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Water and Enlightened Techniques: The *Azuda* (Waterwheel) of Aranjuez (Spain)
Magdalena Merlos Romero and Victoria Soto Caba*

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ABSTRACT

This investigation deals about one of the most unique constructions in the Aranjuez hydraulic engineering program. The *Azuda*, a waterwheel, was built in the middle of the eighteenth century in an area close to the Renaissance canal of the Embocador. First, a spatial and chronological analysis of its construction process and its typology which combines a wheel and an aqueduct, is carried out. Next, it is contextualized in the cultural tradition of the Mediterranean norias and its functions are clarified as it covered both irrigation and recreation. Finally, it is argued how the cultural landscape of Aranjuez was enriched with a work of great aesthetic value, with classical and Muslim roots, being reinterpreted under the spirit of the Enlightenment.

Keywords: Waterwheels, cultural landscapes, hydraulic engineering, Aranjuez, water management

ARTICLE

The *Azuda*¹ is a hydraulic plant constructed in Aranjuez in the mid-eighteenth century during the reign of Fernando VI. Its original function was to extend irrigation across the northern area of the enclave. Its construction is an undeniable part of the work of military engineers in the service of the Bourbon monarchs, particularly under Fernando VI, when working on the water systems that affected the area, both in terms of channels of communication and agricultural irrigation. Furthermore, the work of the Bourbon kings was a continuation of Felipe II's ambitious planning programme for Aranjuez, at the confluence of the Tagus and Jarama rivers.

The plan is composed of: the noria on a canal or *caz* (the autochthonous term for canal); the branch of the canal which the elevated water pours into; and the aqueduct which the first section of this branch is supported on (Fig. 1). However, the analysis of documentary and graphic sources also enabled us to examine the Aranjuez waterwheel (*Azuda de Aranjuez*) as the culmination of technical experimentation for the control of river water at the Royal Site, throughout the early modern period.

¹ It is important to consider the specific Spanish vocabulary, mainly due to the Muslim influence. *Azuda* is a fluvial noria (waterwheel). Canal, *caz* and *acequia* are synonymous, and can be translated as canal, waterway or channel.

* Magdalena Merlos Romero and Victoria Soto Caba, Universidad Nacional de Educación a Distancia. Spain

Fig. 1 a,b,c. La Azuda de la Montaña.

Situation of the Waterwheel

The *Azuda* is located on one of the most important and oldest waterways in Aranjuez, the Caz del Embocador,² a channel dating back to the sixteenth century, which runs from the dam of the same name on the Tagus River and flows into the Jarama River. It runs from east to west, irrigating the northern part of the meadow and sweeps along the upper reaches of Mira-El-Rey and the La Montaña estate. It became known as *Caz de la Azuda* (Water-wheel waterway).³

The location of the waterwheel, at the foot of the La Montaña estate (hence the current name of *Azuda de la Montaña*), arises from the geographical conditions, ideal to ensure irrigation of the *Calle Larga o Nueva* (Long or New Street)⁴, as it was called, which would later unite the *Plaza de las Doce Calles* (Twelve Streets' Square) and the

² Embocador means narrow entry point for the water.

³ The regulation on the protection of the cultural landscape of Aranjuez, MERLOS M., "Cultural landscapes as protected legal assets: Aranjuez, a Spanish World Heritage reference", *Conserva*, 21(2016), pp. 87-101.

⁴ Also called Calle de Caravajal, in honour of José de Carvajal -or Caravajal- and Lancaster, the Secretary of State under Fernando VI who promoted the works.

Puente Largo (Long Bridge) over the Jarama. This was one of the roadways that was integrated into the regional planning during the reign of Fernando VI (1746-1759). The street was conceived as a tree-lined alley, one of the new entry points to Aranjuez from the north that replaced the historic entrance from the west, dating from the times of Felipe II⁵.

History of its construction

The first testimonies to this waterwheel, the *Azuda de la Montaña*, date back to 1749.⁶ The original function of the waterwheel was to irrigate the *Calle Nueva* or *Larga* by raising the water from the Caz del Embocador to a new channel at a higher level with a parallel course (irrigation of the street and roadway) and with two reservoirs for storage of the remaining water. In the last third of the century, it was also considered for the irrigation of grasslands that grew up in the vicinity of the Doce Calles, to serve as pastureland for the ruminants from the nearby *Casa de Vacas* (cowsheds). The irrigation was also intended to reach tree plantations laid out in the vicinity of the new branch of the waterway (Fig. 2). The Plan of the Calle Larga and its construction alongside the pre-existing streets in the vicinity of the Doce Calles was entrusted to Charles de Witte in mid-1749.⁷ However, it came to be designed by the Neapolitan military engineer, José Dattoli, at that time ordinary artillery commissar,⁸ who was working in Aranjuez as a civil engineer.

Fig. 2. Domingo de Aguirre (drawing), Juan Antonio Salvador Carmona (engraving), *Topografía del Real Sitio de Aranjuez*. 1775 (sketch) Hoja 2. © Biblioteca Nacional de España.

The work was directed by the engineer Jacinto Posadas (layout, clearing, levelling out,⁹ trees) with the fundamental participation of the master builder Leonardo de Vargas (for the general plan and of the streets), who believed that there was no need for *foreign assistance* in the project.¹⁰ On the Dattoli design - already in the hands of Vargas on

5 MERLOS, M. Aranjuez y Felipe II. *Idea y forma de un Real Sitio*. Madrid: Consejería de Cultura, Comunidad de Madrid - Ayuntamiento de Aranjuez, 1998.

6 Data gathered by MIGUEL RODRIGUEZ, J. C. de, y SEGURA GRAIÑO, C. (dir. y coord.) *Agua e ingenios hidráulicos en el valle del Tajo, de Estremadura a Algodor entre los siglos XIII y XVIII*, Madrid, Confederación Hidrográfica del Tajo, 1998.

7 ES. 28079. AGP. APA (Archivo General de Palacio. Administraciones Patrimoniales, Aranjuez) C^a 14186. 1749, June-Sept.

8 ARCHIVO MILITAR DE SEGOVIA, Sección 1^a /92 D, exp. 1.

9 ES. 28079. AGP Planos, 2159 1919. 1755, levelling of the Calle Larga by the Swiss regiment.

10 ES. 28079. AGP APA, C^a 14186. 1749, 2 Nov.

November 3 of that same year, 1749¹¹ - and after meeting Vargas and Posada, the two drafted a joint and definitive project, which, at Vargas' proposal, should include a waterwheel, as well as the alteration of the width of the canal del Embocador, and the placing of two storage tanks.¹² Consequently, both the actual construction (excavations, embankments) and logistics (materials supplies, number and species of trees) were required.

The agreed plan was to be approved by José de Carvajal.¹³ However, around the same time, there was some concern about the authorship of the project, it being documented that the task of the royal architect, Santiago Bonavía, had not gone beyond the simple approval of the project.¹⁴

Work began in December under the supervision of the governor of the Royal Site, Baltasar de Prado, who took note of all the incidents and expressed a deep concern both for the perfect fulfillment of the project and for the close monitoring of the actions of Vargas and Posada by their hierarchical superiors. Thanks to the governor's zeal in his documents, the details of the actual construction work¹⁵ are known to us, such as the material requirements, specifically wood and brick, tordered from Reales Tejas (royal tile factory), located in the neighborhood between the canal and the River Jarama.

However, before the start of the works, Prado had objected to some points of the design, for the sake of the perfection he sought to achieve for the project,¹⁶ aspects that would emerge successively during the execution. There were three key issues –all interrelated– that were questioned and reviewed: the layout of the Calle Larga, the provision of bridges and embankments to adapt to both the orography and the course of the channels, and the precise location of the Azuda. Regarding the layout of the Calle Larga, Prado's disagreement was over the plan designed by Dattoli (responsible for the road planning) and the suggestion of equally divided sections; adaptation and redesign of the nearby streets, Malapaga and Chillones; and the alterations of the connection with the Puente de Barcas (Boat Bridge)¹⁷. Not only the presence of Dattoli was requested, but also Jacinto Posadas and the gardener Esteban Boutelou¹⁸ for the selection of plantations for both the Calle Tillones¹⁹ (now Chillones, due to phonetic deformation) on its section north of the Plaza de las Doce Calles, and for the Calle Larga. For the four rows of trees that were to flank it, 6500 was the number estimated as being the necessary amount. Initially, half poplars and half lime trees were proposed. However, due to different growth rates, black poplars alone were eventually chosen.²⁰ Once again, Bonavía, as a royal architect, was limited to supervising the works.

11 ES. 28079. AGP APA, C^a 14186.1749, 3 Nov. "Bargas hizo un plan de la calle según la línea de Don Joseph Datoli". Baltasar proposes one position and Vargas and Posada the definitive one.

Leonardo de Vargas Plano de la calle Larga (ES. 28079. AGP Planos, 2155 3999) and another more complete one of Leonardo de Vargas, Plano del entorno de la Azuda (ES. 28079. AGP Planos, 2156 4000).

12 ES. 28079. AGP APA, C^a 14186. 1749, 15 Nov (document partially transcribed and without date or place in GARCÍA LÓPEZ, Cristina, "Anejo histórico", *Recuperación de la Azuda de la Montaña y su Entorno. Proyecto básico y de Ejecución*. Promotor: Dirección General Del Agua, Confederación Hidrográfica del Tajo, Ministerio de Medioambiente, Medio Rural y Marino, 2009).

"El acuerdo en que los tres han convenido se reduce a aprobar en todo el plano hecho entre Posadas y Vargas así porque Datuli le halla conforme. Tirado el nivel con todo rigor, se halla que el agua debe levantarse 25 pies para que puede regar toda la calle y para que el agua corra con ímpetu por sus caceras tienen por precisas la elevación hasta 28 o 30 pies. Vargas proyecta para esto una Azuda, y Datuli habiéndole oydo se conforma diciendo que para algunos años se puede muy bien fiar el riego a esta especial máquina porque toman suficiente porción de agua y que para adelante se podrá hacer otra cosa que sea permanente, aunque acaso de más coste".

13 ES. 28079. AGP APA, C^a 14186.1749, 18 Nov. Letter to Dattuli and Herrero. (Datulis Herrero)

Map of the gran calle from the bridge, Puente Larga to the gate, Puerta de las Huertas.

14 ES. 28079. AGP APA, C^a 14186.1749, dic, 21 "hoy se ha empezado a hacer la Zúa ... pero llevo a mal el que Don Santiago pretenda sin trabajo llevarse la honra de nuestros desvelos" (Firmado Jacinto de Posada).

15 ES. 28079. AGP APA, C^a 14186. 1749, 9 Dec. Balthasar de Prado addresses Joseph de Carvajal and Lancaster.

16 ES. 28079. AGP APA, C^a 14186. 20 nov 1749 a Miguel Herrero, 1749, 22 Nov, 1749, 4 Dec.

17 ES. 28079. AGP APA, C^a 14186. 20 nov 1749 a Miguel Herrero.

18 On this gardener see Ignacio García-Pereda, Ana Duarte Rodrigues and Francisco Manuel Parejo-Moruno, "The Boutelou Brothers: From gardening to agronomic practices, education and travels in Spain at the turn of the nineteenth century", *Notes & Records of the Royal Society of London*, 2021, 1-19.

19 ES. 28079. AGP APA, C^a 14186.1749, 22 Nov.

20 ES. 28079. AGP APA, C^a 14186..1749, 15 Nov.

It is clear that one of the biggest concerns was the overlap with the Calle Larga on the road section, with the aforementioned square (Doce Calles) and what was to be called the *Puerta Cirigata* or *Pical del Rey* (at the gate named Puerta de las Huertas i.e. the access point to Picotajo), whose location was also decided at that point, and from where the street of Malapaga, calle Larga and the one that would lead to the *azuda* all began²¹. Dattoli's plan started by putting both squares at the same level,²² one of which was also on a slope.²³ Finally, Bonavia's approval of the excavations of the new street²⁴ was obtained and the area was re-planned, with the inclusion of a new bridge and a new road.²⁵

Another essential point of the project was regarding the location and characteristics of the *azuda*. It was Vargas who decided on the location of the Azuda and undertook its design, with the supervision of the *profesores* (teachers) (José Dattoli),²⁶ who disposed of a first digging point for the *azuda*.²⁷ The concern over the inadequacy of this

Fig. 3. Domingo de Aguirre (drawing), Juan Antonio Salvador Carmona (engraving), *Topografía del Real Sitio de Aranjuez*. 1775 (sketch) Hoja 2. © Biblioteca Nacional de España.

location change for the wheel's operation was expressed by Pardo,²⁸ who insisted on placing it at a precise point of the Calle Tillones (one of the streets which crosses the square called Doce Calles), although without success, in spite of arguing the leisure and aesthetic function of its location at the end of a street²⁹ designed by the Queen herself, which ran from the Doce Calles to the canal, at the foot of the La Montaña estate.³⁰ Definitively, as can be seen in the *Cartografía de Aranjuez* (1773) of Domingo de Aguirre (Fig. 3), it was to be build at the end of an

21 ES. 28079. AGP APA, Ca 14186..1749, 4 Dec.

22 ES. 28079. AGP APA, Ca 14186.1749, 10 Dec. Letter from Baltasar de Prado Miguel Herrero (in the same letter the construction of the wheel is recounted).

23 ES. 28079. AGP APA, Ca 14186.1749, 4 Dec.

24 ES. 28079. AGP APA, Ca 14186.1749, 21 Dec.

25 ES. 28079. AGP APA, Ca 14186.1749, dic, 30. Documentation for the Calle Nueva works.

Levelling plan and sketch of the new bridge (plan 909). Contour plan, situation of terrain and plan of new road.

26 ES. 28079. AGP APA, Ca 14186.1749, 22 Nov.

27 ES. 28079. AGP APA, Ca 14186. 1749, 20 and 22 Nov.

28 ES. 28079. AGP APA, Ca 14186. 1749, 22 Nov.

29 ES. 28079. AGP APA, Ca 14186. 1749, 22 Nov.

30 ES. 28079. AGP APA, Ca 14186. 1749, 4 Dec.

unnamed street that ran from the Plaza de Pical del Rey, which could be identified with what Prado had seen from the aforementioned sluices and cuts across the Calle de los Tillones. This does not appear in Leonardo Vargas' first plan (Fig. 4)³¹ but rather in a later one (Fig. 5).³²

The point of the plan that seems indisputable is the one that concerns adapting the Caz del Embocador to accommodate the noria, by widening and deepening it, as was required in the original project of 1749. The goal was

Fig. 4. Leonardo de Vargas. Plano de la calle Larga. ES.28079.AGP Planos, 2155 3999

Fig. 5. Leonardo de Vargas. Plano del entorno de la Azuda. ES. 28079. AGP Planos, 2156 4000

to increase the speed of the water and enable it to reach the new channel, which was to run from south to north, and the brick-built reservoirs (now disappeared) that had to be built along Calle Larga, to accumulate the irrigation water and dose it.³³ It was deemed necessary to raise the water to an elevation of 28-30 feet (about 8 metres).³⁴ Also, for this purpose, they considered providing sluices on the canal to hold back the water and then release it to increase its force, making the wheel move and establishing a course for the water that did not fit in the buckets.

31 Leonardo de Vargas, 1749. Plano de la calle Larga. ES. 28079. AGP Planos, 2155 3999.

32 Leonardo de Vargas, 1749. Plano del entorno de la Azuda. ES. 28079. AGP Planos, 2156 4000.

33 ES. 28079. AGP APA C^a 14186 .1749, 15 Nov.

34 ES. 28079. AGP APA C^a 14186 .1749, 15 Nov. "Tirado el nivel con todo rigor, se halla que el agua debe levantarse 25 pies para que pueda regar toda la calle y para que el agua corra con ímpetu por sus caceras tienen por precisas la elevación hasta 28 o 30 pies". Spanish foot = 0,278635 metres.

One of the final questions was the one concerning the layout of bridges.³⁵ Dattoli designed the construction of another bridge to resolve the problem of the slope and channel the water along a stone-built ditch over a brick archway.³⁶ This bridge, that would connect up the noria wheel and start the new channel facing from north to south, may have been the precursor of the aqueduct that was located there at the end of the century. This detail *a priori* suggests that the aqueduct was not built initially; as the work progressed, bridges (and amassing of materials) were needed to collect or guide the water, but there is no express mention of it. Nor does it appear in the already mentioned plans of 1749.

Furthermore, the alleged absence of any references and graphic representation of the aqueduct (unless this was implied in the name of the plan) has led some researchers to think that it was not built in the early stages of the plan, and to believe in a complex history of both construction and function.³⁷ The controversy became even more complex when it was admitted that its design had to include irrigation at the highest point, the La Montaña estate,³⁸ among others, when its only purpose was to serve the tree-lined Calle Larga (also called *calle Nueva* or *de Carvajal*), and immediately after this, during the reign of Carlos III, the irrigation of the meadows for the royal cows to graze on.

However, in Domingo de Aguirre's detailed cartography (1773), the beginning of the new branch (Carvajal canal) was indicated for the irrigation of the Calle Larga (Long Street) with a straight line perpendicular to the Caz del Embocador, from where it took its water from; a section that confirmed the solution found for the slope at the location of the waterwheel and whose length was the same as that of the current aqueduct (87 meters) (Fig. 3). The aqueduct that has endured till today has a downward-sloping rectangular section, and consists of twelve rounded lime and pebble arches, formwork of facing brick framework, supported by pilasters of the same material and with lime mortar foundations. The testimony of an exceptional traveller who ratified the existence of the aqueduct in 1782 was decisive. Charles de Bourbon, the future Charles X of France, recalls his arrival in Aranjuez in 1782³⁹ and quotes the long street and the aqueduct:

En quittant le pont, on entre dans une belle avenue de quatre rangs de tilleuls arrosés par des rigoles pratiquées à leur pied, et dont l'eau est amenée par un aqueduc qui la tire du Rio Tajo, près d'Aranjuez. Cette avenue côtoie la rivière; le terrain est aride; mais on est agréablement escorté par des daims, des chevreuils et des cerfs qui viennent bondir autour des voyageurs.

(After leaving the bridge, one enters a beautiful avenue of four rows of lime trees, irrigated by furrows at their base, the water coming from an aqueduct that collects it from the Tagus, near Aranjuez. This avenue runs parallel to the river; the terrain is arid, but we are pleasantly accompanied by fallow deer, roe deer and red deer that come bounding around the travellers).

The construction of the aqueduct must be seen in relation to the height to be reached, and the larger dimensions of the noria wheel, always a striking size, but which increased throughout the second half of the century, from the diameter of 8 metres (28-30 feet)⁴⁰ in 1749 to 14.45 metres (52 feet) in 1804.⁴¹ On this point we should highlight the opinion of Dattoli on the suitably temporary nature of the water device, always understanding that in the

35 ES. 28079. AGP APA, C^a 14186..1749, 4 Dec.

36 ES. 28079. AGP APA, C^a 14186..1749, 28 Dec.

37 GARCÍA PÉREZ, Cristina, CABRERO, Félix "Canañes de la Azuda o del Embocador y Caz Chico", *Arquitectura y desarrollo urbano*. Aranjuez. Vol. IX, Consejería de Medio Ambiente y Ordenación del Territorio de la Comunidad de Madrid, Fundación COAM y Fundación Caja Madrid, 2004, pp. 651-652; GARCÍA LÓPEZ, Cristina, 2009.

38 GARCÍA LÓPEZ, Cristina, 2009 insists on the irrigation of the La Montaña estate.

39 BOURBON, Ch. de, « Voyage du Comte d'Artois à Gibraltar, 1782 », *Revue rétrospective, ou Bibliothèque historique, contenant des mémoires et documents authentiques inédits et originaux...* 3, II (1838), pp. 41-43.

40 ES. 28079. AGP APA, C^a 14186. 1749, 15 Nov.

41 ALVAREZ DE QUINDÓS, J. A., 1993, p. 339. This description must necessarily agree with that of 1803, mentioned by GARCÍA PÉREZ, Cristina, CABRERO, Félix, 2004, (ES. 28079. AGP APA leg. 52), sought without success in the corresponding boxes.

future it would have to be a stable and permanent construction⁴².

The first wheel was made of wood at the abandoned nearby cowsheds called *Casa de Vacas*.⁴³ This 1749 wheel was simple and provisional in nature. In fact, in 1763, at the proposal of Esteban Vecchi, some of the wooden elements were replaced by others in bronze, such as the axle.⁴⁴

Esteban Vecchi⁴⁵ was to be decisive in the new works on the waterwheel during the reign of Carlos III, that mainly affected the Caz del Embocador on which the plant was based: these involved alteration under the wheel (where metal reinforcing elements were added), the formation of a small dam in front of it, so that the water gained maximum advantage for the strength and height created, and the provision of two sluices at the height by the bridge on the Madrid road that crossed over the canal.⁴⁶ These works were to be undertaken by the master architect, Domingo Bertini.

These changes were related to the need to increase irrigation: it was at this time that Vecchi, with the support of the Secretary of State, Ricardo Wall, created grasslands in the area of the Doce Calles to feed the cattle in the new Casa de Vacas, the *Casa lechería* (“Dairy House”), to accommodate the new herd that had arrived in 1762. The building was also constructed by Vecchi and located nearby, on the site agreed by the royal architect, Jaime Marquet, the Azuda or waterwheel site being the healthiest area for the livestock to be housed, and closer to the meadows than it was initially proposed, adjacent to the urban area in the Huerta de Secano (non-irrigated orchard)⁴⁷.

At the same time there was a risk of leaving the areas north of the Tagus without any irrigation, due to the destruction of the flood-gate of the channel, and the need to dry out the channel, as revealed by Charles de Witte in 1763 who proposed placing a sluice at the mouth of the channel.⁴⁸

Fifteen years later, in 1778, by a Royal Order of 26 January, the construction of a three-bedroomed house was entrusted to Manuel Serrano, also one of His Majesty’s architects and an architect of merit of the Royal Academy of San Fernando.⁴⁹ With this building the whole waterwheel complex was then completed, concluded to meet the needs of irrigation and control of the water supply that the century of Enlightenment and the Physiocratic spirit had lent to this Royal Site.⁵⁰

The nineteenth century in Aranjuez begun with the rebellion that marked the beginning of the War of Independence. Political events such as those of the liberal Triennium, and the Carlist wars had their destructive echo in a place that bore witness to these events, as a result of it belonging to the Spanish monarchy.

Narciso Pascual y Colomer, architect of the Royal Sites in 1844, reported the examination of the buildings and possessions of Aranjuez,⁵¹ including the “Zúia de La Montaña” (azuda or waterwheel on the La Montaña estate), which had to be reconstructed to accommodate the increase in the diameter of the wheel. The urgency of restoring it (the third priority of the works programme) is explained in the third point of the report of the visit by

42 ES. 28079. AGP APA, C^a 14186. 1749, 3 Nov.

43 ES. 28079. AGP APA, C^a 14186. 1749, 10 Dec. Letter from Baltasar de Prado to Miguel Herrero

44 ES. 28079. AGP APA, C^a 14220. 1763, 25 Nov. from Juan Manuel de Retortillo to the Marquis of Grimaldi.

45 ES. 28079. AGP. Personal files. C^a1073/9.

46 ES. 28079. AGP APA, C^a 14220. 1763, dic, 15.

47 ES. 28079. AGP APA, C^a 14220. 1763, 25 Nov.

48 ES. 28079. AGP APA, C^a 14220. 1763, 31 Oct.

49 ES. 28079. AGP. Personal files. C^a 1642/1.

50 GARCÍA PÉREZ, Cristina, CABRERO, Félix, 2004, refer to the auction of the La Montaña house in 1873: the ground floor with keeper’s living area, entrance hall, kitchen, living room, bedroom and farmyard.

51 ES. 28079. AGP APA., C^a 14360. 1844, jun, 13 (cfr. MERLOS, M. “El patrimonio inmueble de Aranjuez. Su evolución en el siglo XIX”. *Espacio, Tiempo y Forma*, serie VII, H^a del Arte, 1995, pp. 273-304.

the Royal Site supervisor on June 17.⁵² An order was given that day for its “restoration” (*Construcción de la Azúa y recorrido de la reguera que conduce el agua al Puente Largo*) after practically repeating the terms expressed by the architect the day before. Ultimately, this was the restoration of the trees that linked the Puente Largo over the Jarama with the town centre of Aranjuez, i.e. the refurbishment and aesthetic restoration of the avenue at the entrance to Aranjuez, coincides with the start of the reign of Isabel II, the last moment of splendour of this Royal Site.

In that same year of 1844, following the plan proposed by the architect, the Administrator of Aranjuez, bought the machine of Azúa, which was owned by Paulino Roper, for 300 reales (ancient Spanish currency).⁵³ This was probably the metal wheel that can be seen in a photograph of 1902⁵⁴ (Fig. 6), which functioned until the 1920s.⁵⁵ Finally, water power gave way to the electric engine.

In the history of the waterwheel, the studies published so far have included a request from the General Joaquín Ahumada y Centurión made to the Crown in 1880, for the establishment of a water-driven device to take water from the Caz de la Azuda.⁵⁶ But this was a different project, designed for the purpose of irrigating la Montaña, an estate which was located at the division of the general’s property, and where he had crops. It was intended to not

Fig. 6. La Azuda. 1902

harm the rights of irrigators, as can be seen in the requisition document and the plan that accompanied it, corresponding to a waterwheel over a well, using irrigation channels.⁵⁷ It seems that he chose to build a new machine for his own use, after having requested the repair of the waterwheel for the irrigation of his estate years before.⁵⁸ It should not be forgotten that the need to raise water to a higher level (the estate of La Montaña) than that of the original irrigation branch had never before been considered. The *Guía de Aranjuez*, (*Guide to Aranjuez*), written

52 ES. 28079. AGP APA., C^a 14360. 1844, jun, 17

53 ES. 28079. AGP APA., C^a 14360.

54 PARDO, C. Album-guía del real sitio de Aranjuez. Madrid, Tip. “La Revista Moderna”, 1902. Ed. fac. Aranjuez, Doce Calles, 1987. GARCÍA LÓPEZ, Cristina, 2009 circa 1890 establishes the replacement of the wheel although it provides no documentary evidence.

55 LÓPEZ GÓMEZ, Antonio, *Antiguos riegos marginales de Aranjuez* (“Mares”, azudas, minas y canales), Madrid, Real Academia de la Historia, 1988, p. 51;

56 LÓPEZ GÓMEZ, Antonio, 1988, p. 51.

57 ES. 28079. AGP APA., C^a 14419. 1880, junio, 11. Application “Don Joaquín Ahumada, Montaña, establecimiento aparato hidráulico para tomar aguas del Caz de la Azuda con destino al riego de aquella”.

Curiously this official from the Chief of Staff, in the last years of the 19th century military governor of Barcelona, maintained the time-honoured tradition of links between engineering and the army. He had collaborated with Ibáñez de Ibero in the geodesic measurement of Spain and was an official collaborator of the Geography magazine.

58 ES. 28079. AGP APA., leg 124, 1874, 30 Dec and Mar., 1875.

by Ferdinand Nard in 1851, explained how the waterwheel is used to irrigate the seedbeds and the Long Street.⁵⁹ The restoration of the Aranjuez waterwheel (2009-2012) was based essentially on the photograph of 1902. The aqueduct has been restored and reconstructed in the abandoned sections with fully guaranteed results (fig. 7). The wheel has been restored using a modern reproduction (fig. 8). It consists of an axle, crown, twelve spokes, and 48 paddle-buckets (4 between each spoke), which fuse the two traditional elements into exceptional multipurpose parts for movement and elevation, as well as water collection.⁶⁰

ALZADO

Fig. 7. Aqueduct of the Azuda. Elevation. (Recuperación de la Azuda de la Montaña y su Entorno, 2009)

However, regarding its century-old appearance, the five-sided drying crosspieces of Hispano-Muslim inspiration were phased out, simplifying the model and making it closer to the Roman *rotae*. The wheel of the noria is held between two stirrups of different heights (one up to the level of the axle, the other to the level of the aqueduct, as in Cordoban *Albolafias*), through which the canal runs. The current diameter (14.35 meters) corresponds to the 52 feet of the 1804 wheel.

Fig. 8. Waterwheel (Recuperación de la Azuda de la Montaña y su Entorno, 2009)

TIPOLOGY

Typologically, the result of the combination of wheel and aqueduct refers back to the same origins and improvements in norias in the eastern Mediterranean, such as those of the River Orontes.⁶¹ Therefore, it is necessary to travel back to the Late Middle Ages to find the closest reference that confirms once more the Islamic impulse given to irrigation systems created in Mesopotamia and Rome, in general, and to norias in particular, systems that

59 NARD, F. Guía de Aranjuez: su historia y descripción, y la del camino de hierro, con la situación y detalles de sus palacios y jardines, calles y plazas, fuentes y edificios notables, templos, fábricas, fondas, cafés, y cuanto puede interesar al viajero. Madrid; Imprenta de la viuda de R.J. Domínguez., 1851.

60 Step from flat profile of paddles to parabolic, which was better adapted to impact of water and permitted the movement of heavier contraptions without the need to increase the water flow. Diameter: 14.35 m. Height water raised to: 11.35 All technical data on the waterwheel from CABRERA ALONSO, 2009.

61 MIRANDA, Adriana de, Water architecture in the lands of Syria: the water-wheels, Studia archaeologica, Número 156, Roma: "L'Erma" di Bretschneider, 2007.

are part of the Hispano-Muslim tradition adopted in early modern Spain.⁶²

Thus, the example of Aranjuez presents the peculiarity of what have been termed “hydraulic norias”,⁶³ a term that has its equivalent in Spanish (*azuda*), a river-based noria, although in this case, adapted to the course of a canal, not a river. Linked to this, are examples such as the aforementioned Albolafia in Córdoba, or the *azuda* in Toledo.

On the other hand, the brick-built aqueduct - usual in the Spanish waterwheels (Córdoba, Ñora, Rueda) - refers ultimately to the history of Roman essayists (Sextus Julius Frontinus). In the case of Aranjuez, the bays were solved by means of superimposing arches and lintels, in a typical resource reminiscent of the models of Palladio or Sansovino; although, in this case, unusually only the intrados of the semicircular arches are supported by the impost of the supporting pillars.

In addition, this plant was termed *Samaritana* on one occasion.⁶⁴ Although the name of *the Samaritan woman* has been seen as part of the Hispanic tradition of “baptizing” waterwheels with the names of women⁶⁵, the truth is that this name is an obvious reference to the famous water-lifting device (sixteenth century) that raised the water of the Seine to the Louvre⁶⁶, also used as a Gallicism, as the documents themselves systematically resort to the word *azuda* or waterwheel⁶⁷, which identifies the typology of the Aranjuez artefact.

CONCLUSIONS

Following the founding spirit of Aranjuez as a Royal Site, the relationship between man and nature was established on the entertainment-based use of this device and its enriching value. Moving ahead to the physiocratic ideal of the enlightened eighteenth century, these premises had already existed in Aranjuez from the sixteenth century. So, the water, river and irrigation network (channels, dams, ponds) in addition to having a productive purpose, was also invested with an aesthetic and entertainment function and intangible dimension.

The waterwheel served Horatio’s binomial of the classical tradition, beauty and utility. There, one can recognize the purposes of irrigation and ornamentation (the Calle Larga), as well as productive (meadows for pasture), leisure, and industrial.

The earliest documents explain, how, when it comes to determining its location, not only functional questions but also the purposes of leisure must be considered. It had to be accessible, through another new street open for this purpose, which cut across it, and had to provide access by carriage for the queen. and the novelty. which a new feature on the avenue must have meant for the courtiers.⁶⁸ That street, which the Queen herself had designed, from Pical del Rey to the canal, and which crossed Chillones street, was to be the access point; the last section, also wooded, of a avenue from the palace, through the orchards of Picotajo, that would take the queen to this new feature of entertainment.

In addition, the documents insist on the necessary completion of the works in winter, before the arrival of the king and queen in Aranjuez to enjoy the leisure-filled Spring days.

62 On this topic see RODRIGUES and MERLOS ROMERO, “Noras, Norias and ‘Technology-of-Use’”, 2020, pp. 331-350.

63 SHIOLER, Thorkild, *Roman and Islamic Water-Lifting Devices*. Copenhagen: Odense University Press, 1973.

64 ES. 28079. AGP APA. C^a 14186. 1749, 17 Nov.

65 GARCÍA LÓPEZ, Cristina, 2009.

66 “Noria” (waterwheel) was an alternative translation for the word “well” in the New Testament parable.

67 ES. 28079. AGP APA. Caja n^o 14186.

68 ES. 28079. AGP APA. Caja n^o 14186.1749, 22 Nov.

The aesthetic and leisure purpose is evident, also contextualized in the season when the court spent considerable time at the Royal Site. This was the leisure and utilitarian addition to the Calle Larga and the ponds that line it.

The restoration work undertaken between 2009 and 2012 considered all these uses. Leaving aside the waterwheel's undeniable historical and cultural value, its social and environmental function have also been considered: from the recovery of the plant (the wheel, aqueduct and canal), in use during the summer months, to the walk at a location that has been landscaped and where elements of a didactic nature have been added that interpret the culture of water in Aranjuez, revitalizing the role of water engineering and its own aesthetic values, in the shaping of the Aranjuez Cultural Landscape.

Irrespective of whether the waterwheel was erected, and the participation of military engineers in the project, the waterwheel responds to a traditional typology on the Iberian Peninsula, derived from Mesopotamian and classical models, which were revised by Muslim culture in the Middle Ages and still survived in the Christian realm.

Currently, after the process of restoration and rehabilitation of the area, the waterwheel exemplifies the new formulas of sustainable development, based on the use of energies both alternative and classic, such as the use of water currents. This is understood as a symbolic value, which steers us towards traditional methods and techniques, and a desirable respect for the environment. Moreover, it is also a sign of the ancient relationship between Aranjuez and water. Its attractive design makes it a beautiful example of industrial heritage and the most representative water element of the Royal Site.

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