

One of the Most Prominent Landmarks of Our Scientific Heritage: Sheikh Muhyiddin's Sāqiyah in Damascus

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Abstract

Sheikh Muhyiddin's Sāqiyah in Damascus exemplifies Islamic scientific heritage, showcasing the advanced engineering and innovation achieved during the Islamic Golden Age. The Sāqiyah, a mechanical water-lifting device, demonstrates the importance of water in Islamic culture and its association with purity and spiritual practices. Designed by the notable engineer Taqi al-Din al-Shami in the 16th century, the structure combines art, science, and spirituality, demonstrating the Islamic world's commitment to public welfare through technology. The Sāqiyah served various community needs, providing water for mosques, hospitals, and irrigation.

Keywords

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1. Introduction

The *sāqiyah* (Arabic: ساقية) is a mechanical water-lifting device and a place for drinking water. It is a channel used to irrigate land and crops. In Islamic architecture, a wheel or machine is installed over the mouth of a well, a channel, or a small watercourse (like a small riverbed) to lift water using the wheel. (It is worth mentioning that the *Nā'ūra* differs from the *sāqiyah* in that the former consists of only one wheel that performs all three functions of the waterwheels of the *sāqiyahs*: pushing, scooping, and lifting. They are also built on the courses of large, flowing rivers. Researchers confirm that the first *Nā'ūra* appeared in Syria during the Aramaic era. Archaeological evidence, such as a mosaic depicting a *Nā'ūra*, discovered in the ancient city of Apamea, located 55 km north of Hama, indicates that the *Nā'ūra* was used on the Orontes River around the second century AD. The use of *Nā'ūras* then developed and spread throughout Arab and Western civilizations. (Yaghi, 2011, p. 173).

The *sāqiyah* (*waterwheel*) typically consists of containers or buckets that scoop water from its small watercourse, and when rotating, empty it into a unique basin connected to a channel or waterway. The water then flows through this channel to the area to be irrigated or supplied. The rotation process is conducted by two interlocking gears, one horizontal and the other vertical, connected to the body of the *sāqiyah* or its frame by a horizontal column (Yaghi, 2011, pp. 169-172).

Among the many *sāqiyahs* that once dotted the landscapes of the Islamic world in general but in Syria in particular, the *sāqiyah* of Sheikh Muhyiddin in Damascus holds a special place. Designed by the renowned engineer Taqi al-Din Muhammad bin Ma'ruf al-Rasid al-Shami in the 16th century, this remarkable structure served a practical purpose. It symbolized the fusion of art, science, and spirituality in Islamic architecture. Today, it remains one of the most prominent landmarks of our scientific heritage, reflecting the advanced engineering and cultural values of its time. This *sāqiyah* is a testament to Islamic civilization's ingenuity and scientific achievements.

2. The Historical and Cultural Context of *Sāqiyahs*

The *sāqiyah* has its roots in ancient water-lifting technologies, but during the Islamic Golden Age, these devices reached new heights of sophistication. In Islamic architecture, *sāqiyahs* were not merely functional structures but also expressions of the Islamic emphasis on water as a source of life, purity, and spiritual renewal. Water played a central role in Islamic daily life, from ablutions before prayer to irrigation gardens and crops. The *sāqiyah* symbolized this sacred relationship between water and human life. Waterwheels (*sāqiyahs*) are a form of social welfare infrastructure, much like bathhouses (*hammams*), hospitals (*bīmāristāns*), public fountains (*sabīls*), and mills (*nā'ūras*). These structures represent a vital category of buildings deeply tied to Islamic religious and social principles. They embody the spirit of communal solidarity and mutual support promoted by Islam, reflecting its vision of societal well-being on multiple levels (Yaghi, 2011, pp. 136, 169, 175).

Sāqiyahs were built either as standalone structures or connected to luxurious palaces, hospitals (*bīmāristāns*), mosques, and large Sufi lodges (*takāyā*). They played a significant role in providing water for Muslims' needs, particularly personal and family hygiene. Water is not only a source of life for Muslims but also carries a purifying significance rooted in Islamic religious practices, such as ablution (*wuḍū'*) and ritual purification (*ghusl*) before prayer.

In Islamic architecture, particularly in Syria, *sāqiyahs* operated in two ways:

- **Via Animal Power:** The first gear is horizontal, and the second is vertical, connected to the body of the *sāqiyah* or its frame by a horizontal column. The movement of

animals in a circular path rotates a vertical column, which in turn operates the *sāqiyah* and lifts water from the river or well to a designated basin (Rizq, 2000, p.137), Fig.1.



Figure 1: A model of the animal-powered waterwheel. © Author's Collection

- **Via Water Power:** The first vertical gear is fixed directly on the surface of the river or waterway. The water flow rotates the gear and then moves a second horizontal gear. This, in turn, drives another gear or a chain of buckets that scoop water and lift it to the designated basin.

This type of *sāqiyah* saw significant development in Syria starting from the 7th century AH (13th century AD) when the Arab scholar Al-Jazari. (530 AH - 1136 AD / 603 AH - 1206 AD). Badī' al-Zamān Abū al-'Izz ibn Ismā'īl al-Razzāz, known as Al-Jazari, was born in the Jazira region of eastern Syria and later served as the chief engineer in Diyarbakır, northern Jazira. Al-Jazari is regarded as one of the greatest engineers and chemists in history. He designed numerous highly significant machines, many of which were previously unknown anywhere in the world. Among his inventions were water-raising machines, water clocks with automatic alarm systems, valve systems, automatic control mechanisms, and many others, all of which he detailed in his remarkable work, (The Compendium on the Theory and Practice of the Mechanical Arts), (al-Jāmi' bayn al-'Ilm wa al-'Amal al-Nāfi' fī Ṣinā'at al-Ḥiyāl), (Ceccarelli 2010, pp. 1-21), (Hill 1991a, pp. 64-69). Donald R. Hill, an engineer and technology historian known for his pivotal 1974 translation of The Book of Knowledge, emphasized that the significance of al-Jazari's contributions "cannot be overstated (Elices 2020). He wrote a mechanical description of this saqiya in his book "The Compendium on the Theory and Practice of the Mechanical Arts" (al-Jāmi' bayn al-'Ilm wa al-'Amal al-Nāfi' fī Ṣinā'at al-Ḥiyāl) at the beginning of the 13th century AD. He also created a miniature model of this pump/saqiya. Later, in the 10th century AH (16th century AD), the engineer Taqī al-Din Muhammad bin Ma'ruf al-Rasid al-Shami introduced notable improvements in the precision and operation of these machines. The *sāqiyah* remained in operation, albeit partially, until the early 1970s.

In the Al-Salihyah neighborhood, northwest of Damascus (Fig. 2), the *sāqiyah* of Sheikh Muhyiddin was a standalone structure and part of a broader network of water systems that sustained the city's inhabitants and its lush gardens. Damascus, known as the "City of Jasmine," owes much of its beauty and fertility to the Barada River and its tributaries, including the Yazid River, on which the *sāqiyah* was built. The *sāqiyah* not only provided water for the shrine of

the revered mystic Muhyiddin Ibn Arabi but also served the surrounding neighborhoods, takiyy Al-Salemya (Sufi lodge), and bīmāristā al-Qaymari (hospital), adjacent to this sāqiyah, which was established in 1254 AD-603 AH, highlighting its role in supporting both spiritual and communal life.

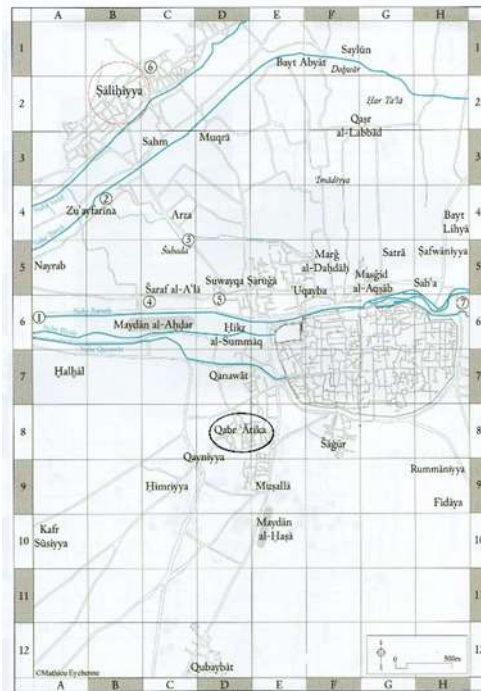


Figure 2: The general location of the Al-Salihiyya Neighborhood in the city of Damascus. (Eychenne, Meier, & Vigouroux, 2018)

3. The Designer of this Sāqiyah

This sāqiyah (Fig. 3), which is also known as the "Nā'ūrat Sheikh Muhyiddin," was designed by the engineer Taqi al-Din al-Shami. He was a polymath whose engineering, mathematics, and astronomy contributions were groundbreaking. He was born in Damascus in 931 AH (1525 AD) and died in 993 AH (1585 AD), (Taqi al-Din Ibn Ma'ruf, n.d.). Among his famous inventions was a machine for rotating skewers for grilling meat over a fire, which rotated automatically without animal power. He also contributed to establishing the Istanbul Astronomical Observatory and served as a judge in Nablus. He authored several works, including *Kitab al-Ṭuruq al-Saniyya fi al-Ālāt al-Rūḥāniyya* (The Sublime Methods in Spiritual Machines), (Hill, 1978b, pp.117-118). This book is significant because it fills a gap in the history of Arabic technology, particularly in mechanical engineering, which details advanced mechanical devices and their applications. Taqi al-Din completed this book in 1552 CE, predating Agostino Ramelli's work (1588 AD) and even earlier than the works of European engineers like Cardano. Taqi al-Din also described the screw pump, which became widely used in Europe in the 17th and 18th centuries (Al-Hassan, 1987).

Taqi al-Din's design for the sāqiyah incorporated innovative features that set it apart from earlier models. His use of interlocking gears, vertical and horizontal wheels, and a chain-and-bucket system demonstrated a deep understanding of mechanical principles. The sāqiyah was capable of lifting water from the Yazid River to a height of approximately twelve meters, a remarkable feat of engineering for its time. Taqi al-Din's work on the sāqiyah was part of a

In 1157 AD-552 AH, Badī' al-Zamān Abū al-'Izz ibn Ismā'īl ibn al-Razzāz, known as Al-Jazari, came to Damascus at the request of Sheikh Abū 'Umar Muḥammad ibn Aḥmad ibn Qudāmah al-Maqdisī, who founded the Al-'Umariyya School that same year. Al-Jazari designed a waterwheel (*sāqiyah*) to serve the school and supervised its construction. This waterwheel was a model of the chain pump, which Al-Jazari later named the "Chain and Bucket Pump" (*miḍkhāna al-zanjīr wa al-dalw*) in his book *The Compendium on the Theory and Practice of the Mechanical Arts*, written in 1205 AD.

In 1254 AD- 653 AH, the Al-'Umariyya waterwheel\ *sāqiyah* was replicated as part of the construction project for the al-Qaymari Hospital (*Bīmāristān al-Qaymari*). According to the account of Ibn Ṭūlūn in his description of the al-Qaymari Hospital, it is inevitable that a dedicated waterwheel was attached to the hospital at the time of its construction to supply it with water. This waterwheel was similar to the one described by Al-Jazari in his aforementioned book.

When the Ottoman army entered Damascus in 922 AH (1516 AD), Sultan Selim I ordered the construction of a mosque and a dome over the tomb of the Sufī Muhyī al-Dīn ibn al-'Arabī (known as the Khānqāh Mosque) in the neighborhood now called "Ḥayy al-Madāris" (the Neighborhood of Schools), adjacent to the Al-Qaymari Hospital. This mosque was the first Ottoman architectural project in Damascus. Later, the Sulaymāniyya Takiyya was built opposite the Ibn al-'Arabī Mosque. To ensure a steady water supply for the mosque and later for the takiyya, Sultan Selim commissioned the engineer Taqī al-Dīn al-Shāmī to design and build a waterwheel capable of lifting water to a high level and providing the necessary water for the mosque, the takiyya, the adjacent hospital, and possibly the surrounding neighborhood, which had seen numerous attempts over the centuries to raise water for its buildings. These earlier attempts included water-lifting structures commonly referred to as *nā'ūras* (waterwheels), leading to the area being known as "Ziqāq al-Nawā'ir" (the Alley of Waterwheels). Taqī al-Dīn completed the Yazīd River waterwheel. Dr. Aḥmad al-Ḥassan suggests that the remaining waterwheel may be the same one installed at the Al-Qaymari Hospital during its construction. If so, this would mean that Taqī al-Dīn rebuilt, developed, and updated this waterwheel, which remains today (Fig. 5).



Figure 5:
The image shows the close relationship between the site of the *sāqiyah* and the Mosque of Muhyiddin Ibn Arabi.

5. Similarities Between Al-Jazari's *Sāqiyah* and Taqī al-Dīn al-Shāmī's *Sāqiyah*

A visual inspection reveals similarities between Al-Jazari's design for the water-raising machine in his manuscript *The Compendium on the Theory and Practice of the Mechanical Arts* and Taqī al-Dīn al-Shāmī's *sāqiyah*, known as the *Sāqiyah* of Sheikh Muhyī al-Dīn. In the illustration drawn by Al-Jazari, his waterwheel operates by water falling onto scoops that rotate

a wheel. In contrast, Taqī al-Dīn's waterwheel relies on long wooden boards distributed around the wheel's circumference, which rotate by the force of horizontal water flow.

It is worth noting that the basic design in Al-Jazari's manuscript was a prototype. It consisted of a basin made of marble and copper, along with a set of scoops that rotated by the force of falling water. The presence of an animal in the manuscript symbolizes that this model mimics the waterwheels that animals traditionally powered at the time (Fig. 6).

Figure 6: A model of Al-Jazari's sāqiyah described in his book, "The Compendium on the Theory and Practice of the Mechanical Arts." (Taqi al-Din Ibn Ma'ruf, n.d.)



6. Mechanism of the Sāqiyah

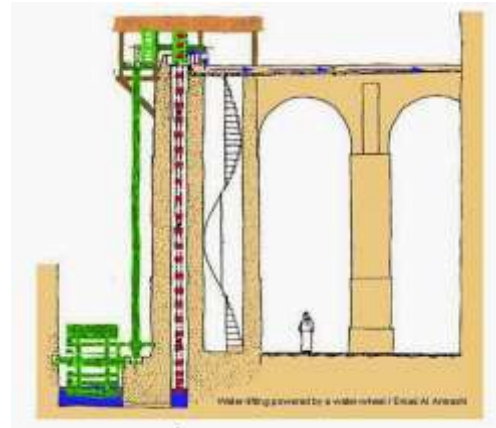
The sāqiyah of Sheikh Muhyiddin is a masterpiece of both form and function. Its structure consists of a tall tower housing a spiral staircase, reminiscent of the minarets of Islamic mosques. At the top of the tower, a refurbished wooden canopy shelters the intricate machinery of the sāqiyah.



Figure 7: The lower wheel of Sheikh Muhyiddin's sāqiyah on the Yazid River. © Author's Collection

The device is powered by a vertical wheel mounted on the Yazid River (the river flows at the foot of Mount Qasioun and is attributed to Yazid ibn Muawiyah, who renovated it and turned it into a river) which rotates through the force of the flowing water (Fig. 7). This wheel drives a series of interlocking gears and chains, which lift water using a series of buckets (Fig. 8).

Figure 8: A cross-section of the moving and fixed parts of Sheikh Muhyiddin's Waterwheel.
<https://kattler.dk/scholars/uk/index.html>



Sheikh Muhyiddin's sāqiyah consists of a vertical wheel (Fig. 9-1) on the Yazid River, rotated by water flow. The wheel drives a vertical toothed gear (called lakām-اللكام) (Fig. 9-2), which meshes with a horizontal gear (Fig. 9-3). This horizontal gear, in turn, rotates a vertical column (called sārī-الصارى) (Fig. 9-4). At the top of this column is another horizontal gear (called ṭabaq-الطبق) (Fig. 9-5), which drives a vertical gear (called liqāṭa-اللقاطة) (Fig. 9-6). This vertical gear rotates a vertical wheel (called māwiya-الموية) (Fig. 9-7) via a horizontal axle. The māwiya drives two long iron chains with buckets spaced 60 cm apart (Fig. 9-8,9), lifting water from the river level to a height of approximately twelve meters.

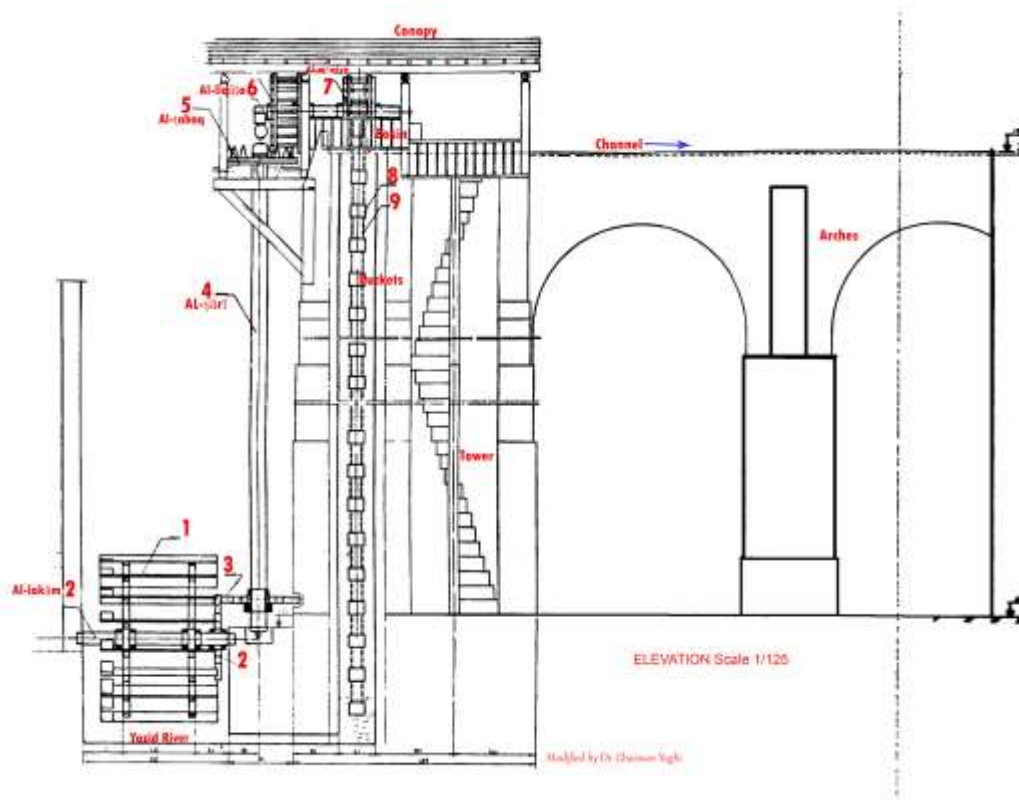


Figure 9: A cross-section showing all the waterwheel parts and its working mechanism.
 (© G. Yaghi, 2011).

The machinery of the sāqiyah is supported by a tall tower (Fig. 10) with a spiral staircase reminiscent of minaret staircases, allowing access to the upper mechanisms, which are covered by a refurbished wooden canopy. At the top of the tower is a small basin where the buckets empty the lifted water (Fig. 11).

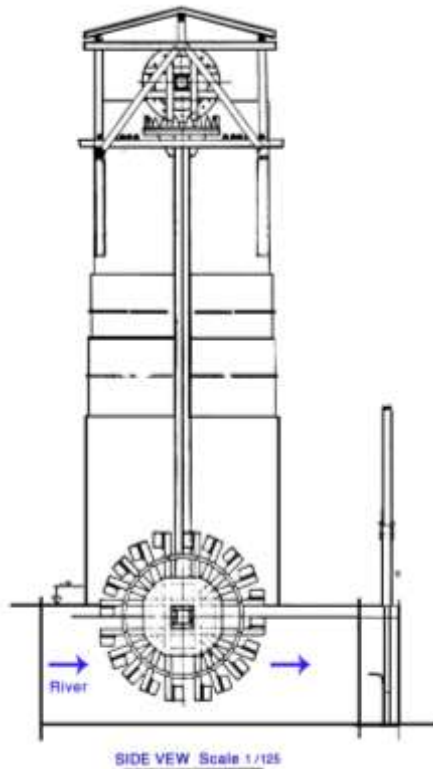


Figure 10: A cross-section of the mechanical parts and the waterwheel's working mechanism. (© The archives of the Directorate-General of Antiquities and Museums – Syria)



Figure 11: The upper wheel and the bucket chain © Author's Collection

The water then flows through an elevated channel supported by high arches to a specially constructed reservoir. From there, the water is distributed to the mosque of Muhyiddin Ibn Arabi and Salimiyya *Takāyā* and the Al-Qaymari Hospital/*bīmāristān* (Fig. 12).



Figure 12: General view of the waterwheel and channel connected to the Muhyiddin Ibn Arabi Mosque. © Author's Collection

A channel was also extended to the mosque's ablution pool, and water taps for ablution were installed along the reservoir wall, the remains of which are still visible. The large reservoir, about twenty-five meters above the river level, is built of stone and can be seen from the main road separating the mosque and the takiyya (Fig. 13). Additionally, small buckets were attached to the perimeter of the vertical wheel to lift water to a lower height, sufficient to supply a nearby house and garden (Fig. 9-9).

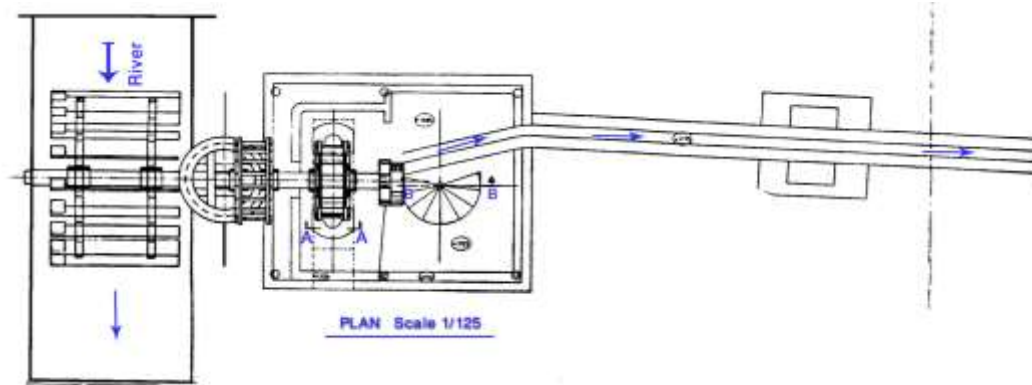


Figure 13: horizontal view of the upper section of the waterwheel and the water channel connected to the Muhyiddin Ibn Arabi Mosque. (@ The archives of the Directorate-General of Antiquities and Museums – Syria)

7. The Scientific and Social Significance of the Sāqiyah

The sāqiyah of Sheikh Muhyiddin is a remarkable example of Islamic scientific heritage, highlighting the advanced engineering and innovation of the Islamic Golden Age. It reflects the Islamic emphasis on water as a source of life, purity, and spiritual renewal, aligning with religious practices like ablution and irrigation. The sāqiyah demonstrates the Islamic world's mastery of mechanical principles and its commitment to improving society through technology. Providing water to mosques, hospitals, and communities embodied the Islamic values of charity and public welfare. Today, this sāqiyah stands as a testament to the enduring legacy of Islamic scientific achievements and their impact on global heritage.

Also, this sāqiyah was more than just a technological marvel; it also symbolized its time's spiritual and social values. The shrine of Muhyiddin Ibn Arabi, one of the most influential Sufi mystics in Islamic history, attracted pilgrims and scholars from across the Islamic world. The sāqiyah ensured that these visitors and the local community had access to clean water for drinking, ablutions, and irrigation.

The sāqiyah also reflected the Islamic emphasis on charity and public welfare. Providing water to the hospital and the takiyya supported the care of the sick and the spiritual education of Sufi disciples. In this way, the sāqiyah embodied the Islamic ideal of using science and technology to improve society.

8. Preservation and Legacy

The sāqiyah of Sheikh Muhyiddin remained in operation for more than five hundred years, maintained by generations of caretakers who ensured its continued functionality. However, by the 1970s, the sāqiyah had fallen into disrepair and ceased functioning for several reasons: first, the lack of transparent maintenance budgets, which is why some of the buckets are now made of tin sheets; second, the official introduction of water from “Ain al-Fijeh” into areas previously

fed by the waterwheel; and finally, the decline in the flow of river water after the extension of Ain al-Fijeh, which resulted in the withdrawal of water and its diversion through pipes and aqueducts, distributing it over a larger area; and finally, the pollution of the river, rendering it unfit for drinking, after its water had previously been used for cooking and washing.

Today, the General Directorate of Antiquities in Syria and the Damascus Governorate are working to restore this historic landmark. Their efforts include removing encroachments, repairing the machinery, and developing a comprehensive plan to return the sāqiyah to working condition.

Once restored, the sāqiyah will serve as a testament to the Islamic world's scientific and architectural achievements, as a tourist attraction, and as an educational resource. It will remind future generations of the importance of preserving our scientific heritage and the enduring legacy of figures like Taqi al-Din al-Shami.

9. Conclusion

The sāqiyah of Sheikh Muhyiddin in Damascus is a shining example of the ingenuity and creativity of Islamic civilization. Its intricate design, advanced engineering, and cultural significance make it one of the most prominent landmarks of our scientific heritage. As efforts to restore and preserve this remarkable structure continue, it symbolizes the enduring connection between science, spirituality, and society in the Islamic world. By studying and celebrating such achievements, we honor the contributions of our ancestors and inspire future generations to build on their legacy.

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