An urban warehouse for foodstuffs in the *Iulia Valentia Banasa* colony (*Mauretania Tingitana*, Morocco)

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Mots-clés : *Maroc,* Mauretania Tingitana, Iulia Valentia Banasa *(Sidi Ali Bou Djenoun), entrepôts, stockage, production céréalière, Gharb romain, Ier-IIe s. apr. J.-C.*

Résumé : *Les témoignages archéologiques de greniers ou d'entrepôts en Afrique du Nord sont peu nombreux, ne s'étendant qu'aux sources épigraphiques et littéraires. Les recherches récentes menées par l'INSAP de Rabat et l'Université de Sienne dans la ville de* Thamusida *(Maroc) ont apporté un éclairage nouveau sur l'étude des grands et petits entrepôts. Cet article analyse le cas du bâtiment quadrangulaire avec contreforts de la ville de* Banasa*, un exemple d'entrepôt bâti pour répondre aux besoins de la micro-économie urbaine. L'étude a permis d'analyser le contexte territorial dans la période comprise entre la fin du Ier s. apr. J.-C. et la seconde moitié du IIe s. apr. J.-C., lorsque, avec la construction du grand* horreum *de* Thamusida*, le blé du territoire de* Banasa *s'est inséré dans un contexte de production céréalière à l'échelle extraterritoriale.*

Keywords: *Morocco,* Mauretania Tingitana, Iulia Valentia Banasa *(Sidi Ali Bou Djenoun), warehouses, storage, cereal production, Roman Gharb, I-II. A.D.*

Abstract: *The archaeological evidence of grain stores and warehouses in North Africa is limited; knowledge is mainly based on epigraphic and literary sources. The recent research conducted by INSAP of Rabat and Siena University in the city of* Thamusida *(Morocco) shed new light on the study of large and small warehouses. This article identifies a quadrangular building with buttresses in the city of* Banasa *as another example of a warehouse built to satisfy the need of an urban micro-economy. The study includes a modelling of the territorial context in the period between the end of the 1st century A.D. and the second half of the 2nd century A.D., when with the construction of the great* horreum *of* Thamusida*, it is argued the Banasitan grain was included in the cereal production context on an extra-territorial scale.*

الكلمات المفاتيح : المغرب، موريطانياالطنجية، يوليا فالنسيا بناصا(سيدي علي بو جنون)، مخازن، تخزين، إنتاج الحبوب، غرب روماني، القرنين الأول والثاني ميلادي.

التلخيص : تعد الشواهد الأثرية التي تخص مخازن حبوب شمال افريقيا نادرة ما يجعلنا نكتفي بالمعلومات المتأتية من المصادر القديمة أو النقائش. إلا أن الأبحاث الأخيرة المنجزة من طرف المعهد الوطني لعلوم الآثار والتراث بالرباط وجامعة سيانا في مدينة تاموسيدابالمغرب مكنتنا من مزيد التوضيح حول دراسة المخازن الكبيرة والصغيرة.
سندرس من خلال هذا المقال حالة المبنى الرباعي المدعم الموجود بمدينة باناصا وهو مثال لمخزن بني تلبية لحاجيات الإقتصاد الحضري الجزئي.
مكنت الدراسة من تحليل السياق المجالي خلال الفترة الممتدة من نهاية القرن الأول ميلادي وحتى النصف الثاني من القرن الثاني ميلاديحيث تم بناء المخزن الكبير بـ تاموسيدا وتم ضم الحبوب المتأتية من مجال باناصا ضمن سياق إنتاج الحبوب على صعيد يتجاوز حدودها الإقليمية.

1. Settlement characteristics

Iulia Valentia Banasa, a city in the province of *Mauretania Tingitana* (north-west of Morocco), was founded on the left bank of the river Sebou, along the road between *Tingi* and *Sala,* in the central area of the Gharb plain (fig. 1).

The city was one of the colonies created by Octavian between 33 and 25 BC, in the period between the donation of the realm of Bocchus II to Rome and the advent on the throne of Juba II. In 1871, thanks to an epigraphic find, C. Tissot was able to recognise the city, previously known only from literary sources, in the ruins found in the locality Sidi Ali Bou Djenoun[1].

During the French protectorate, the ancient colony was subjected to excavation work led by R. Thouvenot, head of the *Service des Antiquités du Maroc* and attended by A. Luquet, curator of the site until 1957. A. Luquet carried out the first surveys of the buildings[2]. The research continued under the direction of M. Euzennat, who between 1955 and 1956 directed some of the investigative excavations in the southern district and the north, secondary, *cardo*. In that area several ceramic kilns of the pre-Roman period were discov-

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1. Euzennat, Marion 1982, p. 69.

2. R. Thouvenot and A. Luquet published the data regarding the uncovered ruins in various articles printed in *Publications du Service des Antiquités du Maroc*: Thouvenot 1954 a-e; Thouvenot, Luquet 1951a-c and in a monograph: Thouvenot 1941. Regarding the bibliography of the first research activities see Euzennat 1991.

Fig. 1: Cities in the province of *Mauretania Tingitana* (from Thamusida 1 2008, p. XVI, fig. 13).

ered. These date to the 5th-4th century B.C. Recent missions, directed by Franco-Moroccan teams, conducted studies of the baths[3] and a pre-Roman settlement[4] in the southern area. The city was built on two artificial hills separated by a central valley where the forum was located, with a loosely orthgonal urban system of irregular parallel streets[5]. A city wall ran all round the settlement, positioned at a lower level compared to the internal buildings. The visible area covers around 4 hectares and geophysical prospection on the site has shown the area inside the walls to be a little more than double that size[6].

In Roman times, the city represented an important strategic and defensive centre with auxiliary troops. Although epigraphic documentation shows that troops were indeed present until the beginning of the 3rd century A.D. no certain trace of any *castra* has been found[7].

Using the road axes as references points, the settlement can be divided into 8 sections (fig. 2): the *forum* (1) is positioned at the centre of the settlement, at the crossroads between the *cardo* and the *decumanus*, with the *basilica*, the *curia*[8] and the *Capitolium*[9]. The second district runs from the forum to the *decumanus* and contains mainly commercial buildings. District 3 lies to the south of the obliquely aligned *decumanus* and contains further commercial buildings, dwellings and baths[10].

District 4 is characterised by distinctive houses on two floors[11]. District 5 contains only one excavated building of a commercial nature, the *macellum*[12].

District 6 is located to the west and contains commercial and domestic buildings[13]. District 7 is on the north of the hill and here there are various blocks of buildings with elite dwellings[14] and the baths[15]. Finally, district 8 comprises a series of long rectangular *insulae* on the south side of the main *cardo*; the buildings in this area are residential and commercial[16]. This article will analyse the quadrangular building to the extreme south of District 2.

2. The quadrangular building in district 2 and the new research

The city has yelded a large number of inscriptions which have been particularly significant in the understanding of many aspects of daily life in the province of *Mauretania Tingitana*. One inscription found in *Banasa* and dating back to A.D. 215-216 (a letter from the Emperor)[17] informs the city that although neither wheat nor money had been sent to Rome for years, he had decided to cancel the debt with an act of liberality for *Banasitani* in exchange for men and other contributions[18].

The local community was required to recommence the payment of taxes and contributions. The reference to the city and the supplies is certain. Nonetheless within the city and near the river frontage no structures that could indeed be interpreted as warehouses have yet been identified. The area along the river cannot be easily examined given the considerable bild up of alluvium (fig. 3).

In a note in *Le limes de Tingitane. La frontière méridionale*, M. Euzennat gives us a brief description of a building that was unearthed in 1954 in the south-east district, suggesting a small quadrangular construction with external buttresses on three sides, each of which measuring 18 m long[19]. He gives no particular description of the building, but only refers to the general excavation that was undertaken in those years in the craftsman's district in the south-east.[20]

Unlike R. Thouvenot, who believed the building was contemporary with the original colony, M. Euzennat dates the structure to the end of the 1st and the beginning of the 2nd century A.D. based on the ceramic material and the Domitianic and Nervan coins found at the foundations.

3. Arharbi, Kermovant, Lenoir 2001, p. 148-149.

4. Arharbi, Kermovant, Lenoir 2001, p. 149-153.

5. According to the analysis by S. Girard (1984, p. 84-93) of the excavated stratigraphy in some trenches around the settlement of the first levels of occupation were all at the same height. The creation of two higher points therefore was due to later building from at least the 2nd century B.C.

6. Lenoir 1996, p. 1067-1072.

7. Euzennat 1989, p. 61-62. The presence of a *castrum* to the west of the city near the river was hypothesised by A. Luquet on the basis of an aerial photo from 1942. See Jodin 1974, p. 38-40.

8. J.-Ch. Balty (1983, p. 127-129) considers the building to be the *curia* of the city, based on its location and the discovery only a few metres away to the south east, of one of the thermal baths of *Tabula Banasitana* (*IAM* 2, 94). Imperial edicts had to be presented in a *curia*.

9. Boube 1967, p. 276-283, p. 340-352; Brouquier-Reddé, El Khayari, Ichkhakh 2004; Euzennat, Hallier 1986, p. 78-82; Thouvenot 1941, p. 7-13; 1954b.

10. Thouvenot 1941, p. 29-31.

11. See : *Maison du Diplôme de Domitien* (Thouvenot 1954d, p. 40-45; Euzennat 1989, p. 65); *Maison à la mosaïque de Vénus* (Thouvenot, Luquet 1951b, p. 65-71); *Thermes aux fresques* (Thouvenot, Luquet 1951a, p. 21-32; Arharbi *et alii* 2001, p. 148-149); *Grands thermes Ouest* (Thébert 2003, p. 257; Thouvenot, Luquet 1951a, p. 10-21);

12. Euzennat 1991, p. 1326.

13. See *Maison de Fonteius* (Thouvenot, Luquet 1951c, p. 82-84); *Maison aux quatres piliers* (Thouvenot, Luquet 1951c, p. 84-86); *Maison du Macellum* (Thouvenot, Luquet 1951c, p. 86-99); *Petits thermes Ouest* (Thouvenot, Luquet 1951a, p. 40-49).

14. See *Maison du génie de l'abondance* (Thouvenot 1941, p. 23-27).

15. Thébert 2003, p. 255-256 ; Thouvenot, Luquet 1951a, p. 33-40.

16. Thouvenot 1954c, p. 20-33.

17. Thouvenot 1946 = *AE* 1948, 10. 9.

18. See Di Vita-Évrard 1988. For the previous bibliography see *ibid*., p. 287, n. 2. Giangrieco Pessi 1988, p. 119 where reference is made to the attempts of Caracalla to stem a looming crisis and to follow a plan that recalculated that of his father Septimius Severus. Regarding the economy of the city of *Banasa* in the provincial age, see Alaioud 2004; 2010. Regarding *Mauretania Tingitana* and the aspects concerning the export of wheat see Papi 2017; Papi, Martorella 2007a. Regarding the typology of the *horrea* in North Africa see Virlouvet 2009. Regarding the *horrea* of Numidia see Papi, Martorella 2007b.

19. Euzennat 1989, p. 66, n. 113.

20. For the bibliography see Euzennat 1989, p. 66, n. 113.

Fig. 2: Map of *Banasa* with the numbered districts (from Arharbi, Kermovant, Lenoir 2001, fig. 1). The quadrangular building is shown in black.

Fig. 3: *Banasa*. Build up of land due to flooding on the left back of the river Sebou (photo F. Martorella).

Since 2010 and thanks to the project *Granaries and Warehouses in North Africa and Egypt during the Roman Age* (GRAWINAE). *Typology, building techniques, function, productive context*[21], coordinated by the author of this paper, it has been possible to study the topic of food supplies in greater depth with a focus on the archaeology of warehouses located in the wheat provinces of North Africa in the Roman period[22]. The in-field investigation (the documentation of the structures that are still visible and the analysis of the masonry) together with bibliographic research, have allowed us to update and reconsider the plan proposed by A. Luquet (fig. 4 and 5), confirming the identification of the building as a warehouse for foodstuffs [23].

2.1 Structural analysis

The building is approximately square, with walls surviving roughly 0.80 m tall from the foundation pit. The externally-measured surface area is 307.22 m², while the internal floor surface area is 201.19 m².

In the south-west corner, there are ruins of a small internal room of 17 m². There is no evidence of the position of the original entrance which most probably was on the southern side. There are no other visible apertures onto the internal space either.

The 1.00-1.10 m thick walls were built on elements of different sizes in a series of distinct layers. The spaces between the stones of the wall faces are filled in with stone chips and small stones. The quoins are made up of alternating headers and stretchers.

The in-field investigation and the architectural report, together with the research from the archives, have allowed me to reconsider the plan of the building and correct the architectural data.

Figure 7 shows the elements of the north-west and north-east buttress pillars that were not reported by A. Luquet. They are however shown in a city plan by M. Euzennat[24].

The buttresses used to support the external walls are well anchored into the structure, on each end they can be seen as extensions of the orthogonal walls (fig. 8).

The building technique seems to be the oldest of all the buildings included in the original form of the urban network and the orthogonal road plan dating back to the colonial founding.

However, based on the information and dating provided by M. Euzennat[25], it can be hypothesised that the same construction method was still being used during the reorganisation of the monumental centre, between the end of the 1st and the beginning of the 2nd century A.D.[26].

Later (3rd century A.D.) the whole area was levelled. The building was flattened and its walls were used as foundations for two more constructions to the west and the south-east (see fig. 4, plan by A. Luquet). The area was filled with earth in order to raise the floor level as can be seen from the higher entrance to the new building directly positioned on top of the west perimeter wall (fig. 9).

The excavations in 1954 unearthed some of the plan at a foundation level. Only the perimeter walls were discussed in detail in the report, while the floor level was not (see fig. 4).

Recent investigation has led to the analysis of certain areas that were still hidden and comparing this with the plan by A. Luquet, the re-elaboration of the plan and the structures that are no longer visible has been possible. The small quadrangular room, in the south-west corner of the building, still has visible traces of its foundation along the southern internal wall. A protrusion of about 0.10 m shows the floor level that is no longer present (fig. 10).

From the analysis of the internal and external walls, no traces of any kind of insulation were found, nor were there remnants of an internal flooring in the central room or traces of a floor level on the walls. It can be assumed that only the small room to the south-west had a real floor at a height of 0.40 cm. The internal floor must have been made of wood and raised. The limited height of the perimeter walls means that there is no evidence of holes for beams, nor are there

21. http://cordis.europa.eu/result/rcn/143795_en.html

22. Catherine Virlouvet supervised the research project at the Université de Provence, and in particular within the *Centre Camille Jullian (CCJ), Archéologie Méditerranéenne et Africaine (UMR6573) - Maison Méditerranéenne des Sciences de l'Homme*, Aix-en-Provence. The bibliographic research took place in the archives of the *CCJ* and the *Institut National des Sciences de l'Archéologie et du Patrimoine* (*INSAP*, Rabat, Morocco), where the reports from the studies carried out in the investigation sites in question are kept. The interest in the quadrangular building at *Iulia Valentia Banasa*, which was identified by the author of this paper as a warehouse in 2006, runs parallel to the research promoted by the University of Siena (coordinator Prof. E. Papi) and the INSAP (coordinator Prof. A. Akerraz) on the site of the ancient city *Thamusida*. E. Papi contributed suggestions, technical and logistical support regarding the data taken from *Banasa*. The authorisation to research and collect data was made possible thanks to the former director of INSAP, Aomar Akerraz.

23. The map of the buildings by A. Luquet was found in 2012 by the author in the archives of the *Centre Camille Jullian*.

24. Euzennat 1989, p. 66.

25. Euzennat 1989, p. 66, n. 113.

26. Brouquier-Reddé, El Khayari, Ichkhakh 2004, p. 1891-1898.

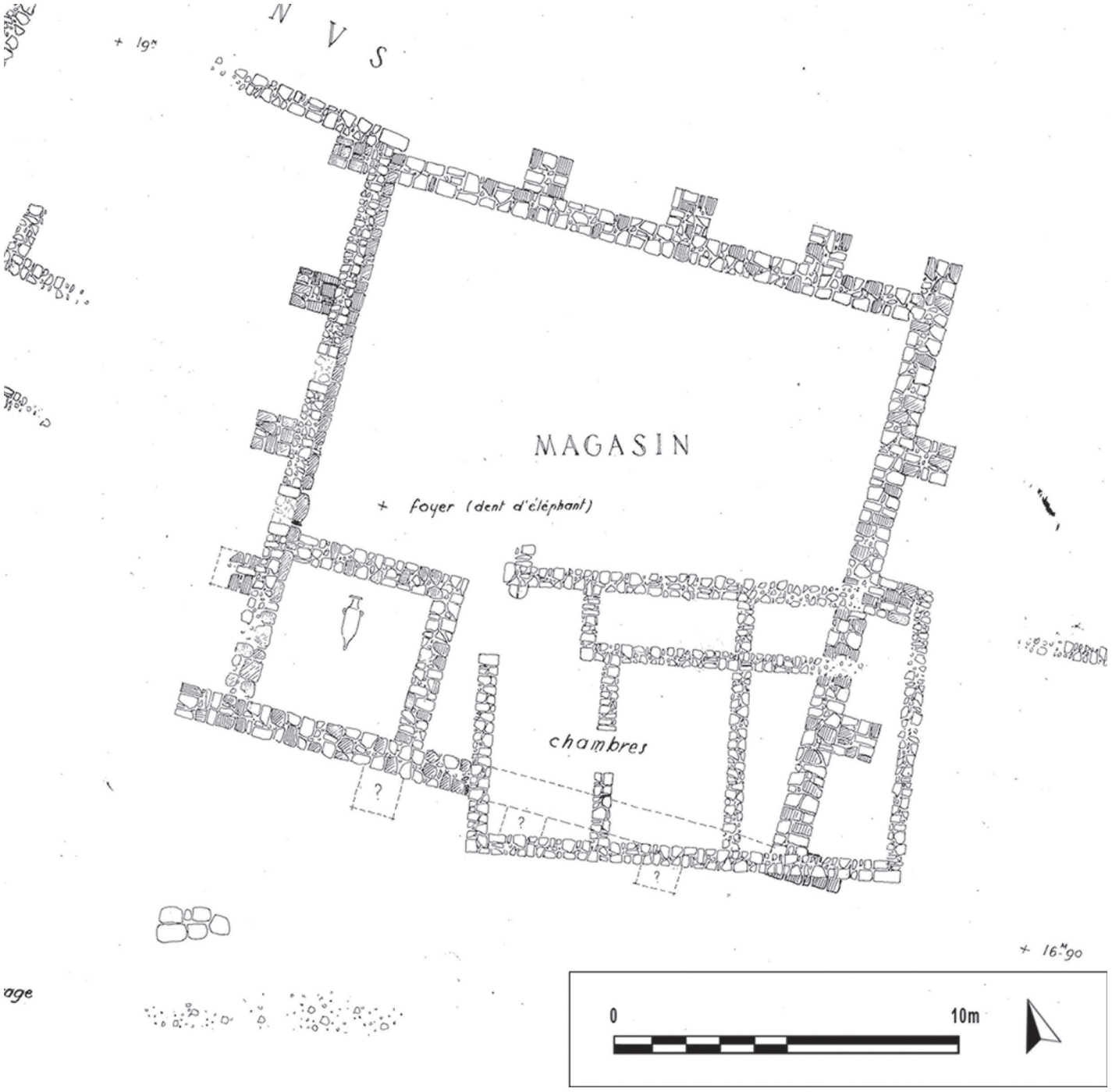

Fig. 4: Plan by A. Luquet (Centre Camille Jullian, Archéologie Méditerranéenne et Africaine – UMR6573 – archives)*.

* The authorisation for research in the archives of the *Centre Camille Jullian*, *Archéologie Méditerranéenne et Africaine (UMR6573)* was given by Dominique Garcia, director of the Institute from 2008 to 2011.

Fig. 5: Aerial photograph of the latest excavation showing the quadrangular building (from Luquet 1966, p. 373).

Fig. 6: Warehouse, seen from the north. The dotted line indicates the north-east and north-west sides (photo F. Martorella).

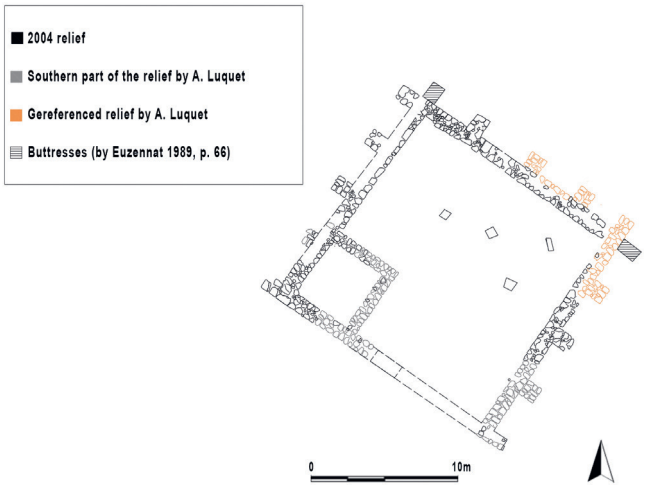

Fig. 7: Plan of the warehouse (drawing F. Martorella).

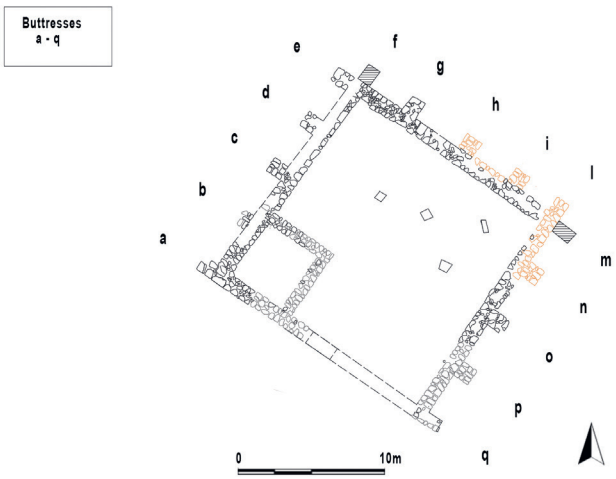

Fig. 8: Buttresses (drawing F. Martorella).

signs of partition walls like those in the warehouses in the neighbouring Roman city to the south-west *Thamusida*[27].

Inside the building there is a series of more or less regular parallelepiped limestone blocks brought to light by the excavators of the time, but not documented because they were probably considered to be in a non-original position (fig. 11).

The parallelepiped sandstone[28] vary slightly in size (block A: 0.80×0.40×0.60 m; B: 0.90×0.40×0.60 m; C: 0.75×0.47×0.68 m; D: not identified) and are visible in the aerial photograph taken of the latest excavations (see fig. 5).

The most likely hypothesis is that the blocks are the surviving traces of a set of stone bases that supported a wooden floor. The blocks would have been positioned in a regular manner throughout the internal surface area and will have supported joists and planking above floor. The flooring in the *Banasa* warehouse must have been built therefore with raised wooden planks in order to guarantee the best conditions for aeration (fig. 13). This is a system commonly seen in military granaries in the provinces[29].

External buttresses and stone bases with the same supporting function have been found in granaries of the Hadrianic period belonging to the Roman forts of *Vercouicum* (modern day Housesteads)[30] and *Arbeia* (modern day South Shields)[31]. Other examples include some granaries in Germany[32].

The architectural characteristics of the building together with the general design therefore are similar to those found in military camps in *Britannia*. However, this type of raised floors was not exclusively a prerogative of the *castra* of the north-west provinces.

27. Papi, Martorella 2007a.
28. See Aberkan 1989.
29. Rickman 1971, p. 213-250; Gentry 1976, p. 10.
30. Rickman 1971, p. 223, fig. 41; Gentry 1976, p. 82 and fig. 11.
31. Rickman 1971, p. 222, fig. 40; Gentry 1976, p. 92 and fig. 14.
32. Rickman 1971, p. 241-243, fig. 52 e 59.

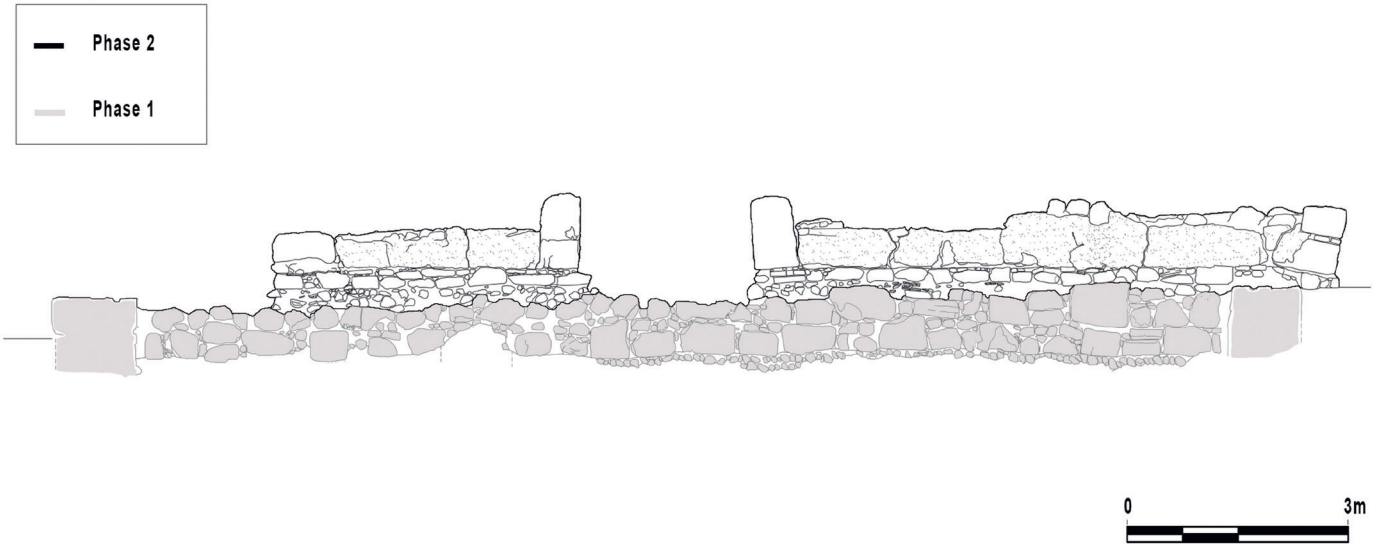

Fig. 9: Internal view of the west perimeter wall (in grey) on top of the wall built previously (in black) (drawing F. Martorella).

Fig. 10: Small room to the south-west showing where the floor level was positioned (photo F. Martorella).

Fig. 11: Stone blocks (A-D) supporting a raised floor (photo F. Martorella).

Fig. 12: Warehouse with stone blocks supporting a wooden floor, visible from the outside (west side) of the *Vlpia Marciana Traiana Thamugadi* colony*. (photo F. Martorella).

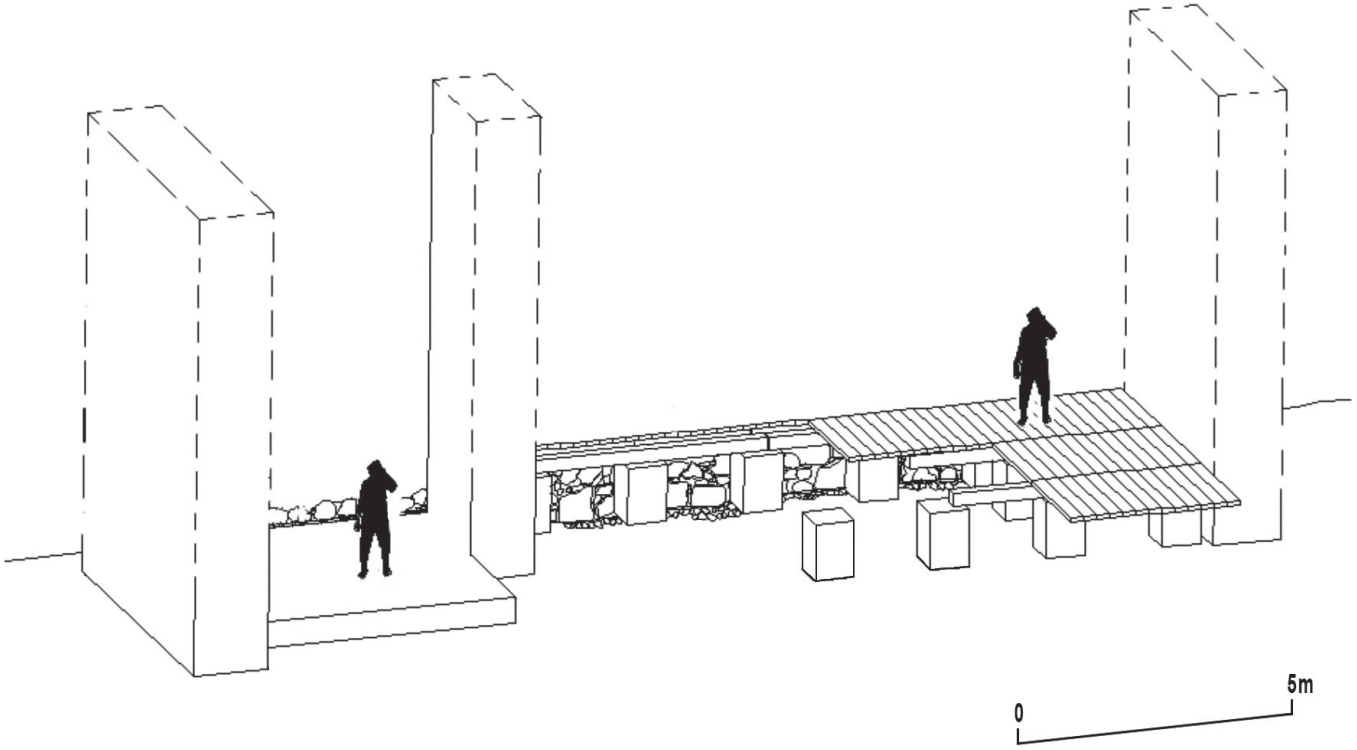

Fig. 13: Reconstructive and axonometric hypothesis of the floor levels of the *Banasa* warehouse on the basis of architectural survey data. On the left, you can see the floor of the small quadrangular environment to the south west; in the centre stone blocks to support the wooden plank (drawing F. Martorella).

* The warehouse was identified by the author of this paper in 2016 when recording architectural data of the two warehouses in *Thamugadi*. The expedition, coordinated by the author, came about thanks to the collaboration between the École française de Rome (Catherine Virlouvet) and the Université de Batna 1 (Fatima-Zohra Bahloul). Regarding some warehouses in the roman city of *Thamugadi*, see Martorella, Zohra Bahloul 2020, p. 1-34.

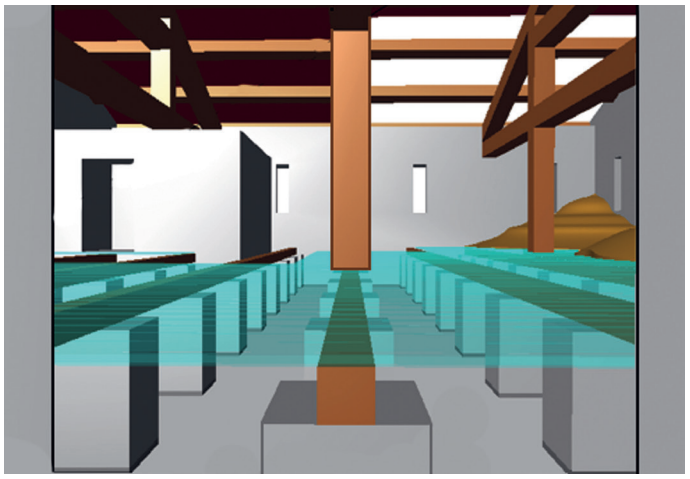

Fig. 14: 3D reconstruction of the internal space (stone blocks, beams and transparent wooden plank flooring) (F. Martorella).

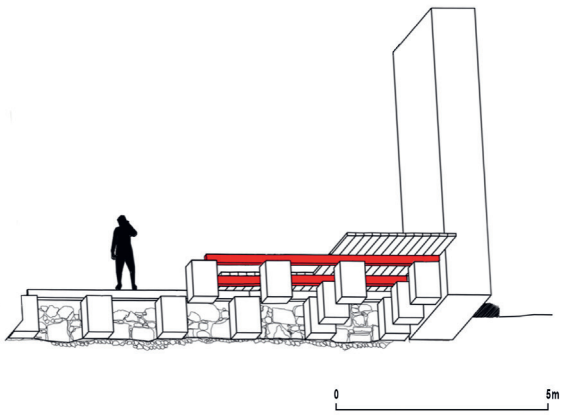

Fig. 15: In red, wooden beams (20×20 cm) in oak with an interaxel spacing of 1.78 m and an effective span of 5.94 m (drawing F. Martorella).

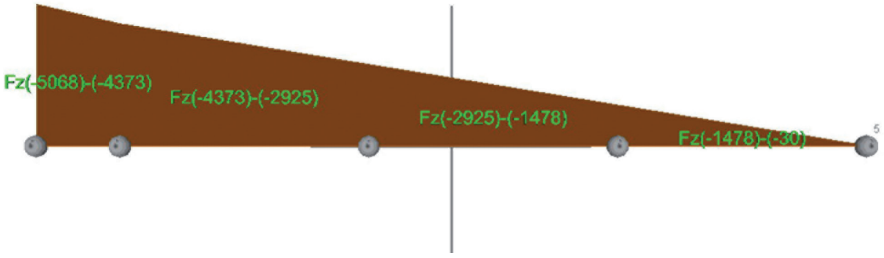

Fig. 16: Distribution diagram of the load (permanent and occasional) along the wooden beam measuring 5,94 m (drawing F. Martorella).

The *Banasa* example, in a veteran colony, has its nearest parallel in North Africa, more precisely in an as of yet unpublished warehouse of the colony *Vlpia Marciana Traiana Thamugadi*, the city founded in A.D. 100 by Trajan on the northern slopes of the Aurès (modern day Algeria) (fig. 12).

The structural analysis together with the possibility of calculating the entire usable surface area allows and suggests how the internal environment was structured.

In order to guarantee the highest level of insulation and to keep away damp, the pillars were positioned at regular intervals in what could be called a chess-board pattern, at a height of about 1 m were designed to hold a number of beams that would have supported the wooden floorboards (fig. 14).

At *Thamusida*, traces of *quercus suber* have confirmed the suspicion that the wooden beams had been sourced from the nearby forest of Mamora, further supporting the idea that there was a mezzanine level entirely built of oak given that the material was so readily available. This would also have applied for the warehouse of *Banasa*[33]. Subsequent to this interpretation and using the hypothesis that quadrangular beams (0.20×0.20 m) with a maximum length of around 6 m were used, I have been able to reconstruct the internal flooring[34]. Through a possible calculation of the limit state design (LSD)[35] I have been able to calculate maximum load that the wooden floor would have been able to carry.

The length of the beams would have been conditioned by the trees available[36] and in particular the space between the supporting blocks would have been at a distance of 1.78 m, given their position. The reconstruction has allowed us to evaluate the measurements of the structure (0.20×0.20×5.94 m beams; flooring with 0.05×0.20×1.78 m planks) as well as the load (both permanent and occasional), which has meant we could test the LSD and the resistance. The permanent load

33. In the port granary of *Thamusida*, on top of the internal foundations of the south perimeter wall, traces of carbonised wooden beams were found (*quercus suber*) which were 0.20 m wide and positioned so as to support the raised wooden flooring. See Papi, Martorella 2007a.

34. In *Thamusida*, given the space that needed to be covered and the limited length of the wooden beams *quercus suber*, joints would have had to be used especially in the A-frames used to support the roof, as in the warehouses in *Mauretania Tingitana*, see Rebuffat 2010.

35. LSD is a modern system used to calculate the technical norms relative to general criteria used in order to check the safety of a building, its load and over-loading. The coefficients that are applied to the loads are defined depending on the materials used and the type of building (*quercus suber* wood in this case), as well as the building method (reconstructed from structural analysis here), and the use of the building (raised flooring), in order to obtain the correct level of resistance.

36. Rebuffat 2010.

is due to the beams (0.20×0.20 m) and the weight of the planks[37] (fig. 15).

The occasional weight taken into consideration was that of stored grain in loose piles (exerting a greater stress) with a specific weight of 842 kg/m^3 distributed in various ways (from 5.068 kg to 30 kg) along a beam length of 5.94 m (fig. 16).

2.2 Storing systems

Once the load capacity had been calculated, the internal usable surface area was considered and evaluated, as well as the access points and the storage activities, the supporting capacity of the flooring and the weight of the wooden pillars supporting the roof. The estimates also consider the three alternative systems of grain storage: firstly wooden chests, secondly loose piles on the flooring and against the walls, and thirdly using sacks.[38]

Using wooden chests would surely have guaranteed a better management of the foodstuffs. If we consider chests of at least 1 m in height and 1.5 m wide when full, we can estimate a total average volume between 59.05 m^3 and 88.60 m^3, with a variable capacity between 49.72 tonnes (1 m chests) and 74.60 tonnes (1.5 m chests). These purely hypothetical measurements are consistent with wooden containers of variable heights (between 1 and 1.5 m) that were still in use until the mid 1980s in the Mediterranean area (fig. 17).

My calculations have shown that piles of grain could easily have been deposited along the internal walls taking up a surface area of 164 m^2. The flooring would have been able to support up to 340.26 m^3 of grain (286.49 tonnes)[39]. However, the estimation does not include the weight of the wooden pillars positioned centrally supporting the roof that would surely have limited the storage area available as no weight could have been exerted to the side of these pillars.

Fig. 17: Wooden grain bin (1×1×2,5 m) (photo F. Martorella).

37. As for example in *Thamusida,* Papi, Martorella 2007a.

38. Rickman 1971, p. 85.

39. If we consider the total space available, the whole building could have contained up to a maximum of 500 tonnes: Papi 2017, p. 429.

The area available for storage would therefore have been almost halved (fig. 18).

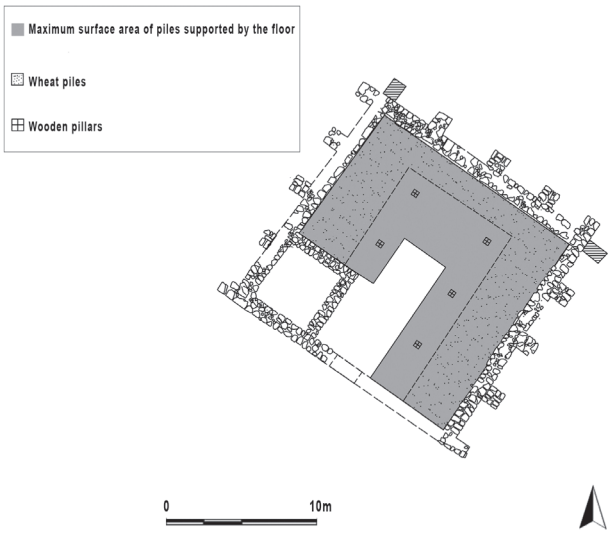

Fig. 18: Surface area available for piles of wheat avoiding the roof pillars. In grey, the maximum total surface area that the flooring could support (safe load) (drawing F. Martorella).

Given this limitation, the storage area can be calculated at 98.80 m^2 with the wheat piled up against the west, north and east walls. The maximum height of the piles of wheat that could be stored against the west and east walls would have been 2.45 m and 228 m respectively. The north wall however had a more limited area available with the pillars measuring 2.80 m, which meant that the wheat could have been piled against this wall up to a maximum width of 1.75 m and maximum height of 1.22 m. The total average volume therefore would have been considerably reduced to 101.86 m^3, or 85 tonnes. Compared with the loose piles on the floor, the use of sacks would have reduced the load capacity when we consider the necessary gap between the perimeter walls and the sacks, the apparent specific weight, and the difficulties involved in storing and checking the foodstuffs.

If we suppose that there would have been a gap of 80 cm between the sacks and the perimeter walls, and between the sacks and the central pillars, the possible surface area available would be 202 m^2. Assuming an average height of the piles to be between 1m and 1.5 m, the maximum volume would have been between 80.97 m^3 and 121.46 m^3. Given that the apparent specific weight measured 15 % and needs to be taken away from the weight of the wheat in kg/m^3, the maximum variable capacity can be estimated between 59.28 tonnes (in piles 1 m high) and 88.92 tonnes (in piles 1.5 m high). These load calculations show that the floor would have been able to support piles of sacks stacked over 3m high. The structural analysis together with the climatic aspects of the area in question should guarantee the correct preservation of the foodstuffs in a solid, well built and hydrothermally safe environment.

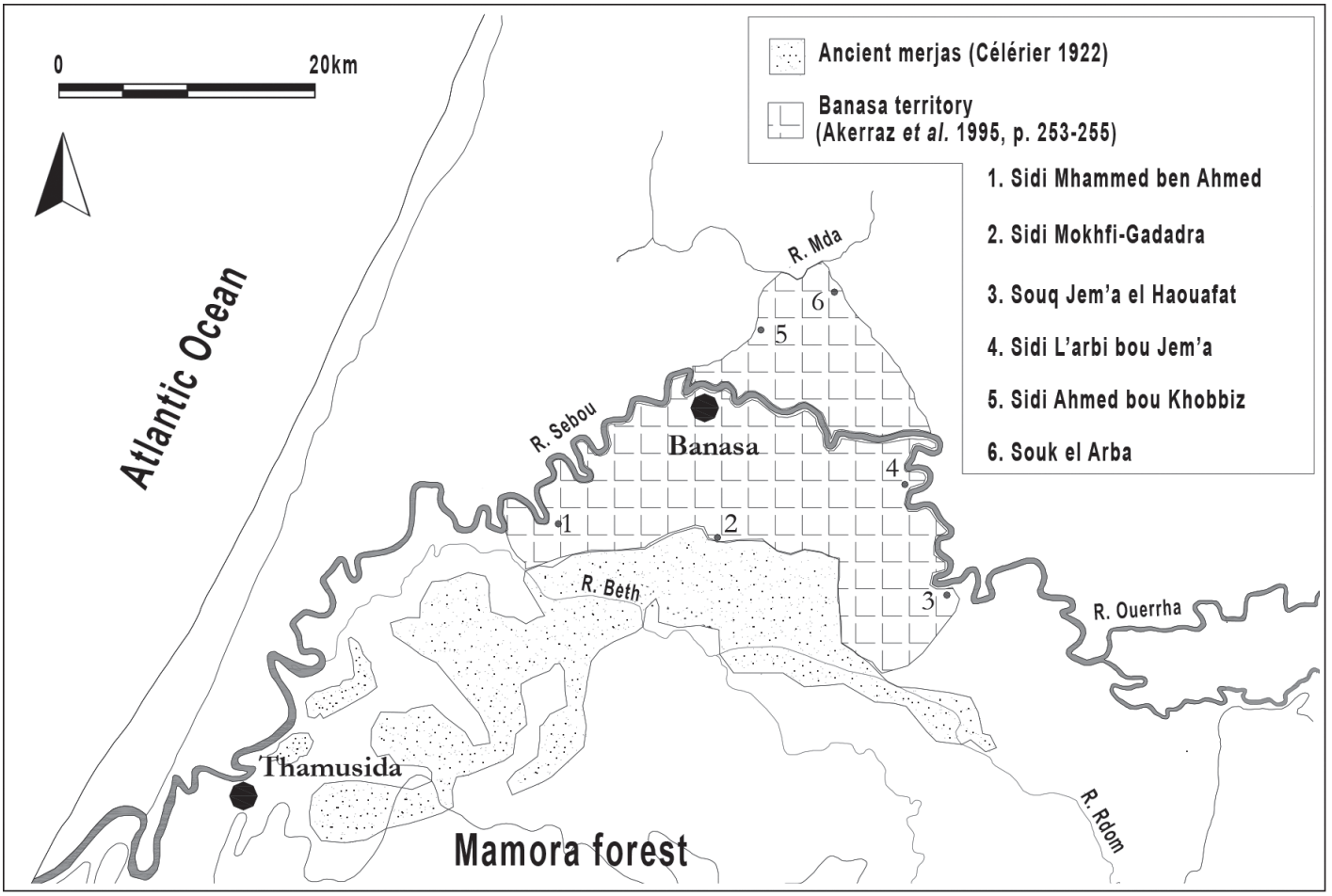

Fig. 19: *Banasa* territory (drawing F. Martorella).

3. The productive context of *Banasa*

In ancient times the navigable river, a barrier neither feared nor considered impassable, was a determining factor in agricultural and economic development for the cities that sprang up and developed along its banks. Recent studies attest that the commercial interest gave the river an exceptional strategic importance[40]. The foundation of the *Iulia Valentia Banasa* colony was not to be strictly connected to the creation of a defensive system on the river but rather to a *reclassement* of veterans and a desire for economic development in the region[41]. M. Euzennat assigned an area of about 5.000 ha to the territory of the colony[42] (fig. 19).

The discovery of the several sites within c.20 km of the city, according to the data that was taken from the exploration of the Sebou basin, shows the occupation and frequent use of the flood plains in the area between the left bank of the river and the northern boundary of the *merjas*, or marshes.

The assumed southern border would have run from the sites of Sidi Mhammed ben Ahmed 14.5 km to the southwest, Sidi Mokhfi-Gadadra 10.9 km to the south, to the site of Sidi L'arbi bou Jem'a or even further east to the site Souq Jem'a el Haouafat. A further extension to the north until Sidi Ahmed bou Khobbiz towards Souq el Arba up until the river Mda cannot be excluded either (see fig. 19)[43]. The ruins of the farmers' dwelling that would have characterised the territory are no longer visible since they have been covered by alluvia.

The palaeoenvironmental conditions of the city and the territory were probably not dissimilar to those around the city of *Thamusida* [44], with marshes (*merjas*) and differences that attest to slight climatic and hygrothermal variations. Agricultural activity is concentrated also in this case on blackish clay soils (*Tirs*). The possibility of growing wheat and other cereals without irrigation depends on the depth of the water table (1-5 m) and its low salt content (fig. 20). We know that wheat can tolerate a soil salinity of up to 9 grams of sodium chloride per litre; if greater, the harvest would decrease considerably.[45]

On the basis of the soil characteristics, the yield of the soils in the area in question have been estimated. The soils of the plain give a medium-high evaluation for the production of cereals and can be classified as follows:

blackish clay soils of the fluvial plain (*Tirs*), deep with flat morphology (Hypocalcic Vertisols) and high evaluation for the production of wheat;

40. Akerraz, Brouquier-Reddé, Lenoir 1995, p. 235-256; Akerraz, Rebuffat 2005, p. 243-244; Rebuffat 1986.

41. Rebuffat 1986, p. 643-644.

42. Euzennat 1981, p. 377-378 ; 1989, p. 98-99.

43. Akerraz, Brouquier-Reddé, Lenoir 1995, p. 254-255.

44. Arnoldus Huizenveld 2008.

45. *FAO* 1973, p. 193.

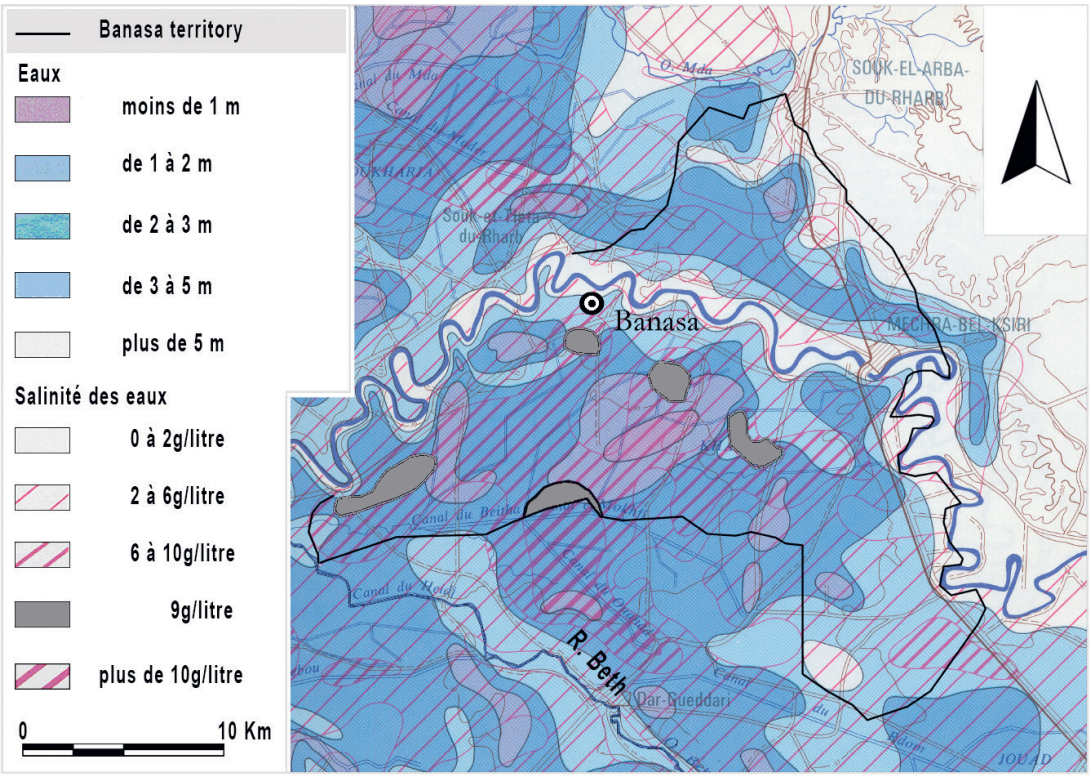

Fig. 20: *Banasa* territory, water table and salinity (from *Atlas* 1970, 30).

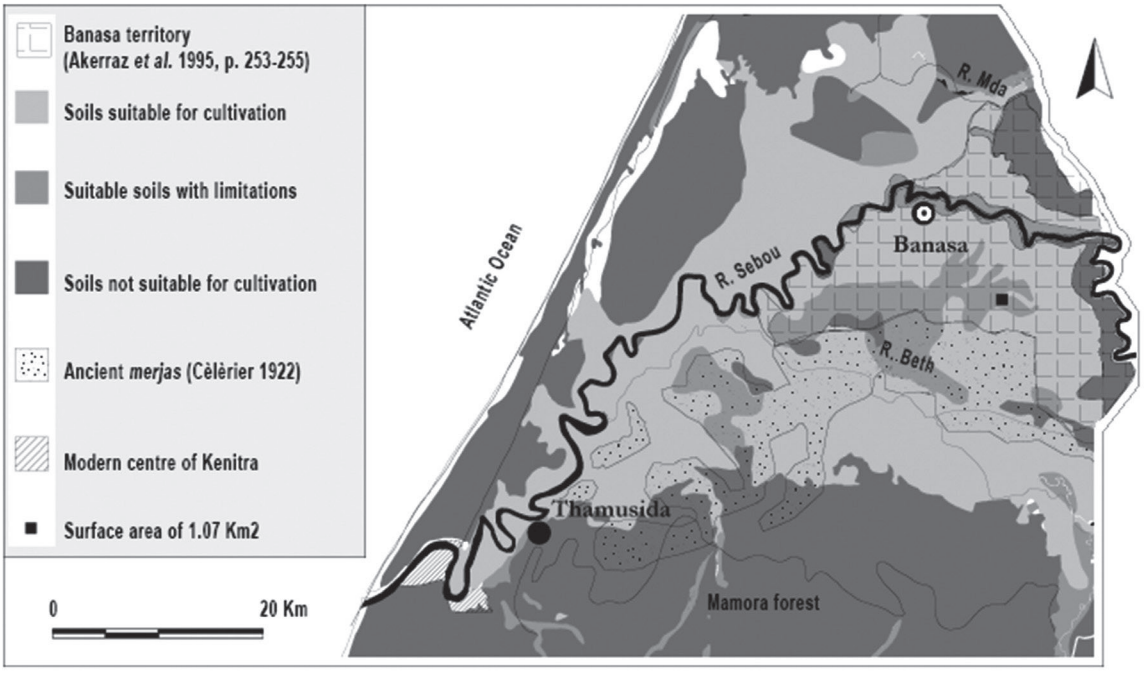

Fig. 21: Gharb plain and estimated boundaries of the *Banasa* territory (drawing F. Martorella).

loamy fluvial and grey loamy-clay soil (*Dhess*), deep, with flat morphology (Calcaric Cambisols) and high evaluation for the production of wheat;

sandy fluvial soils, deep, with flat morphology (Calcaric Arenosols) and medium wheat production.

The soils with a high potential for the production of cereals are presented with fine, deep or limited depth texture with low risk of water stress.

The soils with an average potential for the production of cereals present a medium or coarse texture with moderate risk of water stress.

Figure 21 shows an area of 3531.98 km^2, within which the area of the *Banasa* territory (477.06 km^2) was delimited on the basis of the indications provided by the surveys.

The land has been divided into seven categories:

1) *Banasa* territory;

2) soils suitable for cultivation: good quality soil for the wheat, maximum production and low risk that the crops are compromised (*Tirs*, water table between 1 and 5 meters deep, presence of NaCl less than 2gr / l);

3) suitable soils with limitations: medium-quality soil for cereals, low production and high risk that the crops are compromised (Tirs, water table between 1 and 5 m deep, presence of NaCl of 2-6 g / l);

4) soils not suitable for cultivation;

5) marshes (*merjas*), difficult to evaluate[46];

6) land occupied by the modern centre of Kenitra;

7) ideal square of 1.03 km per side (1.07 km^2) graphically represents the necessary surface area needed to product the amount of foodstuffs that could be stored in the *Banasa* warehouse.

The analysis and the comparison of traditional cultivation systems of cereals can still provide interesting evidence for the study of ancient food production and yield.

The varieties of soft and hard grain seed sown at the time of the protectorate attest to yields varying between 500 and 800 kg, which, as has already been pointed out, is close to the broad band of intermediate productivity (6-7 times the volume of seed) which is between the good averages reported by Varro and the very low averages of Columella[47].

Within the *Banasa* territory, we can consider 257.79 km^2 of *Tirs* and *Dhess* soil suitable for cultivation, adding to a surface area of 102.24 km^2 of soil with limitations, and making the total potential surface area as much as 360.03 km^2. The soil that is not suitable for grain cultivation, making up 89.16 km^2, has been subtracted from this total.

If we consider the productivity of the lands cultivated by the local population with an average minimum yield of 6-8 q / ha, the 36.000 ha of land with medium and high agricultural potential would guarantee a yield of between 21.600.000 and 28.800.000 kg.

Considering the maximum quantity of grain that could be stored in the granary according to the technical characteristics (85,700 kg) and supposing a minimum yield of (21,600,000 kg), the quantity that could be stored inside makes up only 1/252 of the whole harvest. Given a maximum yield (28.800.000 kg) and the maximum load that the floor could have supported (286.000 kg), 100 granaries like our case study example would have been necessary to house the entire production. If we suppose there were a bi-annual crop rotation, leaving the land for pasture or for growing vegetables, there would have been an advantage/disadvantage in that the yield would double.

An ideal square of 1.03 km per side (1.07 km^2) graphically represents the necessary surface area needed to product the amount of foodstuffs that could be stored in the *Banasa* warehouse.

Conclusions

Only a few traces of warehouses have been identified so far in the North African provinces in contrast with the known cereal production recorded in literary sources[48].

Archaeological remains of store houses or warehouses in the *Mauretaniae* are rare, extended only in part by epigraphic and literary sources. In *Caesariensis*, the warehouse, which is no longer visible, located at the port *Iomnium* (Tigzirt) and commissioned by Antoninus Pius and built with the man power from a military base (around 800 m^2), could have been used as an armoury and supply store for the army[49].

At *Rapidum* (Sour Djouab) the warehouse in the fort of the *cohors secunda Sardorum*, was built around 122 A.D. The building (14.20 m by 0.80 m), which was discovered in 1929 by Seguy-Villevaleix, was built with walls that were 0.80/0.90 m thick and inside there were three dividing walls to a hypothetical raised flooring[50].

Inscriptions record the existence of *horrea* that are not better defined at *Cartennae* (Ténès) in *Sitifensis*[51] and the military warehouses of *Tubusuctu* built between 1st May 305 and 25th July 306[52]. From the Peutingerian Map we learn of the toponym *Muslubium* (*Muslubion orea*) between Choba and Bougie[53]. In *Sitifis* (Sétif) the grain store and the public bakeries rebuilt at the end of the 4th century A.D., were used locally[54], while the toponym *Horrea*[55] recorded between *Sitifis* and *Saldae* relates to a territory that had a high cereal production for sustenance and the regional market as well as the economy of the imperial *dominia*[56]. The cereal paid as

46. Célérier 1922, p. 109-138, 209-239.

47. Forni 2002, p. 445.

48. Martorella, Zohra Bahloul 2020; Hamrouni, Aloui 2019; Ghalia, Villedieu 2018 ; Salido Domínguez 2011, p. 519; Rebuffat 2010, p. 266-274; Papi, Martorella 2007a; 2007b; Villaverde Vega 2001, p. 514; Laporte 1989, p. 92-94.

49. *AE* 1957; M. Euzennat (1957, p. 73-79) thinks of *[horrea arma]-mentaria* rather than *[horrea fru]mentaria*.

50. Laporte 1989, p. 92-94.

51. *CIL* VIII, 9669.

52. *CIL* VIII, 8836; Di Vita-Évrard 1992, p. 848.

53. Cagnat 1912-1913, p. 315.

54. *CIL* VIII, 8480.

55. Rickman 1971, p. 321.

56. The port of *Saldae* exported products from the *Tubusuctu* territory and cereals from the *Sitifis* region. See Fentress 1990, p. 118-119.

a kind of rent was collected by the imperial administration where it was harvested as in the case of *Caput Saltus Horreorum*[57], north-east of *Sitifis*, before being transported to the nearest ports and sold[58]. The cereal-producing regions of *Mauretaniae* and the ports should therefore have been characterised by a rich chain of warehouses for harvesting and distributing.

Under the Roman occupation *Mauretania Tingitana* carried out payments in wheat. The inscription dating to A.D. 216 regarding the amnesty of back taxes (wheat and money), was an invitation to the people and of the provinces of *Mauretania Tingitana* to resume the cycle of ordinary contributions, while, at the same time, providing an extraordinary supply of animals[59].

After having analysed the financial and fiscal reports of the province and perhaps of the provinces nearby, the central authority announced a fiscal amnesty on arrears of tax[60].

A copy of that edict was found in *Banasa* in the northern district[61] and from the point of view of the Empire's fiscal history, it represents evidence of the role that was assumed by the *Tingitana* as a supplier of goods. From this it can also be determined that such productivity was irregular.

Apart the great *horreum* of *Thamusida*[62], dated to the second half of the 2nd century A.D. and situated on the left bank of the river Sebou, along the *amnis Sububus magnificus et nauigabilis* (Plin., *nat*., 5, 5), no other buildings that can be interpreted as warehouses have yet been identified*;* it has been noted that the considerable increase in land level makes the area along the river rather unclear.

In the city of *Banasa* we can now add the quadrangular building with buttresses, dated between the end of the 1st and the beginning of the 2nd century A.D..

However, the dimensions of the building are not large (201.19 m^2 floor space). The limited capacity for storage (around 290 tons) and its location in the southern district, near the Gharb plane, seem to confirm its use as a harvest and distribution store in an urban and micro-economical context. The building would have been used for the continued domestic production characterised by small mills[63].

It was only from the second half of the 2nd century A.D. with the building of the great *horreum* of *Thamusida*, that the cultivated grain in the fields and in the areas around the city together with that produced by neighbouring villages or cities like *Banasa*, began to be included in an extra-territorial context. To the south of the middle section of the river Sebou, the Banasitan territory would have been characterised by a consistent production of cereal alongside irrigated crops[64]. The water of the river Sebou allowed the ships of a medium capacity to reach the port of *Thamusida*, while only small boats would have been able to reach the city of *Banasa*[65]. By using the favourable current of the river Sebou, it can be hypothesised that the grain of Gharb would have arrived at the port of *Thamusida* on small boats and, after being examined, in the great port *horreum* waiting for the *naues granariae*.

57. *CIL* VIII, 8425 and 8426; *ILS* 5964.

58. Mohamedi *et alii* 1991, p. 270.

59. Thouvenot 1946, p. 556-557; Rebuffat 2002.

60. Di Vita-Évrard 1988, p. 296.

61. Thouvenot 1946, p. 548-558.

62. Papi, Martorella 2007a. See also Rebuffat 2010, p. 278.

63. Alaioud 2004, p. 1900. Regarding the presence of millstones and *boulangeries*, mainly located in the northern district, see Alaioud 2010, p. 576-581.

64. Gozalbes 1998, p. 355.

65. Gozalbes 2000, p. 564.

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