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**The Heritage of Hydraulic Engineering in Algeria: Between Historical
Investigation and Archaeological Inquiry –
A Case Study**

تراث الهندسة الهيدروليكية في الجزائر: بين البحث التاريخي والأثري - دراسة حالة

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Abstract:

This paper examines the heritage of hydraulic engineering in Algeria through an approach that combines historical investigation and archaeological inquiry. The study aims to highlight the development of hydraulic structures during the ancient and medieval periods and their influence on shaping the urban fabric and economic structure of Algerian society. Relying on the analysis of historical sources and geographical documents, the study emphasizes the widespread presence of sophisticated hydraulic structures, particularly watermills. Employing a comparative approach, the paper investigates various historical and archaeological evidence to underscore the innovative features of traditional water engineering in Algeria. Additionally, this paper documents the remaining material evidence to ensure the preservation of this unique engineering heritage.

Keywords: Hydraulic structures, Historical investigation, field inquiry, hydraulic Heritage, urban infrastructure.

المخلص

تناول هذه الورقة البحثية تراث الهندسة المائية في الجزائر من خلال منهج يجمع بين البحث التاريخي والأثري. وتهدف الدراسة إلى تسليط الضوء على تطور المنشآت المائية خلال العصور القديمة والوسطى، وتأثيرها في تشكيل النسيج العمراني والبنية الاقتصادية للمجتمع الجزائري. وبالاعتماد على تحليل المصادر التاريخية والوثائق الجغرافية، تؤكد الدراسة على الانتشار الواسع للمنشآت المائية المتطورة، ولا سيما طواحين المياه. وباستخدام منهج مقارنة، تبحث الورقة في أدلة تاريخية وأثرية متنوعة لتسليط الضوء على السمات المبتكرة للهندسة المائية التقليدية في الجزائر، إضافةً إلى ذلك، توثق هذه الورقة الأدلة المادية المتبقية لضمان الحفاظ على هذا التراث الهندسي الفريد.

الكلمات المفتاحية: المنشآت الهيدروليكية، البحث التاريخي، الاستقصاء الميداني، التراث الهيدروليكي، البنية التحتية الحضرية.

1. INTRODUCTION

Using renewable energy for human benefit is not a new concept. Thus, in historical eras, living conditions made it necessary to harness the available energy resources in nature and adapt them to meet certain needs. Water and air were the most important resources for humans because they were considered key sources of energy, according to the technological capacities of those eras.

In this context, Muslim scientists have excelled in the field of mechanical engineering. This field featured prominent names such as Ibn Moussa, al-Jazarī, Taqī al-Dīn, and others who devoted their efforts to developing this science and employing its techniques in various industrial fields. Most

notably, watermills have undergone significant development, with Muslim scholars working diligently to innovate advanced types, thus achieving an important scientific and technological milestone.

The scientists' interest and their innovation did not come from the simple need to respond to operational needs only. Rather, it stemmed from a high level of scientific knowledge that contributed to the development of watermill technologies in an innovative and advanced manner.

It is worth noting that researching watermill technologies places the researcher before a delicate subject that requires an extensive study of source material, both written and archaeological; the widespread presence of these facilities in medieval

Maghreb cities is linked to a set of environmental and economic conditions, including an abundance of water, suitable topographical features, and their connection to local agricultural practices.

Research on watermills during the Islamic era is particularly important. These facilities represent a unique example of advanced engineering techniques that contributed to the economic and social development of the region. Additionally, these mills exemplify the exploitation of natural resources within an ecological balance, making the study of their history and technology a cognitive and academic necessity. Moreover, the scarcity of comprehensive studies combining historical, archaeological, technical, and social aspects further incentivizes this research.

This study is motivated by the primary research problem, which aims to address the following question: **To what extent did watermills influence the scientific and technological heritage of Islamic Algeria, and in what ways can this heritage be documented through analysis of surviving archaeological remains and written**

2.

A watermill is a traditional machine that transforms the energy of running water into mechanical energy. The primary

¹. These mills were often built on the banks of rivers and streams, employing precise engineering techniques to regulate water flow and ensure continuous operation. Watermills represent an early embodiment of the concept of the sustainable exploitation of natural resources. The mills used during the Islamic period confirm this, as they were employed for multiple purposes within an economic and environmental logic that is still relevant to contemporary resource management policies.

3. History of the Discovery and Classification of Watermill Types

Historical and archaeological research indicates that the earliest known models of watermills appeared in ancient Greece during the third century BC². This prototype

sources? In light of this, the study aims to document the technical and architectural characteristics of watermills in Islamic Algeria and analyze the factors that contributed to the spread of these facilities and the reasons for their subsequent decline. Additionally, the study highlights the economic and social roles of watermills in Algerian societies during the period under study.

To achieve these goals, the research employs an integrated historical and archaeological approach. This approach combines the study of written sources, such as travelers' and geographers' books, as well as Hisbah documents. It also involves analyzing field archaeological evidence in multiple regions of Algeria, including Tlemcen, the High Plateaus, Miliana, Mitidja, Kabylie, Djelfa, and Barika. In addition, the study draws on various references and the archaeological evidence of water installations in different locations, as well as previous studies on Islamic engineering techniques and watermills in the Islamic Maghreb.

1. Definition of Watermills: function of this mill is the grinding of grain; however, it is also utilized in a variety of craft activities, including blacksmithing, woodworking, and papermaking

constitutes the first practical documentation of using running water to rotate the millstone, representing an important technological shift toward harnessing natural energy for mechanical purposes.

In the Mediterranean, in particular in the western region including North Africa, the use of watermills developed clearly during the Roman period, beginning in the first century BC³, due to the spread of Roman agricultural and engineering works, including irrigation canals and mills, in many areas that today form part of Algeria.

In this region, watermills are an integral part of the technical and agricultural heritage. Archaeological remains found in several areas, such as the High Plateaus and northern regions, indicate that this

technology spread during the Roman period and continued to be used as part of traditional irrigation systems and natural resource management in later periods.

3. Historical and Archaeological Documentation of Watermills in Algeria

1.3. Historical Evidence:

Different regions in Algeria are home

to numerous watermills. The following list comprises historical evidence of mills that were in operation during the medieval Islamic era. The list is based on available historical sources and presented in tabular form. Each entry includes the city, the historical source, the period, and the cited historical text.

Table 1: Historical evidence of watermills known in the medieval Islamic era (by the author)

The city	The historical source	The period	The cited historical text
Meliana	⁴ Ibn Hawkal	4AH/10CE	"... An ancient city with mills on its river, irrigating much of its valley, and it has a share of the Chlef River..."p89.
	Abu Ubayd al-Bakri ⁵	5AH/11CE	"...a Roman city with ruins, trees, and rivers where mills grind..." p61.
	Al-Idrisi ⁶	6AH/12CE	"...It has a river that irrigates most of its gardens... and has mills on it..."p253
	Author of al-Istibṣar ⁷	6AH/12CE	"...It is a fortified city at the foot of a mountain called Nakar...from this mountain flows a great spring, so powerful that mills grind on it..." p171.
	Al-Hamiri ⁸	7AH/13CE	"...It has trees and rivers where mills grind"p547. "...Its river irrigates most of its farms and gardens, and it has mills on its river."p547.
Tlemcen	⁹ Ibn Hawkal	4AH/10CE	"...It is an ancient city with running rivers, mills, fruits, and brick wall..." p88.
	Abu Ubayd al-Bakri ¹⁰	5AH/11CE	"...This city, Tlemcen, is the heart of the central Maghreb region. It has markets, mosques, including a congregational mosque, trees, and rivers with mills on them, such as the Setfsif River..." p76.
	Al-Idrisi ¹¹	6AH/12CE	"...This valley runs east of the city and has many mills on it..." p.248

	Al-Hamiri ¹²	7AH/13CE	"...It has a river originating from the nearby mountain known as the Two Rocks, and an additional river east of the city is home to numerous mills..." p135.
	Hasan al-Wazzan ¹³	10AH/16CE	"... three miles east of the city you see several mills for grinding wheat on a river called Safsaf, and you see others near the city on the slopes of Ras al-Qalaa to the south..." p20.
Oran	Abu Ubayd al-Bakri ¹⁴	5AH/11CE	"...The city of Oran is fortified, endowed with running water, watermills, and orchards..." p.738
Afkan	¹⁵ Ibn Hawkal	4AH/10CE	"... A city of mills and Hammams..." p88.
	Al-Idrisi ¹⁶	6AH/12CE	"...Afkan, a city with mills...it is traversed by a valley that bisects it and connects it to Tihert." p. 251.
	Al-Hamiri ¹⁷	7AH/13CE	"... A city between Tlemcen and Tenés with mills, Hammams, and castles... it is traversed by a valley that bisects it and connects it to Tihert."p51.
Guezrouna	Abu Ubayd al-Bakri	5AH/11	"...It is a city on a large river with mills and orchards (it is called Mitidja) and has farms and theaters...it has running fountains and watermills..." P.65 and 66.
El Ghedir	Abu Ubayd al-Bakri	5AH/11	"...and the Sahar River, on which the city of M'sila is located, originates from springs within the city of Ghadir Warwa. Ghadir Warwa is a large city surrounded by mountains and contains an abundant, sweet spring with mills on it..." p.724
Tihert	Ibn al-Saghir ¹⁸	3AH/9	"... And from Talounat spring the waters of the Menia River, which flow from the direction of Tihert, upon which they established their mills..." p74
	Al-Bakri, see Joudat Abdel Karim, pp. 107–108.		Since the reign of Imam Abd al-Rahman ibn Rostom, the people of Tihert established watermills. It is clear that the mills were located in a single place, with one gate leading to it, which is why it was called the Gate of the Mills.
	Yaqut al-Hamawi ¹⁹	6-7 AH/12-13	"... The city of Tihert was fortified and had four gates ... including the Gate of the Mills ... p355.
Mostaganem	Al-Bakri, quoting Abdul Karim Jawdat, p. 108,		Stated that it had watermills.
Al-Khadra City	Abu Ubayd al-Bakri ²⁰ , A-Masalik wa-l-Mamalik Book...,		"... Near Tenés, a large city on a flowing river, where mills are located..." p.744

Tafda City	Al-Bakri ²¹	5AH/11	"...It is a large, populated city, situated on the banks of two rivers, one of which is fed by a thermal spring, from which they drink and on which their mills are built..." p830.
Algiers	Hasan al-Wazzan ²²	10AH/16	"... A river runs near the city on the eastern side, on which mills have been established..." p37

– **Analytical reading of the table**

In Algeria, watermills play a crucial role in social and economic interactions. This is especially true in regions with rivers and hydraulic resources. Ibn Hawkal (4 AH/10CE) indicates that the city of Meliana had numerous watermills on its river, which proves their extensive use of hydraulic resources for grinding and irrigation.

In the 5th century AH (11th century CE), Abu Ubayd al-Bakri wrote that the city of El Ghedir was located on the Sahar River that was an important source of water. There were also numerous sweet springs and watermills, which confirms the integration of these facilities into the city's economic structure.

Al-Idrisi in the 6th century AH (12th century CE) indicates that Tlemcen was a flourishing city on the Stafs River. It had watermills that were used for grinding and irrigating agricultural lands. This confirms the functional relationship between watermills and agricultural systems.

In the 5th century AH/11th century CE, Abu Ubayd al-Bakri indicated the existence of water-powered mills in Mostaganem. In the 6th century AH/12th century CE, al-Idrisi mentioned that the Oran River contained water mills used to meet the needs of the local population.

During the Ottoman period, Oran and Mostaganem experienced increased interest in watermills. These facilities were used to meet the flour needs of inland cities. According to a census conducted in 1830, four watermills were operating in Oued Ain Sefra outside the city, primarily in the Haouz (meaning the surrounding rural areas)²³. In 1848, French engineer Ernest Carat counted 20 active watermills in Todja, out of 101 in the region²⁴, which reflects the continued reliance on this technology until the beginning of French colonialism, and its

widespread use in rural and agricultural areas.

Besides the economic use, watermills played a pivotal role in the social and environmental interaction in Algerian society during the medieval era. They served as centers of trade and daily communication between farmers and merchants, as their operation was linked to the regulation of water used for grinding grain and irrigating agricultural lands, highlighting an early awareness of the concept of managing water resources sustainably, in line with the environmental awareness of the local community.

Historical resources show that these watermills were not simple mechanical facilities, but they were a part of a social and economic system in the city or town. They were mostly managed by hired labor, and often under the supervision of the local Commandant, reflecting an integrated local administrative structure in the operation of these facilities at that time.

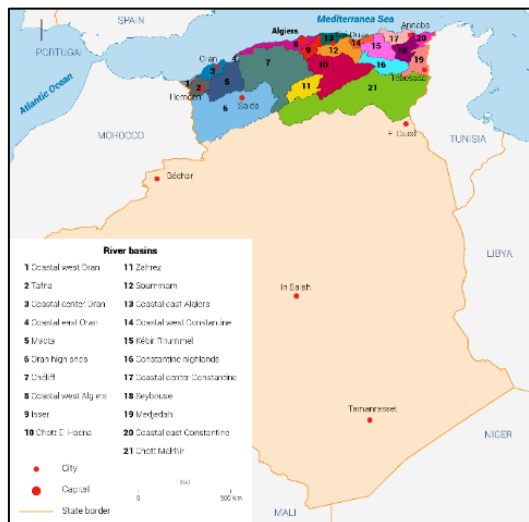
2.3. Archaeological evidence of watermills in Algeria:

Archaeological evidence of watermills in Algeria reflects the technical and engineering achievements of Algerian society during the Islamic era. These mills are concentrated in the northern regions of the country, especially in major river basins²⁵ where surface water is plentiful. This spatial distribution highlights the close relationship between water availability and the effectiveness of water management systems in Algeria.

3.3. Geographical Distribution of Watermills

The archaeological documentation indicates that watermills remarkably spread in regions with abundant surface water availability such as Oued Chelf, Oued

Mellaq, Oued Mascara, and Oued Setfsif. These areas were considered the main water basins (see Map 1). The distribution of watermills in Algeria indicates the extent to which they were integrated with the local ecosystems.



Map 1: Major River Basins in Algeria

<https://water.fanack.com/algeria/water-resources/>

It should be noted that archaeological research on watermills in Algeria has remained limited, especially when compared

to the Roman period, which has benefited from extensive scholarly attention. In contrast, the Islamic era has been almost entirely overlooked, despite the survival of Islamic watermill remains into the modern period. This situation reflects a form of archaeological memory colonization, privileging Roman infrastructure and colonial history at the expense of Islamic-period heritage.

4.3. Archaeological evidence of watermills in Algeria

Despite attempts at field documentation, some archaeological remains have not been comprehensively recorded. Numerous sites still exhibit traces of watermills that have not received sufficient attention in modern archaeological studies. However, several sites containing watermill structures dating back to the Islamic period or later continue to offer valuable insights into how these technologies were utilized across different historical phases. The table below illustrates some of the archaeological watermill remains that are still present in Algeria.

Table 2: Archaeological evidence of watermills remaining in the modern era (by the author)

The city	site/Municipality	The watermill's Name	Refer ences (Appr oximate)	Curr ent Situation	Docume ntation Source	Observations
Batna	Barika-Colonel Shaabani district	The Ben Dghish Mill	35.55° North 5.15° East	Despite the structure's resilience, it is facing the threat of extinction.	Investigative journalism on YouTube - Zohair Khataf, Owner's witness (Abdul Latif ben Daqish) ²⁶	- Established in 1859 by French colonist Marshal Alexandre began operating in 1861. - Bought in 1844 by Ben Daqish - Water-powered, a rare industrial heritage
M'sila	Bousaada	Ferrero Mill	35.2° North 4.2° East	Extinct and used as a photography spot	Documentary film ²⁷	A colonial style, transformed into a global film set, combining heritage, industry, and culture.
Djelfa	Djelfa city- Near the castle "el-Zina" Oued Malah	Not defined	34.6° North 3.2° East	Abandoned - threatened with extinction	A field video ²⁸	A site of archaeological significance, overlooked and neglected, lies near a well-known historical landmark, the Zina Castle. The remnants of the basin and waterwheel are still intact. An architectural masterpiece threatened with extinction, suffering from neglect and lack of

						development.
Bejaia	Imghdasen Village, Akfadou Municipality (Aqafdou), Chemini District	(Da Tayeb Mill) The last watermill in Akfadou	36.58° North 4.62° East	Partially operational and may have ceased functioning recently Relatively preserved	Documentary video of Jamal Alilat ²⁹ Popular video with Da Hussein	Established in 1953, built in a traditional sandstone style, it is situated within mountain gardens, highlighting authentic local agricultural and architectural heritage. It was part of a network of more than 20 watermills.
Tizi Ouzou	Aghrib-Ait Souad Village	Ait-Souad Mill	36.707° North 4.391° East	Partially preserved- Not operational	Documentary You Tube video ³⁰	Located near a mountain stream, it was used for grinding grain. Architectural remains built from local stone document traditional agricultural activity.
Bordj-Bouarrerij	Bordj Ghadir - Oued Zmala	- Kheitit Mill (Water-powered) - Hajj Sharif Mill - Operational mill	36.07° North 5.03° East	Partially abandoned remains-One entirely destroyed	A field video ³¹	A network of local watermills, reflecting a once active agricultural economy, forms a model of collective and individual ownership of traditional mills.
Bouira	Mechdala or Lakhdaria	Not defined	36.4° شمالا 3.7° شرقا	elatively preserved	Google Earth	May be used for touristic purpose
Tlemcen	Beni Senous South of the state	Former watermill	34° شمالا 1° West 976 Meter	Facing extinction	Google Earth	Not documented in local heritage
Oran	Hont Municipality near Hont Falls	Ancient watermill	35.6° North 0.5° West	Abandoned	Google Earth	o clear architectural remains Ruined remains
Sétif	Beni Aziz	Former watermill	36.3° North 5.0° East	Partially preserved	Google Earth	It needs maintenance; it follows a watercourse.
Ain defla	-Alaataf -Al kherba (now El Amra)	Two ancient watermills	36.2° North 2.2° East	Partially preserved	Google Earth Local videos ³²	There are remains of two old watermills
Saida	Sidi Ahmed Municipality	Not defined	34.8° North 0.1° West	Facing extinction	Google Earth	It appears in satellite images
Khenchla	Tamza or Mahmal, west of the state	Not defined	35.3° North 6.8° East	Abandoned	Google Earth	It probably dates back to the colonial era.
Biskra	Near western south of the state	Former watermill	34.7° North 3.7° East	Relatively preserved	Google Earth	Probably operational Built of dry stone.
Laghouat	Al-Rumaila area	Not defined	33.8° North 2.8° East	Almost demolished	Google Earth	Stone remains only
Sidi Belabass	Takhmart	The watermill	35.2° North 0.6° West	Partially preserved	Google Earth	Near a permanent watercourse
Tebesa	Hanchir				Google Earth	A field visit is required for assessment, mentioned in official studies and local heritage.

- An analytical reading of the table:

The archaeological table shows that watermills are still present in the Algerian landscape, but these facilities are threatened with disappearance and neglect. Despite the prominent architectural evidence in different regions, the lack of official recognition of these mills as part of Islamic heritage reflects a clear flaw in heritage policies. Documenting these facilities is a scientific and historical necessity to restore the value of a technology that was once a fundamental pillar of the economy and society.

Through the analysis of historical and archeological evidence of water mills in Algeria during the Islamic era, a clear overlap was found between the textual and physical realities. As shown in Table 1, historical sources indicate that these mills were widespread in large cities such as Tlemcen, Oran, Miliana, and Tiaret. These facilities were an integral part of the economic and urban structure, supported by permanent water networks of rivers and springs.

As for the contemporary

archaeological evidence listed in Table 2, it confirms the continued existence of these watermills in similar locations. However, it also documents a different reality in terms of their condition. The vast majority of these mills are threatened with extinction and lack the minimum levels of care and restoration. This is despite their historical and technological importance.

The gap between historical documentation and archaeological reality reveals a disruption in the strategy for preserving heritage memory, as greater attention has been devoted to the Roman era or the colonial period. In contrast, the Islamic heritage has been neglected. This necessitates a reassessment of this heritage as an authentic civilizational asset that deserves protection and valorization within the framework of comprehensive and balanced cultural policies.

3.2. Map of the archaeological locations of watermills

Map 2 shows the main sites with watermill remains in Algeria. Google Earth was used to document and define these locations. This digital documentation will enhance the accuracy of historical statistics and facilitate field research and archaeological documentation.



Map 2: Principal Archaeological Sites with Watermill Remains in Algeria (by the author)

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¹² Al-Hamiri, Moḥammad ibn Abd al-Mun'im, al-Rawḍ al-Mi'tar fi Khabar al-Aqtar: A Geographical Dictionary, edited by Ihsan 'Abbas, Lebanon Library, printed at Heidelberg Press, Beirut, 2nd ed., 1984, p. 135.

¹³ Hasan al-Wazzan (9th–10th century AH), Wasf Ifriqiya, vol. 1, translated from French by

²⁵ <https://water.fanack.com/algeria/water-resources/>

²⁶ Zohair Khataf, "The Ben Daqish Mill in Barika (Batna): A Heritage from the Past Bound in Oblivion, built in 1859," published 8 March 2020, see: <https://www.youtube.com/watch?v=YPFnniE7Iv0>

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²⁸ <https://www.youtube.com/watch?v=xvkhAm83dU> Damiz: The story of the old mill and the reasons behind the neglect of landmarks like it. October 12, 2019. See: Ziane Ismail, The Story of the Djelfa Mill and its Surrounding Funerary Monuments, 03/09/2022 <https://www.djelfainfo.dz/ar/sites/13597.html>

²⁹ <https://www.youtube.com/watch?v=aeWbUzs1d9s> Djamel Alilat ;le dernier Moulin a eau de l °Akfadou 24 fevrier2024 see: Rabhi Amar;le dernier moulin a eau de l °Akfalou ;2021,Assirem Gouraya,30novembre 2021 <https://www.youtube.com/watch?v=4-XRJJADuDE> see: <https://www.youtube.com/watch?v=HGvrOtoVKKYY>

³⁰ <https://www.youtube.com/watch?v=syFHrjbRp48>, Ciné Saharidj-Mekla-Tizi Ouzou, sur les traces des moulins à eau (partie 1), 25 oct .2024

³¹ <https://www.youtube.com/watch?v=oBCG6n0JqMU>, Ciné Saharidj-Mekla-Tizi Ouzou, sur les traces des moulins à eau (seconde partie), 31 oct .2024

³² Alsayeh, "The Tourist: Remains of the Old Water Mill (1903) in Kharba (now El Amra), Ain Defla," 27 February 2025, 12:36. <https://www.facebook.com/watch/?v=9142089762580761>