

# The Mill at the Orbetello Lagoon: Mechanisms and Hydraulic Energy

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**Abstract** The objective of this research was to investigate, by means of direct knowledge and analysis of historical sources, the running and mechanisms, including hydraulic, of the windmill on the Orbetello lagoon. Currently, evidence indicates that this particular architectural heritage was just one of nine historic mills that no longer perform their original function. Also, the conformation and characteristics of the lagoon are no longer the same as those of the period in which the mills arose.

## 1 History

Long out of use, the mill at Orbetello is located on the lagoon in the town's historic centre. Orbetello is a municipality in the province of Grosseto, known for the nature reserve in the middle of the lagoon, and joined to Monte Argentario by a road built on an embankment (the artificial dam was built in 1842 by Leopold II, Grand Duke of Tuscany), which divides the lagoon into two parts: the Levant and the Ponente. A rare postcard presented here depicts the Garibaldi theater and bathing establishment in the Levant lagoon on the left, and the Iris theater and bathing establishment in the Ponente lagoon on the right. Portions of Piazza Umberto I (now Piazza del Popolo), the Etruscan walls, the embankment, the mill and Monte Argentario can also be seen (Figs. 1 and 2). In 1913, the Società Nazionale Ferrovie e Tramvie of Rome inaugurated a railway line running along this embankment. The "Baccarini" train traveled between Orbetello and Porto Santo Stefano for thirty-odd years, until the line was bombed in 1944 (Fig. 3). Though many attempts were later made to repair the line, none met with success, and service along the route was never restored (Figs. 4 and 5).

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**Fig. 1** Orbetello, the embankment and view of Monte Argentario, Torriti and Ulivi postcard, ca. 1910. In Savoi and Andruccetti (1994)



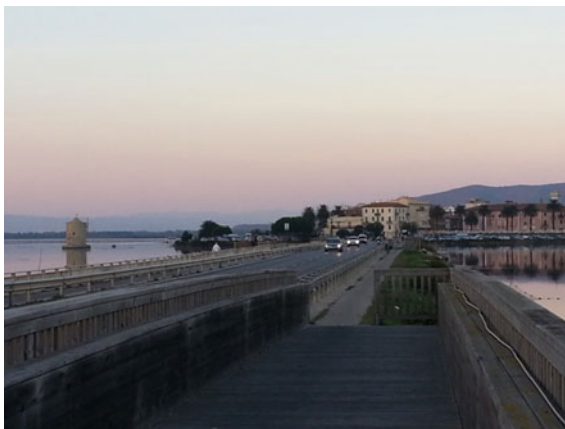
**Fig. 2** Orbetello, Iris theater and bathing establishment. In the foreground, the mill and the Iris bathing establishment, Carlo de Vitt postcard, ca. 1929. In Savoi and Andruccetti (1994)



**Fig. 3** The embankment and railway line, original postcard photograph, property of Dalle Nogare, Armetti and C., Milano (1939). In Savoi and Andruccetti (1994)



**Fig. 4** Photograph of the embankment (Chiavoni 2014)



**Fig. 5** Photograph of the embankment with the mill in the foreground (Chiavoni 2014)



Construction of the mill probably dates back to the end of the 14th century or the start of the 15th, when, having become lords of Orbetello, the Counts Orsini (circa 1358) sponsored many new works in the town. In 1414, the mills were assigned to the community of Orbetello and were later purchased by private individuals. Unfortunately, there are no testimonies from that period, since the ancient documents stored in the Orbetello Municipal archive were lost or destroyed around 1454.

This is the only surviving mill of the nine that once stood in the area. They were all similar and arranged in a line within close range of each other. In the ancient texts, the words ‘pond’ and ‘lagoon’ are used indifferently, and even the term ‘marine lake’ appears, owing to its connection to the sea. The historical maps analysed dating from 1573 to 1742 show Orbetello’s system of mills, with a total of nine represented in some layouts but others showing fewer, as they had disappeared (Figs. 6 and 7). As time went on, all but the one remaining mill were destroyed. In

**Fig. 6** Historical map of Orbetello, circa 1647, approximately. Paper Color cm. 37 × 47 engraved copper Valerio Spada in Florence



**Fig. 7** Plant Orbetello; paper cm. 29 × 36 performed by Jacques Lagniet 1620–1672



addition to the windmills at Orbetello, the area boasted two others, one at Porto Ercole between Forte Filippo and Santa Caterina, and another at Talamone. There were also three watermills in the Argentario Valley belonging to the Chigi family, who had property in the area and were already engaged in trade there. Though nine mills seems too many for a population of around 2000 inhabitants, it has been suggested that the milling industry was particularly flourishing at the time, as the lagoon was more navigable than it is now and grain could thus be transported by sea. It is likely that all the mills were in operation until the early 1800s, after which the number of active mills continued to drop. Most were used only as storehouses until 1917, when Orbetello's western airfield was laid out.

## 2 The Mill Today

The surviving windmill is cylindrical in form, with horizontal circular sections of 5.80 m in diameter on the outside and a wall thickness of around 68 cm (Fig. 8). It is around 6.95 m tall and covered on top by a cone measuring around 1.40 m in height. It rests on a wider base, again cylindrical in shape and measuring around 8.10 m in diameter, rising out of the water by around 80 cm (obviously, this varies greatly) (Figs. 9, 10 and 11).

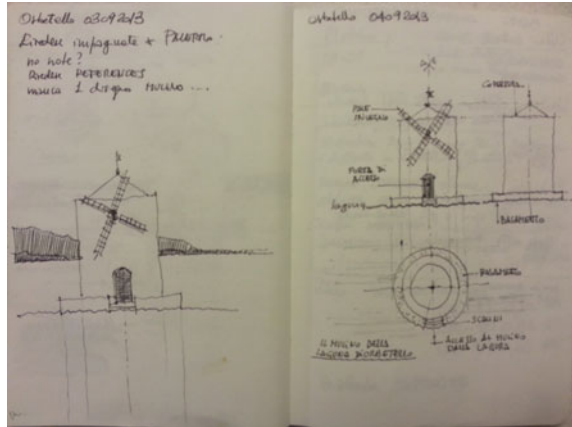
The original construction was built from stone and cement but, during restoration work in 1967 and again in 2000, other materials were inserted to fill in the damaged sections, and copper fixtures and finishings were added as protection from rainwater, along with four wooden sails with steel joints inspired by the design of the ancient sails represented in the engraving by C.H. Wilson in 1832, although smaller. According to some texts by A. Ademollo in 1800, later recovered and defended by Caciagli (1971) and which also appeared among the historical information regarding the Monumental Buildings of the municipality of Orbetello (Fig. 12), the system of nine mills probably ensured that the nutritional needs of the town were met, with the grinding of wheat taking place thanks to the movement of the water caused by the tides.

Wheat was transported to the mills on the small boats typically used on the lagoon in Orbetello and the mills “*did not grind the wheat by means of the wind and sails, as happened later, but thanks to a device driving the water from the pond itself*”. It is understood that, “*in former times, [the mills] exploited the ebb and flow of the seawater (particularly sensitive in Orbetello’s pond) which, every six hours or so, would enter and leave the pond from the tombolo at Giannella near the fish pond tower, causing a large-scale hydraulic phenomenon*”. The nine mills were probably placed in a line as a way of getting the most out of this regular movement of the waters and the constant currents. More recently, these hydraulic machines

**Fig. 8** Pen drawing (E. Chiavoni) of the mill today on the Lagoon (2012)



**Fig. 9** Pen drawing (E. Chiavoni) of the mill today on the Lagoon (2013)



**Fig. 10** Photograph of the mill today on the Orbetello Lagoon (Chiavoni 2012)





**Fig. 11** Photograph of the mill today on the Orbetello Lagoon (Chiavoni 2012)



were given sails to exploit wind power. The sails were directed in such a way as to best exploit the force of sirocco and mistral winds.

Today, in addition to embellishing the panorama around the lagoon, the mill is an important feature of the landscape, both because it bears witness to the system of mills of which it was a part (something known only to those who are familiar with the history of Orbetello), and because it evokes a time-honored practical function that was vital to mankind's survival. Every day, the mill's appearance changes with the passing hours and the shifting light, the shadows on its walls creating an entire palette of colors and effects. At certain times of day, the mill's reflection in the still waters of the lagoon gives us two simultaneous images, a real mill and its virtual twin, each equally entrancing. This architectural emergence attracts a steady stream of photographers, both professionals and passers-by. And for those whose work involves increasing our knowledge of cultural asserts, it is important to record and document the architectural heritage and its setting, not only through photography, but also with watercolor representations (Fig. 13).

Using color captures the characteristics of a subject more intensely, as well as enriching and completing our ability to convey all of the aspects that help make the reality we see before us recognizable (Fig. 14).



**Fig. 12** The Orbetello Mill—Survey Plate 23—Historical changes in built-up areas showing types of characteristic buildings



**Fig. 13** The Orbetello lagoon, watercolor sketch (E. Chiavoni)



It is, thus, a form of analysis that is essential for understanding architecture, a scientific process based on the recognition of shapes, spaces, volumes and proportions which starts with choosing among different methods and tools, favoring those that provide the most pliant means of achieving the best results, and which are, thus, most useful for representing things as they are. Surveying is used as a process of verification that makes it possible to retrace the history of the analyzed object, so that it can be maintained and valorized. It is the interpretative investigation that activates a process of analysis of the individual elements, and which then reassembles the various parts and finds the links that bind them together. The method of study starts from understanding, and drawing is the main author of this procedure; if well done, the graphical representations thus produced can also provide administrators with suggestions for better and more informed management.

**Fig. 14** The Orbetello mill, watercolor sketch (E. Chiavoni)



### 3 Hydraulic Mechanisms

G. Della Monaca's most recent text talks about *"the work done by the mills. There are seven located on the lagoon near the sea gate and others found inland from Porto Ercole and Talamone. The mills on the lagoon were not always working, however, thus, the mills at Porto Ercole were often used. There were even plans to activate a mill within the town walls of Orbetello as a solution for this inconvenience"*. Referring to this sentence, a footnote states that, *"there were nine windmills on the lagoon, but two of them were used for other purposes; the seventh was used as a shelter for fisherman and the last one as a deposit for drinking water from the Monte Argentario springs"*. A subsequent note in the same text states that, *"The mills at Orbetello were wind-driven, although a report written by the mayor of Orbetello, Domenico Maria Sances, dating back to 18 October 1809, suggests that they were later transformed into watermills: in the report, the mayor communicates the state of the watermills that are found in the outskirts of the town, as no windmills are known"*. The historical information that has so far reached us does not always correspond and is sometimes contradictory; so it is not possible to say with

certainty whether the mills on the lagoon in Orbetello started out as watermills or windmills, as stated by some, although several opinions agree that, in different periods and conditions, they alternated between both water energy and wind energy. Nor does an analysis of the surviving mill, which helps us understand its ancient architectural conformation, aid our understanding of how the mechanism exploiting water energy might have worked.

Definite sources have not been found, but some texts dealing directly with the problem of the hydraulic mechanism provide some indications. In the text by G. Caciagli, we read: “...we should assume that the “*buhrstone wheels*” that were used were powered directly by the driving wheels arranged horizontally inside the base of each mill and constantly submerged in water. Thus, the mechanism was “direct driven” via a single fixed shaft on the millstone which ground the wheat, provided there was no gear reducing device between the driving wheel and the “*buhrstone wheel*”. We can also assume that the alternating movement of the water required no special shape for the blades on the driving motors, but doubtless the constant immersion of the wheels in the seawater must have caused considerable lubrication and maintenance issues against inevitable oxidation. This would explain the later adoption of the sail system to exploit the power of the wind”.

## 4 Gearing

The *buhrstone mill* mentioned by Caciagli enabled the grinding of wheat and was one of the oldest types of mill in history. It probably consisted of two wheels made of very hard stone, only one of which was fixed while the other was allowed to rotate. These wheels have a number of grooves. It is thought that the wheat passed through the cone to reach the centre of the pulveriser and had to go through the space between the two wheels, after which it was broken up by the compression forces and finally expelled radially in ground form.

There were two varieties of this type of mill, one with a vertical wheel and the other in which the wheel was horizontal. The latter is likely to have been used in the mills on the lagoon. The horizontal wheel mill had small millstones that carried out an entire rotation every time the water wheel turned and only small quantities of current water were needed for them to function.

The horizontal wheel, or *ritrecine*, consisted of a central pole with recesses engraved into the larger, lower part. This mechanism was secured to the upper rotating millstone by means of an iron crossbar and was activated by water.

The aim of the research, which is still underway, is to contribute to our understanding of the system of mills on Orbetello's lagoon and how they operated in history, in order to safeguard and sustain the only remaining mill.

## 5 Conclusions

The study aimed to increase our knowledge of several of the area's features, including the Orbetello mill, and to identify methods and tools for valorization.

Attention focused on understanding not only the historical and architectural aspects, but also the hydrographic aspects of the machinery and gearing that influenced and characterized the mill. The attention devoted to the architectural aspects is closely linked to the survival—which is by no means to be taken for granted—of such distinctive elements as the millstones, sluices, sails, and mechanisms, which in this case cannot be completely recovered. From a methodological standpoint, this process can be achieved only by starting with a careful census of these cultural assets, identifying their location, classification, number, and dimensions, proceeding with historic and constructional studies until an understanding of their relationship with their surroundings is gained.

One of the aims is to answer the need for knowledge about this mill, which belonged in the past to a particular system of multiple mills related to other systems in the region, given that this building offers potential for repurposing. Only a thorough analysis of such buildings can make it possible to think in terms of development from the standpoint of the networks, systems and routes whereby we can rediscover the region's more recent history through the material testimony it has left behind. It is also important to highlight this building's value for culture and tourism in order to make it better known and appreciated at the regional and national levels.

Accordingly, it is necessary to improve and extend our knowledge of these cultural assets that are so closely linked to mankind's work, with particular reference to the specific system of production, and thus also raise awareness among public and private institutions and individuals of the importance of safeguarding this cultural heritage.

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