioned as a fundamental force in shaping the social, urban, and economic landscape of this Saharan oasis system. The writings of the descriptive geographers, particularly Ibn Ḥawqal and al-Idrīsī, established the earliest geographical representations of Touat within the wider network of trans-Saharan routes. In turn, the travel accounts of Ibn Baṭṭūṭa, al-ʿAyyāshī, and Leo Africanus provide invaluable first-hand observations on everyday life in the oasis communities, offering detailed insights into local practices of water management and the organization of settlement. By contrast, the analytical approach developed by Ibn Khaldūn contributes a broader interpretative framework by linking urban development, social cohesion (*ʿaṣabiyyah*), and economic organization. His perspective makes it possible to understand the Foggara not simply as a hydraulic engineering system but as a hydro-social institution that regulated settlement, property rights, collective solidarity, and the sustainable governance of water resources.

Equally significant was the contribution of the Mālikī juridical tradition, particularly the corpus of local *nawāzil* (legal opinions), through which regional jurists established legal mechanisms safeguarding water rights, regulating maintenance obligations, and ensuring equitable distribution among members of the oasis communities. Together, the Foggara, customary institutions, and Islamic legal principles produced an integrated hydro-social governance system that harmonized environmental constraints with the social, economic, and legal requirements of life in the Touat region.

The findings of this study also open several promising avenues for future research. First, the Touat Foggara represents a valuable historical model of sustainable groundwater management whose underlying principles may inform contemporary strategies for water governance in arid environments. Second, further comparative investigations should examine Touat alongside other

historic qanat traditions, particularly those of Iran, Egypt, and the oasis regions of the central Sahara, including Touggourt, Ouargla, and the Saoura Valley, in order to identify both shared hydraulic traditions and locally distinctive adaptations. Finally, greater attention should be devoted to unpublished archival materials—especially local juridical manuscripts, customary legal records, and contracts relating to water rights—as these sources offer exceptional potential for reconstructing a more comprehensive social history of this unique hydro-social landscape and for deepening our understanding of the institutional foundations that sustained oasis civilization in the medieval Sahara

I. Footnotes

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