DRAINAGE AND IRRIGATION SYSTEMS IN MADĪNA ṬURṬŪŠA (TORTOSA, SPAIN) (EIGHTH -12TH CENTURIES)[1]

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Abstract: From the evidence contributed by the written documentation produced after the feudal conquest of Tortosa in 1148, and by means of the archaeological and hydraulic survey, it has been possible to determine the boundaries of the irrigated and drained areas associated with Madīna Ṭurṭūša and to describe how they were organised before and after the conquest. This paper arises from research focussed on the irrigated urban area called Pimpí, lying north of the city of Tortosa and the sector called, in the earliest documents, *prato Tortose*, which spread south of the city and occupied the left bank of the Ebro all the way to its mouth. The plain of Les Arenes constitutes the starting point of this sector. Pimpí plots were irrigated by wells and water-lifting wheels (*sanīya*) while Les Arenes and part of the southern *pratum* where drained and mainly dedicated to cereal and vine growing. The farmed area linked to Madīna Ṭurṭūša was composed of three distinct areas: the irrigated one, the drained one dedicated to cereal and vines, and the uncultivated *pratum* used as pastureland.
Keywords: *Huerta*, al-Andalus, irrigation, hydraulic archaeology, drainage, Tortosa

Introduction

Madīna Ṭurṭūša (Tortosa) was a city in the administrative district of the Upper Frontier of al-Andalus (*al-thaġr al-a'là*), which ran approximately along the Ebro Valley.[2] Northern frontier cities started gaining prominence in the Islamic chronicles from the second half of the 9th century, when the earliest references to building work, mostly of fortifications, are documented. By the 10th century the expansion of the cities in this region was consolidated, with walls, a fortified palace (*sudda*), a mosque and suburbs (*arrabāḍ*).[3] The earliest forms of settlement were probably precarious and, so, have yielded scarce archaeological evidence, but including storage pits, cesspits and wells. Eventually, in the 10th century, these developed in some areas into a organized urban structure.

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[2] We use the adjective Andalusi when referring to what is relative to Al-Andalus.
[3] Garcia Biosca, and others, 'La gènesi dels espais urbans'.

Ṭurṭūša developed as a *madīna* in the same area as the former Roman town. Archaeologically, only the remains of a building and some slow wheel-made pottery fragments can be dated from before the 10th century in Tortosa.[4] The excavation of an open area in what was a suburb to the south of the *madīna*, in Montcada street, indicates that the zone was occupied as early as the 10th century, but that most buildings, following a regular plan and equipped with a sewage system, date from the 11th century and were in use until the mid-12th, the date of the feudal conquest (1148).[5] In the *sudda* of the *madīna*, a Muslim area of burials was excavated and dated between the 10th and 12th centuries. The burial of the governor ‘Abd al-Salām ibn ‘Abd Allāh ibn Basīl, who died in 961 was identified in this burial place.[6] Another recent excavation discovered Muslim levels dated by pottery between the 11th and the middle of the 12th century.[7]

From the evidence contributed by the written documentation generated after the feudal conquest of Tortosa in 1148, and by means of the archaeological and hydraulic survey, it has been possible to determine the boundaries of the irrigated and drained areas associated with *Madīna* Ṭurṭūša and describe how they were organised before and after the conquest. Furthermore, the distribution of the rural settlements around the city has been established, with a high degree of precision (see Map 1).

Map 1.

This paper arises from research focussed on the irrigated urban area called Pimpí, lying to the north of the city of Tortosa and the sector called, in the earliest documents, *prato Tortose*, which spread south of the city and occupied the left bank of the Ebro all the way to its mouth. The plain of Les Arenes (now of Sant Llàtzer or del Temple) constitutes the starting point for this sector.

The network of roads connecting the settlements on the lower course of the river south of Tortosa can also be identified in the written documents. Near the present-day town of Perelló, the old Via Augusta from Tarragona forked into two roads. One went to Tortosa through the mountainous zone behind the coast, and linked with the Valencia road. The other went through the coastal settlements to Amposta. Tortosa was also the centre of a route parallel to the river that went from north to south through several riverside towns, to L’Aldea, where it met the aforementioned road from Tarragona.

The survey was carried out on a stretch of the fluvial plain, about 11.6 km long, north and south of Tortosa, that includes the irrigated areas of Pimpí (110 ha) and Sant Llàtzer (342 ha) (see Map 2). The goal was to describe the present day conditions of these areas and the organisation of the irrigation to compare it with the information supplied by the written documentation.[8] This comparison enables the main phases of the building and enlargement of the farmed area to be determined, following the method of hydraulic archaeology.[9]

[4] Curto, and others, ‘Resultats de les excavacions arqueològiques’.
[5] David Bea, and others, ‘L’urbanisme del suburbi medieval’.
[6] Curto, and others, ‘Excavacions al castell de la Suda de Tortosa’.
[7] Griñó, Camarasa, and Kirchner, ‘La intervenció arqueològica al Castell de la Suda’.
[8] *Diplomatari de la Catedral de Tortosa (1062-1193)*; *Diplomatari de la Catedral de Tortosa (1193-1212).Episcopat de Gombau de Santa Oliva*; *La Comanda del Temple de Tortosa*.
[9] Barceló, ‘El diseño de espacios irrigados’; Barceló, ‘De la congruencia y la homogeneidad’; Kirchner, and Navarro, ‘Objetivos, métodos y práctica’; Glick, and Kirchner, ‘Hydraulics systems and technologies’. The cartography used includes the ortophotos 1:5,000 from the *Institut Cartogràfic i Geològic de Catalunya* (ICGC) more or less expanded according to the need for detail of the surveyed area. The topographic maps are from the

Map 2.

The surveyed area is characterised by an alluvial zone with a scant drop and prone to periodic flooding with the rise of the Ebro and rainwater coming down several torrents. Nowadays the left bank of the river is irrigated by the Canal de l'Esquerra de l'Ebre ('Left Bank Canal of the Ebro'), which starts twelve kilometres north of Tortosa. It is a big canal, six metres wide and approximately fifty kilometres long. It was inaugurated by Alfonso XIII in 1912, and built to modernise the irrigation system of this area of the Ebro, traditionally based on wells tapping the groundwater with the corresponding *sanīya*(s).[10] These water-lifting wheels were already used by the Andalusi people of Turtuša for irrigation and are mentioned in the feudal documents. Instead, there are no references to main canals. Thus, it is sensible to believe that some *sanīya*(s) located in the area surveyed were first introduced during the Andalusi period. However, the 1912 substitution of one irrigation system for another based on a big canal caused many of these *sanīya*(s) to be dismantled and many of the wells to be abandoned. Often mechanical water-pumps are found inside. Nevertheless, it has been possible to draw up a precise map of their location, and to offer an updated inventory of the total number of surviving *sanīya*(s). In the 1927 aerial photographs, it can be observed that there was a very intense plot division and there has been a process of redistribution of plots since then. However, this redistribution has not affected the main lines of the plot divisions and drainage.

Written documentation, archaeological survey and map of agrarian areas

When Ramon Berenguer IV, Count of Barcelona, conquered Tortosa, he drew up a distribution plan with different criteria depending on the areas. Mountains on the periphery and the coastal area were divided into big domains (*castra, almúnies,*[11] towers), awarded to high nobility members, Tortosa Cathedral and the military orders. Meanwhile, the plains along the river Ebro were divided into plots and handed out as *honours* among the members of the army who had taken part in the siege. An *honour* consisted of a series of scattered plots to farm and a house in the city.[12] Plots located closest to the river were subjected to an intensive process of alienation whose fate was, ultimately, the big feudal estates (Tortosa Cathedral, military orders, Cistercian monasteries, etc.). This explains the preservation of the notarial deeds of transfers (purchases and sales, barters, pawning, donations) in their archives. The documents

same Institute. Photographs shot in 1927 by the *Compañía Española de Trabajos Fotogramétricos Aéreos* (CEFTA) and available at the *Confederación Hidrogràfica del Ebro* (CHE) have been used. The cartography has been arranged with SIG Miramón®

[10] The bibliography about hydraulic techniques conventionally uses the Arabic term *sāqiya* to designate this kind of water-lifting device of oriental origin, characterised by a gear moved by an animal tied up to a horizontal shaft that allows a chain of pots to sink into the well's water and to rise it until the surface. But the Catalan term of *sínia* would come from *sanīya*. The term *sāqiya*, instead, gives way to *séquia* (Catalan) and *acequia* (Spanish), meaning channel. As a classical reference see: Schiøler, *Roman and Islamic water-lifting wheels*.

[11] There is no suitable translation for this term (Catalan: *almúnia*, Spanish: *almunia*), which is from the Arabic *al-munya*. What this term meant in al-Andalus is not very clear. Most of them were found around cities and were, apparently, quite small estates, administered by a single owner. However, the owners were sometimes related to prominent state officers and their *almunia*(s) were luxurious rural properties. Caliphs and state dignitaries used to spend time in their *almunia*(s) located around Córdoba. The Umayyads from Córdoba owned many around Córdoba, with palaces and gardens of plant acclimatization. Lagardère, 'Structures agraires et perception'.

[12] Virgili, 'Les conquestes catalanes'

contribute ample information about the use of the agrarian areas and the location of the fields and other rural landscape elements (dwellings, paths, channels,[13] mills, wells).

The plots located on the alluvial plains of Pimpí and Les Arenes were organized around the axes of the public roads, the roads leading to the farms, the channels and the river bank itself, as shown by the boundaries of fields mentioned in the documents. Apparently, the perimeters formed by these boundaries were rectangular figures in most of the cases.

The documentation contains abundant mentions of crops, both geographically and chronologically well identified. So, in spite of the absence of surface measurements, the information provided by documents allows the observation of coherent guidelines in its location and distribution. An intensive exploitation of the riverside plains can be noticed, with very few mentions of barren land. Through the second half of the 12th and 13th centuries, the big feudal estates promoted plot concentration by means of bartering and buy-and-sell notarial deeds. As the chronology of the documents goes forward, the owners of these estates appear more often as being the neighbours of the alienated fields.

Prat of Tortosa

The settlements south of Tortosa were located in a wide space known from the beginning as the *prat* of Tortosa.[14] The *prat* was a big swampy area mainly dedicated for grazing. There was a need to control the accumulated water by means of drainage, and a web of channels was dug for this purpose.[15] In the southernmost sector of this marshland a number of settlements were located along the coastline, at the edge of what was the mouth of the Ebro in the medieval period: la Granadella, l'Antic, l'Aldea, Burjassènia, Camarles and Candela. The medieval documentation shows a vast grazing area with notable animal husbandry activity that was predominant until the agrarian restructuring led to the construction of the present canal. The short transhumance tracks became fossilised along the *ligallos*, a term still used in Baix Ebre to designate the paths that go from the Ebro's mouth to the coastal mountains.

The northern area of *prato Tortose* was known as Les Arenes in medieval documents and occupied a big meander of the Ebro south of Tortosa. Some documents give the boundaries of this area as the city of Tortosa to the north,[16] the river on the west and the south[17] and mountains to the east corresponding to the Cardó range (Massís de Cardó).[18] This area, of 488 ha, has been modified since the medieval times, mostly during the 20th and even in the 21st centuries. Urban expansion has

[13] We use the term *canal*, for the recently built Ebro canal. It is a big work with nothing to do with the drainage channels documented and identified in the present-day agrarian space. The channels receive, both in the written documents and nowadays, the name of *séquia* in Catalan, which comes from the Arabic term *saqiya* (in Spanish, *acequia*). We use the term *channel* to designate both irrigation and drainage channels.

[14] The first document related to the conquest of Tortosa is the count's donation of Aldea's *almunya,* located in *prato Tortose*. *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 56-57.

[15] Virgili, 'Espacios drenados andalusíes'. A similar process has been documented in Ibiza, in a marshland area around the *Madīna* of Yabîsa, partially drained in the Andalusi period, see: Barceló, González Villaescusa, and Kirchner, 'La construction d'un espace agraire drainé'.

[16] Arxiu de la Catedral de Tortosa, fons de pergamins, calaix 55, carpeta 1 (Arenes), unnumbered parchment.

[17] To the west: *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 152-153, 261-262, 263-264, 526-527 and 537-538; Virgili, *Diplomatari de la Catedral de Tortosa (1193-1212),* pp. 216-217; *La Comanda del Temple de Tortosa,* pp. 176-177, 224-225 and 287-288. To the south: *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 519-521 and 567-568.

[18] To the east: *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 364-365, 368-369, 532-533 and 539.

spread south and occupied a big section of Les Arenes plain. Also, new neighbourhoods had grown in the eastern (La Llet and Sant Llàtzer) and central areas (El Temple). Large communication infrastructures, such as the railway line and a dual carriageway (C-42) nowadays cross Les Arenes from north to south and industrial and commercial estates have occupied significant ancient agricultural lands, reducing the farmed area to 342 ha.

The feudal conquest brought new criteria to agriculture on Les Arenes plain. The conquerors encouraged vine and cereal growing, already habitual crops in Andalusi times. They are mentioned in the documents written immediately after the conquest and have also been recorded archaeologically in recent urban excavations.[19] The colonization by new settlers and development of the vineyards required the recording of abundant written documentation (almost seventy instruments due to the main estates owners: the Cathedral, Order of the Temple and Poblet and Santes Creus monasteries), that now gives rich details for the study of the agrarian landscape.

Two towers are mentioned in this area: the *Turris Lavandera (or Lavanderiarum)* since 1159,[20] and the *Turre Rubea*, close to the *mansum* of Guerau de Salvanyac.[21] These place names no longer exist and it is difficult to define the location of these towers precisely. The only remains of a tower is a wall in the chapel of La Mare de Déu de la Petja. Some plots mentioned in documents were *subtus* the *Lavandera* tower (on a lower level) and had the mountains on the eastern side.[22] This position indicates that the tower was in an elevated place, above the plain, like the tower of La Petja.

The *turre Rubea* (Roja) is mentioned only once, in 1167, when Gales and his wife signed a contract with Pere de Narbona and his family. It states that the Count of Barcelona gave them the tower that it is located *super mansum* (above the farm) of Guerau de Salvanyac. With these references it is not possible to know where the tower was but we know from other documents that this farm was in Les Arenes plain under the jurisdiction of the Templars.[23] The Order of Temple had the dominium of the area south of Les Arenes, in Campredró. So it is possible that the *mansum* of Guerau de Salvanyac could have been on the southern limit of Les Arenes plain and then the Turre Rubea should have been in the neighbouring eastern heights.

The hydraulic network in Les Arenes was organised around a main channel (*cequia mayor*)[24] and other channels running alongside or flowing into it, such as the *esequia media* dug close to an *algezira.*[25] There channels were specifically identified, both related to the area they crossed -like the *cequia de prato-,* and with reference to the plot's owner -such as the *cequia* of Ambrós de Santponç.[26] In most cases, the

[19] Kirchner, Virgili, and Antolín, 'Un espacio de cultivo urbano'; Alonso, Antolín and, Kirchner, 'Novelties and legacies'.

[20] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 154-155, 364-365 and 368-369; *Diplomatari de la Catedral de Tortosa (1193-1212)*, pp. 216-217, 215-216 and 239-240.

[21] *Diplomatari del monestir de Santa Maria de Santes Creus*, pp. 213-214. *Mansus* becomes *mas* in Catalan, and refers to a farm consisting of one or more dwellings, other adjoining buildings related to the agricultural and farming tasks, and the agrarian exploitation. This could be a homogeneous unit, or be made up with scattered fields, as well as forest, pastures, etc.

[22] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 368-69.

[23] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 418-419, 563-564; *Diplomatari de la Catedral de Tortosa (1193-1212),* pp. 318-320.

[24] See a first approach in: Virgili, "Espacios drenados andalusíes", pp. 147-156; *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 364-365 and 395-396.

[25] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 150-151. *Algezira* from the Arabian *al-Jazira* (island). It designated a river island or land in meanders surrounded by water on most sides.

[26] *Diplomatari de la Catedral de Tortosa (1062-1193)*, p. 383.

references are non-specific (*cechia, illa cequia*).[27] Many minor channels appear at the edges of the plots, most of them purchased by Arnau d'Arenes,[28] near the *Lavandera* tower. The channels were often on two of the sides of the field, as a plot surrounded by the p*rat sequia* to the east and the channel of Ambrós de Santponç to the west.[29] There is only one mention of a well, in 1158, when through an exchange Guerau de Salvanyac received a field and a well near his farm and an *alzezira* in Les Arenes, which had belonged to Galib, *scriba sarracenus*.[30] It seems that there was a dense network of channels but, on the other hand, there is barely mention of vegetable gardens (less than 5% of the mentions). Mentions of fields (*campi*) are dominant, and they were presumably destined for growing cereals (54%), while vines (34%) were in constant progression: eight leases for an annual payment express the commitment to growing them.[31] Besides, references to vines show a noticeable spatial concentration due to the fact that vineyards were often next to each another.[32] The reference to one well and several gardens may be a sign that near the *madīna* there was an small area irrigated by means of *sanīya*(s) similar to the one north of the city.

Les Arenes nowadays gets its water from the *Canal de l'Esquerra de l'Ebre* (Left of the Ebro Canal). Before the canal was built, this area was irrigated by means of *sanīya*(s). The space is crossed by the torrents of La Llet and La Petja. The mentions of the *pratum* and the channels point to the existence of marshland, which received rainwater from the streams that flowed into it. The floods by the river and the torrents favoured the accumulation of sediment next to the riverbanks, thus generating slight rises of the terrain, hardly noticeable to the naked eye, but which stopped the draining of water, thus flooding the whole plain. Digging the drainage channels to collect the surplus water and drain it into the river was, thus, indispensable for conditioning the land for farming. The survey's goal was to identify and map the location and line of these drainage channels, if they were still preserved. The morphological analysis of the space from the orthophotos suggested that the paths that organised the area from north to south could have fossilised the trajectory of the original drainage channels. Some ditches along the paths confirm the existence of drainage channels. The scarce preservation of the original main channels, together with the disappearance of the secondary ones as a consequence of the plot re-distribution based on modern criteria, are factors that make their identification difficult. Besides, the lack of maintenance of the system has caused some channels to become silted up. Notwithstanding, it was possible to recognize and map the master lines of the drainage in this space (see Map 3).

Map 3.

This drained area is organised around several main channels that run north-south. Most of these run parallel to the river, except for a perpendicular one and the

[27] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 150-151 and 368-369; *Diplomatari de la Catedral de Tortosa (1193-1212)*, pp. 154-155.

[28] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp, docs. 364-365, 368-369, 383 and 395-396; *Diplomatari de Santa Maria de Poblet. Anys 960-1177*, vol. I, pp. 43-44.

[29] *Diplomatari de la Catedral de Tortosa (1062-1193)*, p. 383.

[30] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 150-151.

[31] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 526-527, 567-568 and 573-574; *Diplomatari de la Catedral de Tortosa (1193-1212)*, pp. 215-216, 239-240, 275-277 and 421-422; *La Comanda del Temple de Tortosa*, pp. 287-288.

[32] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 261-264, 287-288, 336, 519-521; *Diplomatari de la Catedral de Tortosa (1193-1212)*, pp. 216-217 and 391-393.

channelled torrent of La Llet. These drainage channels were probably dug diachronically and represent consecutive phases of the conditioning of this area of 408.4 ha. The oldest drained area has to be the one furthest east in the system, the one furthest away from the river bed marked with number 1 on Map 4, with a channel marked on the same map with the letter *a.* The increase of land reclaimed for farming probably moved closer to the riverbank, adding parallel channels (*b, c* and *d* would come after *a*). In fact, the latest conquest (Area 9 and channel *h*) was still being consolidated in the 1927 picture. It is also possible to propose that the different phases start at the north and east edge, close to the city centre, and thus the final stretches of the channels are more recent. The streams coming down the slope establish natural boundaries to the expansion to the north and south. The concentration of documental mentions south of Tortosa indicates that, at the moment of the conquest, the drainage was not complete. It is even possible that the part in Area 3 closest to the city had been drained and farmed before the occupation of Area 1 had finished. It is difficult to establish the rhythm of the expansion of the drained area, even though it seems to have gone from north to south and east to west. The transversal channel *f*, as well as the stream of La Llet (*e*), indicates the steps in the progression from north to south. Presumably, Sectors 2 and 3 come after Sector 1. Sectors 4, 5, 6 and 7 would come afterwards. Sector 8 follows. Its round shape seems to reproduce an old meander. The last phase would correspond to Sector 9 (see Map 4).

Map 4.

In order to obtain a foundation chronology and more information about the process of drainage, a geo-archaeological study of a sediment column was done. The soil samples were obtained in a 5-m deep trench excavated in a plot that would have been part of the first phase of drainage. The integration of historical records and geo-archaeological data gives an understanding of the evolution of the river floodplain. The predominance of humid conditions and a low to medium-energy depositional environment characterised Les Arenes between the first and 7th centuries AD, broadly coinciding with the Iberian Roman Humid Period (IRHP, c. 650 BC–AD 450) and the Dark Age Humid Period (DAHP, c. AD 500–800). The onset of drier conditions and enhanced river activity are documented starting from AD 686, followed by a lower hydrological regime and the longest dry period of the first millennium at some point between AD 686 and 873/720 and 944. The shift towards drier soil conditions in Les Arenes overlaps with the Medieval Climate Anomaly (MCA, c. 900–1200) and the al-Andalus period (AD 711–1148). The outcome of the geo-archaeological study allows the chronology of the drier conditions to be linked with the initial phase of the drainage of Les Arenes, likely initiated in the 8th century.[33]

South of Les Arenes, the *prat* of Tortosa had other place names including Aquilen (later Naguillem and corresponding to the current hamlet of Campredó), Quinto (*prato de Quinto*) and Pedrera. Documents refer mainly to the riverside and they mention the River Ebro as the western boundary of several plots.[34] About thirteen tenants had land in this area although the Templars were the main landholders and the

[33] Puy, and others, 'Wetland reclamation in al-Andalus'.

[34] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 262-263; *La Comanda del Temple de Tortosa*, pp. 234-235, 238-239, 269-270 and 305-306; Arxiu de la Corona d'Aragó, Ordes Religioses i Militars, Gran Priorat de Catalunya, Orde de Sant Joan de Jerusalem, còdex 115, fol. 50v-51r, 52r and 53v.

Tortosa See also obtained a notable estate during the second half of the 12th century. The documents often mention meadows, lagoons and wild vegetation.[35] In the whole sector, the mentions of fields and pieces of land (66% and 27% respectively) are dominant. There are only two mentions of vineyards and none of vegetable gardens. Finally, an *algezira* with a channel is mentioned.[36] It seems, then, that the area was still not fully cultivated and the fields were mainly dedicated to cereals. Based on the information from written documents, plots were concentrated around the axes of the main drainage channels and near the riverside. They were often surrounded by secondary drainage channels that could have been designed to drain excess water, especially when the river overflowed.

In *Quint*, there was the *cequia de prato* (channel of the meadow). One of the fields in *Quint*, acquired by Alegret d'Altafulla through an exchange, was next to a channel to the north, with the *cequia de prato* to the east and the river Ebro to the west.[37] From this information it can be deduced that this drainage channel had a north-south layout. It was probably one of the main axes of the drainage system. The secondary channels located north and south of the fields were perpendicular to the main channel.[38] An orthogonal network of channels allowed excess water to be drained into the main channels and the river. Nevertheless, the references to wild areas indicate that the *Prato de Quinto* was not fully drained.

Besides, mills could be found in this area. In 1172, the Moncada family acquired a field and the mill of Pedrera, nearby *Quint*, with the channel bringing the water to it (*caput rego*). The mill was later transferred to the Templars. It was adjacent to the river Ebro to the west and a channel and marshland (*palud*) to the north, but there are no remains of it.[39] Another mill is mentioned with the name of Soldevila. Although it no longer exists, some people had known it and can describe how the water from two springs was channelled into it. At Soldevila's place, close to the riverbed, three silos were found. It is possible to relate these to the old Soldevila mill.[40]

There was also a settlement around a tower, which the first documents refer to as the *turris Asmeto*, known later by the name of the Rocacorba brothers, who received it in the distribution, according to the confirmation made by King Alfonso the Chaste and Ramon de Montcada in 1164.[41] The tower was knocked down in 1967 to enable exploitation of the quarries and the clay deposits in the surroundings. There were two other towers in this area: the tower of Campredó and a tower called Llotja or Casa del Prat. There are remains of both of them.[42] None of these towers is mentioned in the written record before the 14th and 15th centuries and they were probably built not long before (see Map 1).

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[35] *La Comanda del Temple de Tortosa*, pp. 228-29 and 232-35.

[36] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 476-478; *La Comanda del Temple de Tortosa*, pp. 228-229; Arxiu de la Corona d'Aragó, Ordes Religioses i Militars, Gran Priorat de Catalunya, Orde de Sant Joan de Jerusalem, còdex 115, fol. 50v-51r; Virgili, *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 451-452.

[37] *La Comanda del Temple de Tortosa*, pp. 238-239; Arxiu de la Corona d'Aragó, Ordes Religioses i Militars, Gran Priorat de Catalunya, Orde de Sant Joan de Jerusalem, còdex 115, fol. 50v-51r.

[38] *La Comanda del Temple de Tortosa*, pp. 234-235 and 238-239.

[39] Arxiu de la Corona d'Aragó, Ordes Religioses i Militars, Gran Priorat de Catalunya, Orde de Sant Joan de Jerusalem, còdex 115, fol. 51r; *La Comanda del Temple de Tortosa*, pp. 232-35; *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 449-50 and 476-78; *Cartulaire général de l'Orde des Hospitaliers*, vol. I, pp. 554-55; Archivo Histórico Nacional, Instituciones Eclesiásticas, Ordenes Militares, Orden de San Juan de Jerusalén, Gran Priorato de Cataluña, códice 662-B, fol. 31-33.

[40] Arbeloa, 'Localitzades tres noves sitges a Tortosa'.

[41] *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 200-201.

[42] About these towers, see: Bolòs and Almuni, 'Castell de Campredó'; Bolòs and Martínez, 'Construcció de la Llotja'.

Thus, moving south from Tortosa, the agrarian landscape becomes uniform, with a predominance of barren fields grouped together in scattered clusters. There are also very few settlements –just *Quint* and the documented mills- before reaching the coastal settlements called *almunia* (*al-munya*). The apparent contradiction of this landscape, seemingly not intended for growing crops despite the existence of a thick network of canalizations, can be explained because it was a marshland (*prato*), prone to flooding by the Ebro, but also and mainly by the streams flowing down from the mountain range on the Ebro's left bank. Better use of the space required draining the stagnant waters by means of a drainage system consisting of a network of channels dug in the ground. The purpose of the latter was to gather the water and drain it, not to use it for irrigation. The documentation makes reference to lagoons and marshland, and the abundant vegetation associated with it –cane and fodder- and the draining system, which was organised around main channels acting as drains to the channels from the plots that join them perpendicularly. At the same time, the land left out of the drainage -the *prat* itself- was the main area for grazing and it stretched from Les Arenes to the mouth of the river, between L'Aldea and L'Antic. According to a 1258 document, addressed to the Muslim people of L'Aldea, who had been deported from Valencia in retaliation for a revolt, they could take their cows, mares, donkeys, sheep and goats to the pasture stretching between the Aldea path and the sea, without paying any rent.[43]

Horta de Tortosa

The irrigated area linked to Tortosa, known from the time of the conquest as Pimpí (*orta*[44] *de Pimpino, Pampino, Punpí*), a name it still retains nowadays, is an wide river plain next to the city's north walls. The sector closest to the river, a slice of land over a soft meander, made up the *algedira d'Abnanicorta*, called also *illa Xiquina*. It had been awarded to the Jewish community of Tortosa by Ramon Berenguer IV in 1149,[45] and was totally covered in vegetable gardens, whose former Andalusi owner's names are listed. Pimpí is very well documented, since many deals for plots transfer were formalized, with details of the different crops (up to 24 documents between 1148 and 1212). In most of them, fields are situated along the route that went northwards from Tortosa, sometimes being beside the riverbank at the same time, which shows that the farmed area was elongated along this axis and that the riverbank was not as channelled as it is nowadays.[46]

In contrast with the uniformity observed south of Tortosa, this sector was characterized by a diversity in the uses of soil, with a balanced distribution of mentions of crops. In Pimpí, next to Tortosa, the *orti* (orchards) represent 50% of the

[43] '*Volumus et concedimus quod dicti sarraceni (...) habeant herbaticos (...) per omnia loca dominationis Hospitalis ad pascendum bestias, scilicet, vaccas, equas, asinas, oves et capras sine aliquo logerio et habeant devesiam de via de Aldea que itur apud Terrachonam usque ad mare ad bestiarum eorum (...)*', *Cartas de población*, vol. I, pp. 444-446. The dispute between the Templar Order rand the Santes Creus abbey for pasture areas in which the king had to intercede (1194) shows how important the control of pastureland was for these institutions. See: Carreras, *El monestir de Santes Creus*, vol. II, pp. 236-237.

[44] *Horta* and *huerta*, in Catalan and Spanish respectively, are terms to refer specifically to irrigated areas, often related to big towns or cities.

[45] *Cartas de Población*, I, pp. 126-128.

[46] There are many documents mentioning plots that can be located in this area. Examples include: *Diplomatari de la Catedral de Tortosa (1062-1193)*, pp. 127-128, 146-147 and 200-201; *Diplomatari de la Catedral de Tortosa (1193-1212),* pp. 343-346; *La Comanda del Temple de Tortosa*, pp. 175-176, 178, 229-232, 243-244, 249-250, 253-254 and 260-261.

mentions, followed by vineyards (25%) and fields (25%). The *orti* in Abnabicorta Island (La Xiquina) still has to be included. The figures have to be interpreted as trends, since different varieties of crop, including trees, were grown together in many of the plots. For example, *orti* and olive groves are mentioned together.

Precisely here, where the proportion of vegetable gardens is higher, according to the place-name identified in the very first documentation (*orta de Pamplino*), there is no mention of any channel. There was not, then, water from the river moving into a network of channels. Instead, wells are documented. The shallowness of the water table in the strips of alluvial terrain next to the course of the Ebro favoured the digging of wells. The term 'well' has to include, by extension, water-lifting wheels and ponds to collect and store the water, although the texts have few mentions of these. A well with a *sanīya* and a pond is documented in one vegetable garden in Pimpí: *orto cum…cenia et çafareg*.[47] In this case, the whole complex is clearly described: the well, the *sanīya* and the pond for irrigating an orchard. There was a well next to the Remolins gate in the city wall and an Islamic cemetery (*ubi sarracenorum olim cadavera sepeliebantur*). This well was probably the same given, in 1157, to the Order of the Hospital by Ramon Berenguer IV: *orto cum ipso puteo et cenia*. This is the oldest written mention of a *sanīya* in the Ebro region.[48]

The survey in the field and the making of the map reveal morphological differences in the division of irrigated plots in Pimpí. Two strips can be distinguished parallel to the river. The one closest to the present riverbank is apparently from the most recent conquest. The one (18 ha.) along the path from Tortosa to the north, the current road, was colonised first and is the one mentioned in 12th-century texts. However, the rate at which it was occupied cannot be established, nor where Abnabicorta Island was. What does really seem clear is that the farmed plots started right next to the city gates (see Map 5).

Map 5.

Present *sanīya* (s)

The surveying has been done systematically. Every existing *sanīya*(s) in the irrigated spaces of Pimpí and Les Arenes has been recorded. The trajectory of the irrigation channels coming from the ponds has been mapped. In all, 145 *sanīya* (s) have been identified although most of them are not in use. In any case, a formal uniformity has been observed in their characteristics. The wells are oval shaped and made wholly of masonry. The wheel and gear were made of iron, and most of them no longer have their *sanīya*(s) buckets. The circular surface the animal walked round to turn the wheel is unevenly preserved in each case. The installation of water pumps led to a heavy modification of the area around the wells. The *sanīya*(s) enable irrigation of groups of plots one or two hectares in size. The only formal diversity observed among the wells is the depth, which ranged between six and twelve metres, depending on the level of the water table. Ultimately, there is a depth beyond which the installation of these water-lifting wheels was not feasible. This depth is well demarcated by the more easterly line of *sanīya*(s) in both surveyed areas: those in Les

[47] Arxiu de la Corona d'Aragó, Ordes religioses i militars, Gran Priorat de Catalunya, Orde de Sant Joan de Jerusalem, còdex 115, fol. 63r; *La Comanda del Temple de Tortosa*, pp. 231-232. In Catalan the term *çafareig*, from the Arabic *sahrij*, designates a pond to collect water used for irrigating a nearby vegetable garden. In this case, the pond was supplied with water lifted from the well with a *sanīya.*

[48] *L'Arxiu Antic de Santa Anna de Barcelona*, vol. I, pp. 294-295; *Cartulaire général,* vol. I, p. 195.

Arenes and Pimpí. For the time being, it is very difficult to know which wells date from Andalusi times, which are from after the conquest and which are more recent. However, their alignment is coherent with the phases of expansion of the farmed area, and it is reasonable to suggest that the newest wells are those closest to the river.

Conclusions

The intensive fieldwork carried out has supplied answer to the question raised by the meticulous study of the written documentation. This is clear evidence, once again, that the textual and archaeological records are necessarily complementary.

The earliest written documentation generated by the conquerors regarding the agricultural landscape during the decades following the conquest of Ṭurṭūša in late 1148 shows two clearly different areas south and north of the city. The north was characterized by a diversity of the crops and a significant presence of *horti*, to the point where these were dominant in some areas (according to the mentions, because we do not have surface measurements). What once was the irrigated area of Ṭurṭūša is significantly mentioned as *orta de Pampino* in the oldest texts, or as it is still called nowadays: Horta de Pimpí. Despite the importance of this irrigated area, there is no evidence of channels to conduct the water to the vegetable gardens. Besides, wells with *sanīya*(s) and few ponds are mentioned. It seems clear, then, that the initial occupation of this area did not mean tapping water directly from the river through a channel. The irrigated area at the moment of the conquest was probably no larger than 18 ha, demarcated by the line of plots along the path from Tortosa and furthest from the riverbank. The many difficulties, mainly technical, to control a river like the Ebro, with the abundant but irregular flow not controlled by dams as it is nowadays, led farmers to seek alternative techniques. The proximity of the water table made it more viable to dig wells and install *sanīya*(s). In fact, the first project to raise the water level of the river with the goal of diverting it through a canal running to Tortosa on the left bank dates from the 14th century.[49] After a century of works, the project failed. It was not until the 19th century, when the present diversion was built, that the river water could be used.

To the south, a complex hydraulic infrastructure made up of a dense network of channels has been found along with mills. Contrary to what could first be assumed in a big irrigated zone, the documentation shows a uniform landscape of land (*terra*, *campum*), eventually destined for growing cereals and grazing (*pratum*). The settlements were few and small. The *prat de Tortosa* was crossed by channels to drain excess water. These channels, running on a lower level than the one for the crop surface, were not used for irrigation. Only in the most northerly sector of the *prat*, the big alluvial plain close to Tortosa, known then as Les Arenes, did the conquerors change the crops to boost vineyards. The Christian incomers found this area already organised by the Andalusi people, even though the latter had not completely drained it. A series of phases have been distinguished through the morphological analysis of the plot division, the survey and mapping *in situ*. The maximum area at the moment of the Catalan conquest is very difficult to determine, but would not exceed the limits that include Area 1, perhaps Area 2 and part of Area 3, in any case, no more than 70 or 80 ha. The rest was probably done in consecutive phases very spread out in time, and it has been impossible to date it these so far. Documentary research is still being

[49] Vidal, *La construcció de l'assut de Xerta-Tivenys*.

carried out to define the chronology of the phases of expansion precisely. Drainage and desiccation could have generated the need for wells and *sanīya*(s). A well is mentioned in a document from immediately after the feudal conquest. This probably indicates that the introduction of *sanīya*(s) in this zone had started already in earlier periods. The distribution of the wells is now coherent with the advance of the conditioning processes of this big plain. Nevertheless, large unploughed marshland areas were still left in the 12th century and made excellent grazing areas for cattle.

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