362

# Historical Spatio-Syntactical Analysis of the Phoenician-Punic settlement during the first millennium B.C.

## The case of Kerkouane and Monte Siray in the central sphere of the Mediterranean (comparative approach)

WIDED ARFAOUI[1], SAID MAZOUZ[2] & MONIR DHOUIB[1]

[1]ENAU, UNIVERSITY OF CARTHAGE, TUNISIA

[2]UNIVERSITY OF LARBI BEN MHIDI, OUM EL BOUAGI, ALGERIA

## ABSTRACT

The Phoenician and Punic urban space has been little dealt with outside the archaeological field, which, for almost half a century, has devoted numerous excavations and publications to it which have, considerably enriched the knowledge on the subject. It is a field that has been struck by its originality and elaboration, which led the geographer and historian of the 1st century B.C Strabo to assert in a famous passage that a certain number of particular morphological characteristics distinguished the Phoenician cities, using a noun that refers to the meaning of "form", "external appearance" or "general appearance", which makes Strabo a precursor in the morphological approach of urban phenomena. The Space Syntax perspective applied to the study of the two best-preserved Phoenician and Punic agglomerations and the least subject to controversy (Kerkouane in African territory and Monte Sirai in Sardinia), has allowed us to study the flexible urban structure of ancient Phoenician cities and has offered us a non-invasive approach to the investigation of urban archaeology and a valuable amount of spatial data that can reveal suggestive features of the nature of urban communities that lived between the fortifications of these two cities. Through this paper, while focusing our study on these two settlements as part of a comparative approach and using the hypothetical restitution based on the virtual simulation and the syntactic analysis (the analysis of visibility and the axial analysis developed by using Dephtmap software), we will confirm the famous passage of the ancient geographer Strabo; we have tried to interpret and restore the behaviour of the residents and visitors of these Phoenician and Punic settlements in order to bring out the particularities of this urban organization on the functional, spatial and finally social level by emphasizing the structuring of the private space, This is a complementary and indistinguishable entity that constitutes this unit which is "the city"

and which has the merit of informing on social and symbolic aspects of its culture and that it can only be considered as a part of an entire social and spatial system that encompasses it.

## KEYWORDS

Phoenician-Punic settlements, urban production, spatial analyses, socio-symbolic expressions, socio-cultural dimensions, historic research.

## 1 INTRODUCTION

This research note examines the added value of spatio-syntactic analysis in the writing of Phoenician and Punic urban history, which is a field that has been little dealt with outside the archaeological field, , for almost half a century, have devoted numerous excavations and publications to it which have considerably enriched the knowledge on the subject. By combining archaeological methods and space syntax, this article, which traces a main axis of a doctoral research entitled "Syntactic modelling of the city and dwelling in the Phoenician-Punic period in the central Mediterranean sphere", offers new perspectives on the physical environment of daily life in the ancient Phoenician and Punic city. It is a field that has been struck by its originality and elaboration, which led the ancient geographer and historian of the 1st century B.C Strabo to assert in a famous passage[1] that a certain number of particular morphological characteristics distinguished the Phoenician cities, using a noun that refers to the meaning of "form", "external appearance" or "general appearance", which makes Strabo a precursor in the morphological approach of urban phenomena.

Therefore, the spatio-syntactic approach to spatial analysis, which crystallized in the 1980s, based on the theoretical work of Hillier and Hanson, develops as a main argument is that the spatial organization of a city directly affects how people perceive, move, or use space - or, in Hillier's own words, "how the urban system is spatially organized is the source of everything else." Space syntax methodology uses a mathematical representation of streets and open spaces to quantify their hierarchical position in a given street network. This spatio-syntactic quantification then becomes an indicator of the magnitude of movement that passes through streets and the types of activities they attract. Despite some unresolved methodological issues, space syntax as a static model of urban life and activities has gained considerable recognition from researchers, supported by empirical evidence that validates its use as a reliable tool for predicting urban movement patterns. It has even become increasingly popular in the field of archaeology, which at

[1] «La première ville de cette section du littoral est Malaca , à la même distance du mont Calpé que Gadeira […] Maenacé est plus éloignée du mont Calpé , elle a été détruite de fond en comble et le peu de vestiges qui en ont subsisté sont ceux d'une ville grecque, tandis que Malaca , beaucoup plus proche du mont Calpé , est phénicienne d'apparence ». Strabon, Géographie, III, 4,2, Lasserre F (Trad.),Paris ,Les belles lettres , coll. 'Collection des universités de France',1996
*Translated text: «The first city of this section of the coast is Malaca, at the same distance of the mount Calpé as Gadeira [...] Maenacé is more distant from the mount Calpé, it was destroyed from top to bottom and the few vestiges which remained of it are those of a Greek city, whereas Malaca, much closer to the mount Calpé, is Phoenician of appearance".*

the same time and among all the human sciences enjoys an exceptional and privileged position in the eyes of space syntax, since it deals more than others with "real space". Space syntax perceives archaeology as an intrinsically spatial discipline, whose interest in space is deeply rooted in its tradition and constantly renewed by its practice (Hillier 2008). The predictive capacity of space-syntax analysis renders it an attractive methodology for urban planning and design, a way for planners to “simulate” the impact of their actions on the use of space.

Yet the capacity of this approach to indicate how an urban system functions is theoretically applicable in retrospect, for describing (or rather “postdicting”) certain social aspects of past urban configurations, relying on their spatial properties. Space syntax can thus "allow historians to better understand how changes in the form of habitable space affected the lives of people and urban culture in particular times and places’, by offering a kind of "unbiased" quantitative description encompassing an entire urban landscape. It also offers perspectives on past events that are quite different from the perspectives offered by personal documents, testimonies, and memories.

For this purpose, the Space Syntax perspective applied to the study of the two best-preserved Phoenician and Punic agglomerations and the least subject to controversy (Kerkouane in African territory and Monte Sirai in Sardinia), has allowed us to study the urban structure of ancient Phoenician and Punic cities and to offer us an approach to conceptualize, thinking about the role of ‘space’ and its relation to life in this built environment that does not rely uncritically on powerful images imported from well-established historical discourses."

Through this paper, while focusing our study on these two settlements and using the syntactic analysis (the analysis of visibility and the axial analysis developed by using Dephtmap software), we have tried to interpret and restore the behaviour of the residents and visitors[2] of these Phoenician and Punic settlements in order to bring out the particularities of this urban organization on the functional, spatial and finally social level by emphasizing the structuring of the public space.

[2] Any building or urban space would thus constitute a physical interface between the interior and the exterior as well as a social interface between residents and visitors and it is according to this elementary conception that spatial syntax analysis proposes a way to deconstruct the architectural and urban space , as evoked by Hillier and Hanson :
[…] In moving from outside to inside, we move from the arena of encounter probabilities to a domain of social knowledge, in the sense that what is realised in every interior is already a certain mode of organising experience, and a certain way of representing in space the idiosyncrasis of a cultural identity […] A building may therefore be defined abstractly as a certain ordering of categories, to which is added a certain system of controls, the two conjointly constructing an interface between the inhabitants of the social knowledge embedded in the categories and the visitors whose relations with them are controlled by the building. All buildings, of whatever kind, have this abstract structure in common: a building type typically takes these fundamental relations and, by varying the syntactic parameters and the interface between them, bends the fundamental model in one direction or another, depending on the nature of the categories and relations to be constructed by the ordering of space (Hillier et Hanson,1984 ).

Thus, this research postulates that these agglomerations possess a distinctive morphic identity (a morphological genotype[3]) which reveals morphic elements specific to these urban spaces and their formal system, and it will be divided into three distinct and complementary levels:

- The first level is an investigation of the historical basis for the existence of a Phoenician and Punic urban genotype[4] (a distinctive morphology). It was considered appropriate to question the literary sources and to evoke the opinions and the notes of the archaeologists and historians specialists of the Phoenician-Punic period on the urban space of this period.
- The second level introduces and justifies our choice of case studies, with analysis and decomposition in order to define their practical organizations, reviewing and inventorying their physical conformations (an attempt at toponymy) in order to recognize and identify their urban structures and morphologies by engaging in a comparison between the results obtained from each specimen.
- The third level deals with the analysis of each of the settlements studied through space syntax in order to verify their distinctive morphic identity. This level consists of inserting the spatial representations related to the two cities into Depthmap software. In a mainly comparative approach, the obtained graphs will be analysed, interpreted and translated into measurable numerical indicators, which will be in turn questioned and questioned in order to confront the results to approach and define the laws which are inherent to them that constitute the morphic logic of these Phoenician and Punic urban systems.

# 2 THEORY

## 2.1 HISTORICAL BASIS OF THE EXISTENCE OF A DISTINCTIVE PHOENICIAN AND PUNIC URBAN MORPHOLOGY

To initiate our topic, it is indispensable to report this historical passage of Strabo[5]:
"[...] the first city that one meets in this part of the coast is Malaca. Situated just at the same distance from Calpé as Gadira, Malaca is the emporium or the market which the Numidian peoples of the opposite coast prefer to frequent. There are important salting establishments there. Some authors think that this city is none other than Mainakè, which tradition gives us for the

[3] Applied to architecture, the concept of genotype is defined as the qualitative (when examining justified plans) and quantitative (when interpreting digital data) consistency in the configuration of spatial systems. In other words, it is the recurrences that can be found in the interface and program of the buildings being considered. Indeed, when certain functions or activities are systematically assigned to certain spaces that are integrated into the building to different degrees, these functions acquire a spatial expression to which we can assign a numerical value. When these numerical differences and their physical expressions are found in a constant arrangement within a sample of plans, we can postulate the existence of a cultural model (Hanson, 1998).

[4] […] genotype being defined in terms of some set of underlying relational and configurational consistencies which show themselves under different phenotypical arrangements. However, sometimes this dominant genotype is realized strongly, in the sense that all the spatial-functional themes are present, and sometimes more weakly, in that some themes are present and others are missing. In yet other cases, these themes seem to be totally lacking, or even inverted. The question to be addressed is […] : can the idea of a dominant genotype be formally demonstrated ? (Hanson, 1998).

[5] Strabo, Geography, Book III chapter 4: Iberia: the Mediterranean coast and Celtiberia, French translation: Amédée Tardieu

most western of the Phocaean[6] colonies, but it is nothing of the kind. The site of Mainakè, city today ruined, is at a greater distance from Calpé, and, moreover, the few vestiges which remain of it denote a Hellenic[7] city, while Malaca, at the same time as it is closer to Calpé, has the completely Phoenician physiognomy. Then comes the city of the Exitans, which also gave its name to a kind of valued saltings [...]" (III 4, 2).

This passage institutes a comparison between Mainakè which is a Phoenician city of non-certain identification (Rouillard, 1992) and Malaka[8] (the current Malaga in Spain), notes in an allusive way that the first keeps the print of the Greek urbanism, while the second which was the seat of a market of the nomads of the opposite coast, had a completely Phoenician physiognomy[9] (= a facies, a form, an appearance) and that it should not be confused with Mainakè, as did other ancient writers who affirmed that a century before, Malaka was called Mainakè. He then compromises the existence of a certain number of distinctive and proper morphological characters that distinguished the Phoenician cities. Thus, Strabo evokes about the Punic site of Malaga in Spain; an urbanism scheme which would be specifically Phoenician, but which he does not describe. The original text uses a substantive equivalent to appearance, which refers to the sense of "form," "outward appearance," or "general allure" which makes Strabo a precursor in the morphological approach to urban phenomena (Dridi, 2015).

Benededikt Isserlin, who was largely interested in the remarkable aspects that could prompt an observer to call a city "Phoenician", questioned the internal layout and organization of Phoenician cities. He particularly raised the question of whether the spatial arrangements of the relatively known cities of that time can give evidence of intentional planning rather than anarchic growth. In his article published in 1973 and while engaging in an investigation of Phoenician-Punic urbanism, he thus attempted to describe the Phoenician-Punic city:

« A typical Phoenician/Punic town would have confronted the beholder with a not very high town wall provided with towers and gates and crowned with round-topped battlements. Behind it, in the most important urban region, would have been discernible a quarter of high tower-like houses, while elsewhere lower dwellings would have prevailed. On entering the main gain, the visitor would have passed along a main road for a short distance to an agora near which he would have beheld at least one important temple with probably Egyptianizing architecture, and perhaps other public buildings. Following the main road or perhaps a parallel, he would have come up to

[6] According to the Larousse dictionary, Phocaean of Phocaea or Phocidia (Ancient Greek: Φώκαια / Phốkaia), the city of the Phocidians (today's Turkish: Foça) is an ancient Greek city of Ionia on the coast of the Aegean Sea, in the Gulf of Smyrna (today's İzmir, Turkey). Its name is carried over into the name of the present-day city of Foça.
[7] According to the Larousse dictionary, Hellenic adjective [in Greek hellênikos], peculiar to ancient Greece. Hellenic culture; Hellenic god; Hellenic manners; Hellenic construction
[8] Malaga (Spanish: Málaga) is a Spanish city, an ancient Phoenician foundation that undergoes during the Middle and Late Punic period (fifth century B.C) important urban and architectural transformations. (Ramon, 2013)
[9] The physiognomy of a place is the whole of the characters and the particular aspects which distinguish it from another.

the acropolis where he might, crossing the line of inner defences, have encountered another sanctuary or two. Somewhere on his route (perhaps near the agora) he would have noted an inner harbour basin (cothon) while in a peripheral region he would have been shown the " tophet[10] "».

A city of this kind would have been sufficiently **sui generis**[11] to impress the traveller familiar with the normal layout of Greek cities as obeying different urbanistic canons" (Isserlin, 1973).

This sketch of the typical Phoenician-Punic city would be thus characterized by:

1- The presence of a relatively low enclosure wall equipped with towers and gates and crowned with merlons with rounded tops,
2- Behind this wall, an urban core occupied by a district of high houses, whereas elsewhere it is the low habitat which prevails,
3- A main road leading from the main gate to an Agora lined with at least one important temple in Egyptian style (Aeolian capitals, cornices with Egyptian grooves) and possibly other public buildings,
4- This way (or a parallel way) extends towards an acropolis protected by an interior enclosure, beyond which would be a temple or two.
5- An artificial harbour (cothon), situated at a place possibly not far from the agora
6- A tophet, generally located in the periphery.
7- The existence of an eminence: elevation/summit as a constitutive and essential element of the Phoenician and Punic city.

However, and in front of the scepticism of the historian Serge Lancel (Lancel ,1995), who according to whom, it is difficult and arduous to strictly define an original Phoenician and Punic urbanistic model in the western Mediterranean, but that, in the absence of a well-identifiable urban scheme reproduced as a stereotype, it is possible to recognize in many Phoenician and Punic cities urban landscapes that present common characteristics. Other archaeologists and historians, like Sandro Bondi, confirm the existence of common distinctive features of the Phoenician-Punic cities. The author mentions, in this respect, that the Phoenician and Punic settlements present a constant morphology with rare exceptions and that the central core of the habitat is constituted by an acropolis surrounded by walls with, all around, residential quarters, cultural buildings as well as premises destined to commercial and industrial activities (Bondi ,1980b).

Stéphane Gsell, in his encyclopedia about the Phoenician-Punic civilization (Gsell, 1920II), reminds us that Carthage as described by Appian and taken up by others, can illustrate a particular type with central characteristics in its plan including a central public space (agora/forum), flanked by some important public and religious buildings, and which adjoined the harbour; and three main roads, which led to the acropolis (Byrsa). Nevertheless, such a description cannot be adapted or even verified on the ground at present because of the upheavals committed by the later Roman, Christian, Vandal, Byzantine, and Islamic occupations, as well as

[10] The term Tophet designates the central part of the open-air sanctuaries and the place of sacrifices in the Semitic East, present in the Phoenician, Libyan or Punic religions. The urns containing the ashes (called cinerary vases) of the dead are deposited there.
[11] ***Sui generis*** : a Latin term, meaning: a thing that has a proper, particular and singular kind

its contemporary urbanization. This description cannot be confirmed by the results of the archaeological studies and research carried out by the archaeological services and especially by the international excavations which have concerned the area of the Punic metropolis since 1974[12]. Though, the topography of the Byrsa Hill required another model of urban organization: at the level of the slopes, the layout of the streets, 6.5 to 7 m wide, is fan-shaped. Despite the topographical constraints, the orthogonality of the insulae, with standardized plans and dimensions, was respected. Excavations never took place on the flat edge northwest of Byrsa, yet Frederick Rakob does not exclude the hypothesis of an acropolis/citadel protected by fortifications on the top of the Byrsa hill, and an inhabited city, located on the less steep slope on the rural side (Rakob, 2002).

Subsequently, if the urban form of Punic Carthage is drawn with many gaps and precautions relative to the nature of the archaeological terrain and insofar as the city, as a metropolis and a foundation ex-nihilo[13] , was undoubtedly a source of inspiration for the Punic cities of the western Mediterranean, then we can refer more to the planning and the quite intelligible type of organization of the two Phoenician-Punic colonies of **Monte Sirai** and **Kerkouane** or in the layout of Motye, as far as it cannot be completely discerned at the present time. This type of urban organization, which, according to some historians, refers to oriental archetypes (from protohistory to the Levant) and to older Phoenician experiences (1000 B.C.: the Iron Age) and which recalls an ancient oriental type, illustrated for example at Tell.Beit Mirsim in Palestine and which was evoked by Lampl (Lampl ,1968) and was the subject of a detailed study by Shiloh (Shiloh,1978), who wanted to demonstrate the existence of a "model", typically Israelite, associating a rounded enclosure, equipped with casemates, with a belt of radiating houses surrounding the heart of the city from which it is separated by a circular street. As for him, Oppenhein thinks that this orthogonality manifested by several Phoenician-Punic cities such as Kerkouane, Monte Sirai and Motyé can bring a proof that Hippodamos of Miletus[14] is not the man who created the orthogonal city (Oppenhein, 1970).

To conclude and according to the existing literature (historical sources, testimonies and archaeological research), the typical Phoenician-Punic city would have confronted its observer by its topographic implantation, generally, corresponding to an eminence which will be reconverted giving birth to an acropolis or a citadel. This acropolis was surrounded by a relatively high wall,

[12] These excavations have managed, in a few years, to clarify, approximately, the topography and urban history of Carthage in a perimeter dedicated to an activity of excavations for more than a hundred years essentially fixed on the necropolises, apart from chance finds and their documentation. Summary in S.Lancel, "La colline de Byrsa à l'époque punique", in the editions Recherche sur les Civilisations, Paris, 1983

[13] According to Larousse dictionary: Ex-nihilo is a Latin expression meaning "from nothing". It is often used in conjunction with a term expressing the idea of creation, as in "creation ex nihilo", literally meaning "creation from nothing".

[14] Hippodamus of Miletus (b. 498 B.C., d. 408 B.C.) was a fifth-century B.C. surveyor and engineer who was also an urban planner known for his "Hippodamean" layout plans, which were characterized by straight, wide streets that crossed at right angles.

provided with towers and gates[15], crowned and surmounted by round machicolations[16] . Obviously, this wall/gate delimits the space and defines the urban articulation and its construction around the city does not only respond to the needs of defence, it is also seen as a gesture that is part of the dialectic of the outside and the inside: "the wall is above all the materialization of a line marking the passage between the city and what is not the city" (Gros, 1996).

To this end, there was undoubtedly among the urbanistic components one (or more) monumental gate that ensured this passage between the “extramuros” and the “intramuros” zone[17]. A Phoenician-Punic city was endowed with a public square[18] , as confirmed by Titus Livius, perhaps a forum according to Justin (XXXX, 7, 8) or an agora according to Diodorus of Sicily (XX, 9, 4) near which one would have seen at least an important religious monument and perhaps many other public buildings (such as the Mastio, which is considered a public building used throughout the history of the city of Monte Sirai, for military purposes and then intermittently for civil purposes.). In a typical Phoenician city, one would have noted a basin or a port/harbour (a cothon composed of two military and commercial basins in Carthage and a single basin in the case of Motye in Sicily), while in a peripheral region, one would have identified a funerary space or a "tophet". According to archaeology, the necropolises were generally extra-mural, but in the current state of knowledge, the relationship between necropolises and the habitat areas is difficult to establish. The relationship between the dead and the living is an challenging subject for the

[15] Appian, describing the triple rampart of the Punic metropolis, reports that "each of these ramparts was thirty cubits high, without taking into account the merlons and the towers; these with four floors and distant of two plethora, the ones from the others, girdled the ramparts. Each rampart was thirty feet thick, and two stories high: as they were hollow and covered with a roof, there were, at the bottom, lodgings for three hundred elephants with, beside, stores for their food, and, above, stables for four thousand horses, with warehouses of fodder and barley, as well as shelters for men, approximately twenty thousand infantrymen and four thousand horsemen ". Appian, Roman History, 130, text established and translated by Paul Goukowsky, coll. Budé, Les Belles Lettres, 1997

[16] A machicolation is a gallery forming a corbel at the top of a wall or a military enclosure and whose openwork floor made it possible, if necessary, to launch various projectiles at the foot of the wall, an often vulnerable zone.

[17] We mention here the great urbanistic inscription of Carthage dating from the end of the IVth century B.C. - mid IIIrd century B.C. which evokes the opening of a new door "The new door which is in this rampart". (Mahjoubi and Fantar, 1966).

**** In the most important urban area, one would have recognized districts of high houses in the shape of small buildings that Appian evaluated to six floors buildings. For his part, Diodorus of Sicily evoked the exiguity of the streets of the metropolis which were bordered by terraced dwellings (XX, 44, 5) whereas those which are with one or two levels should be installed a little the variation in front of the sea as the case of district known as of Magon.

"Scipio now turned all his efforts towards Byrsa, which was the most fortified point of the city and where the greater part of the inhabitants had taken refuge. It was reached from the forum by three ascending streets, bordered on each side by high six-storey houses. From the top of these houses the lines and the stones rained on the Romans; one was thus obliged to remove initially some of them. From there the soldiers dislodged the defenders posted on the neighboring grounds; and each time that they had thus extinguished the fire of their adversaries; they threw boards or beams on the gaps of the adjacent streets to pass, as on bridges, from one roof to the other. [...] Suddenly Scipio gave the order to set fire to the three streets at the same time. [...] While the flames devastated the city, the attackers destroyed all the buildings, which singularly increased the tumult. [...] Some were burned alive, especially the old men, the women, the children, who had hidden themselves in the basements and shouted out in agony; others fell from the upper floors with stones and beams, and were torn to pieces in their fall. Appian, Roman History, 128, Book VI text established and translated by Paul Goukowsky, coll. Budé, Les Belles Lettres, 1997

[18] Tite-Live and Justin are referring to a forum, whereas Diodorus Siculus is talking about an agora: Tite-Live, XXX,24, 10; XXXIII, 47, 10 and 48, 10; Justin XXXX, 7, 8; Diodorus Siculus XX, 9, 4.

historian and the archaeologist because it implies a questioning of the relationship between house, temple and tomb and requires to imagine an urban space distributed among the divinities, the citizens and the dead: a trilogy around which the city is constituted, undoubtedly, but in a broader sense than the city.

## 2.2 IDENTIFICATION AND STRUCTURAL-FORMAL ANALYSIS OF THE PHOENICIAN AND PUNIC SETTLEMENTS:

Before approaching the urban analysis, it is advisable, first of all, to present the case studies on which the exploration of the genesis of the urban form of the Phoenician-Punic agglomerations will focus. It is now imperative to introduce and justify this choice of case studies, to analyse and break them down in order to define their practical organizations, reviewing and inventorying their physical conformations (an attempt at toponymy) in order to recognize and identify their urban structures and morphologies.

The two agglomerations, object of this research are Monte Sirai in Sardinia and Kerkouane in the Tunisian Cap Bon. They are located in the central basin of the Mediterranean. We opted to retain only these two settlements and this choice was motivated by two main criteria:

1- The state of conservation and the possibility of general urban reading of the two sites, which will avoid reconstructions that could lead to erroneous results.
2- The variations of configurations (landforms, landscapes, altitudes) and implantation of the two sites: on a dominant hill for Monte Sirai and on a peninsula for the case of Kerkouane.

The choice not to retain for this part of the urban analysis other Phoenician-Punic agglomerations (such as the example of Carthage, Motye, etc.) stems from their lack of spatial connections, their poor state of preservation or, for some, the inextricable complexity - both spatial and chronological - of their layout.

However, these case studies with their apparent variations made it possible to measure the specificity of the morphic identity proper to the Phoenician and Punic settlements, while defining the morphic elements which are common to them and the laws of composition which are inherent to them.


Figure 1: overview of the two case studies (based on Google maps)

Figure 2: Kerkouane : a settlement on a peninsula (6th century B.C - middle of the 3rd century B.C) Aerial view on the site of Kerkouane (Source: Tunisia seen from the sky, 2010)

Figure 3: Monte Sirai: settlement on a dominant hill Phoenician foundation in the second half of the 7th century > Carthaginian colony > 1st century B.C (Source: Bartoloni,2004)

## 2.3 THE PHOENICIAN - PUNIC CITY OF KERKOUANE

Kerkouane is an ancient Punic city discovered by Pierre Cintas and Charles Saumagne in 1952, located on the peninsula of Cape Bon, 130 km from Carthage. Its surface is estimated at 7 to 8 ha, it was delimited by two walls separated by a 10 metre-wide corridor and flanked by towers and doors. It was excavated over four periods.

It is very important to note that the archaeological interest of this city19 lies mainly in the fact that it presents one of the rare examples of Punic City, whose foundation goes back to the 6th

[19] "In terms of architecture and Punic urbanism, it is thanks to the excavations of Kerkouane that we are best informed. This Punic city of Cap Bon is protected by ramparts which, segmented, take on a semi-circular appearance. The results of the excavations make it possible to present the profile of the city with its double wall enclosure which encloses the urban framework: living quarters, sanctuaries, artisanal spaces, etc. A wide corridor runs between the inner and outer walls, allowing for the rapid circulation of troops, while at the same time lending itself to the construction of works intended to reinforce the defensive system: towers, staircases, warehouses, casemates. The internal wall belongs to the first times of the creation of the city; it would be to place between the 6th and 5th c. B.C, as for the external wall, it

century B.C. and that the Romans did not rebuild after the annexation of Africa to the Roman empire, thus bequeathing us an urban space with a perfectly legible scheme and urban organization and precious information on the multiple aspects of its economic and social life. The city has the considerable advantage of having been definitely abandoned, probably during the first Roman-Carthaginian war, around the middle of the 3rd century B.C.

The diggings of Kerkouane have led to the excavation of several residential areas that the road network organizes into insula or islets, following a quasi-circular urban plan where the streets cross each other orthogonally and impose an airy plan of the city arranged in chequerboards, the whole elaborated inside a wall separating the city of the living from the necropolises and from the cultivable land. The shape of the blocks is variable, but of a certain regularity, grouped and continuous served by the network of streets sometimes circumventing the natural site sometimes having a certain orthogonality. The architecture is distinguished by the diversity of materials and construction techniques used.

Excavated at sixty percent to the present day, the number of dwellings at Kerkouane is estimated at 300 and the number of its inhabitants at 2100 (Fantar, 1984). From the point of view of urban planning or urban syntax, the discovery of the sanctuary has shown that in the Punic City, sacred spaces were not necessarily relegated to the periphery but could be at the heart of the habitat. In other words, from the point of view of practices and usage configurations, the city was organized around its religious and political core in concentric circles (by extrapolation from the part of the city that has not yet been uncovered, which is quite probable according to several references). But while moving away little by little from the hypothetical centre of the city, the residential blocks begin to be ordered around a precisely elliptical network structure. The city is presented in a flexible ovoid form like a large bubble. The urban fabric shows an a priori chequerboard layout with streets combined with insula of variable dimensions and contiguous components, including squares and plazas. The residential areas and the public, civil and religious buildings are arranged according to an urban plan developed within a wall made up of two enclosures separated by an intermediate central space. The streets cross each other orthogonally and impose an airy plan with an architecture that is distinguished by the diversity of materials and construction techniques used. These physical conformations are established with a consideration of the structuring of the full/empty, of the matter from the plan view of the whole city, but they do not explain alone the organization of the urban network.

dates from the 3rd c. B.C and marks the last state of the city, i.e. the period included between the invasion of Agathocles, in 310 and the definitive destruction of the city, in 255, by the Roman consul Regulus, at the time of the first Romano-Carthaginian war. " Fantar M.H., 1985, Kerkouane, cité punique du Cap-bon, II, INA, Tunis.pp 125

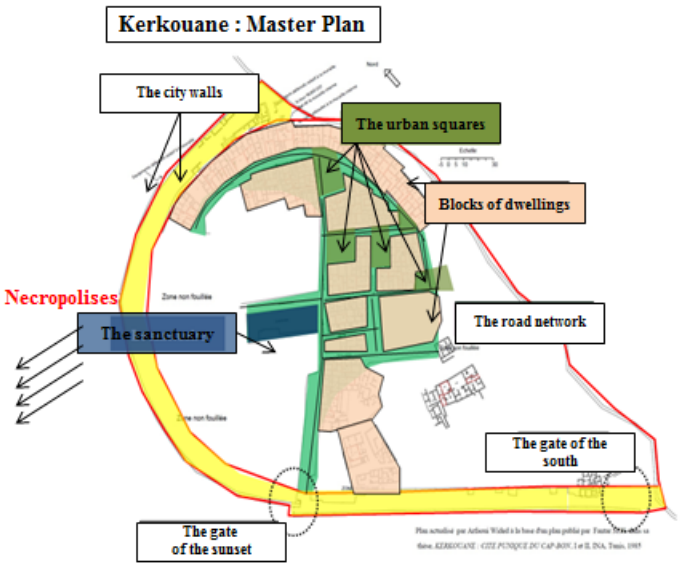



Figure 4: Practical organization of Kerkouane city
(Source: Author based on a plan of (Fantar,1984))

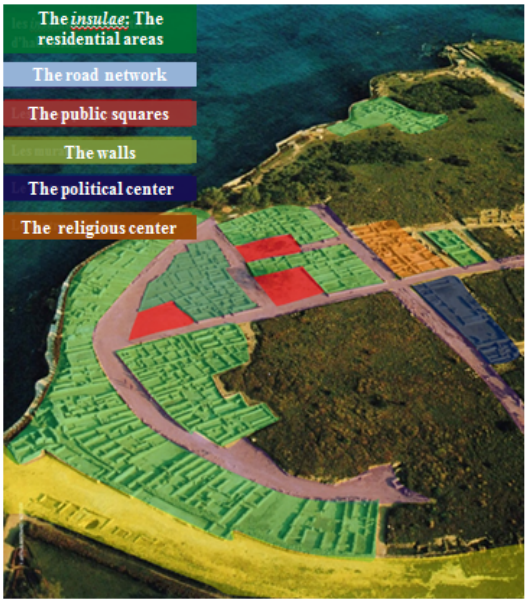



Figure 5: Functional organization of Kerkouane city
(Source: Author based on aerial view)

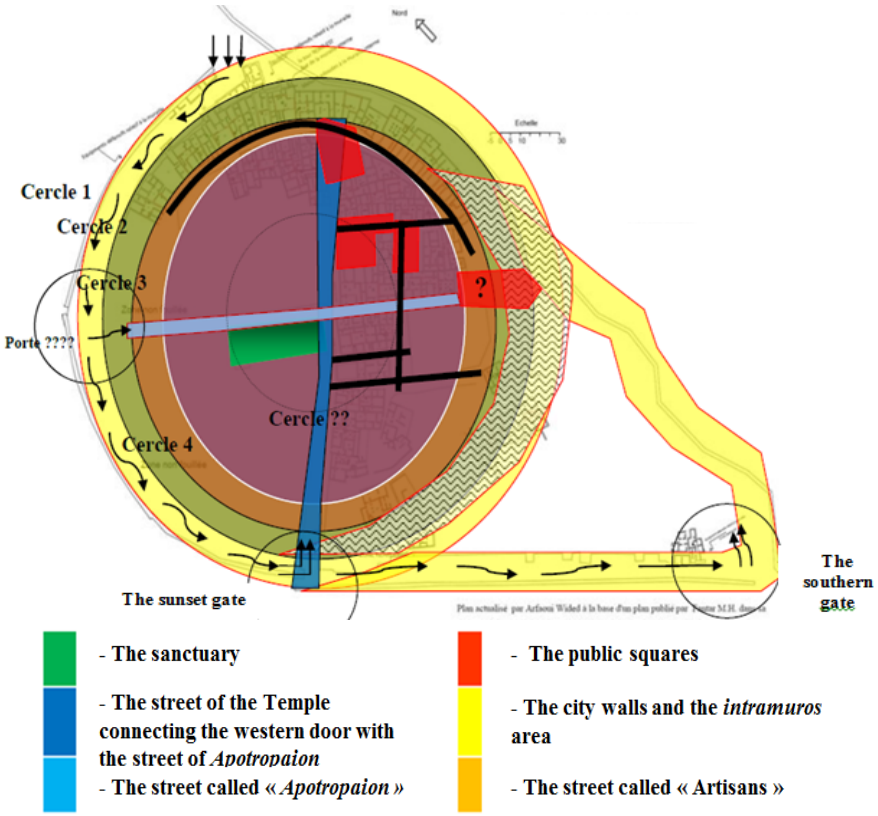



Figure 6: Structure and urban morphology of the city of Kerkouane
(Source: Author based on a plan of (Fantar,1984))

By superposition the structure of the city from the physical and morphological point of view to its organization of practices and configurations of places we deduce the following urban organization: At first view, the Punic city of Kerkouane is presented under a radioconcentric plan that is organized in concentric circles going from the centre that corresponds to the orthogonal crossing of the two major axes of the agglomeration (street of the temple street of the Craftsmen) to the periphery that corresponds to the two walls surrounding the city and thus clearing an intermediate area of passage, a kind of corridor.

The agglomeration testifies to a marked hierarchy of the ways and squares and develops in four concentric circles, namely:
-The first two circles correspond to the corridor which marks the limits of the agglomeration and symbolically separates the city of the living (intra muros) from that of the dead (extra muros).the passage by this corridor is quasi-obligatory. According to the state of knowledge which we have it is necessary to make the whole of the corridor to arrive at the two gates, put at the day, which are the gate (west) of the sunset and the southern gate.
-The third circle corresponds to the dwellings of sector 1, which are adjacent to the wall. This circle is delimited by the boulevard - Apotropaïon Street (circular communication way).
-The fourth circle corresponds to the dwellings of the central sector.

This radioconcentric system is organized around a centre which corresponds geometrically to the crossroads due to the intersection of the two principal arteries (the centre of all the circles): functionally, this centre concurs and adjoins the sanctuary of the city. Other secondary streets, which are more than just traffic lanes, seem to obey a strictly orthogonal grid and play a commercial and social role, such as the street known as "the two squares" or "the artisans" "collector", "glassmaker" and "sphinx".

## 2.4 THE PHOENICIAN AND PUNIC CITY OF MONTE SIRAI

In recent years, immediately after the discovery of this city and following the first years of excavations, historians of the time have concluded that this settlement is mainly military. They have estimated that it was a Phoenician and then Punic fortress built in opposition to the Nuraghic[20] agitation.

[20] The Nuraghic age from 1800 to 500 B.C.: The passage from the Eneolithic to the Bronze Age represents a crucial moment of the Sardinian history. In fact we pass from the previous cultures to the Nuraghic civilization and already the terminological change "culture/civilization" indicates a deep evolution.At the beginning of the Nuraghic civilization it appears, framed in the ancient bronze (1800-1600 B.C.), the culture called of Bonnanaro from the name of the village, in the territory of Logudoro, where the hypogean necropolis of Corona Moltana is found where the first typical pieces were found. This culture, that the archaeologists considered in the p ast as the first phase of the Nuraghic civilization, shows a significant change in the production of the ceramics, because the overabundant decoration that characterized the productions campaniformes disappears. We cannot fail to point out the medical practice of the trepanation of the skull with the survival of the subject subjected to the operation, as attested by the bone recalcification. The passage from the ancient bronze to the middle bronze (1600-1300 B.C.) marks the real beginning of the cultural phase that we call Nuraghic civilization.

More recent studies in relation to the remaining Phoenician and Punic colonies (Guirguis, 2008a) have shown that, since its origin, the city of Monte Sirai proclaimed a purely civil and urban character and this for a short period, precisely between 360 and 238 B.C. It then became a fortified centre. Its location far from the sea and on a hill dominating the whole area, made it even more safe, secure and strategic.

The city of Monte Sirai is organized as follows: (01) an extramural zone where we find the necropolis, the tophet but also defensive buildings and rural dwellings (02) an intramural zone or the acropolis with a road network composed of roads, square and two crossroads, islands of houses and a political-religious center marked by the Mastio which was, in fact, a temple/sanctuary and the main sacred monument of the city.

The entrance to the Punic City, also known as the acropolis, is through a fortified corridor that rests on the houses leaning outwards. Therefore, the outer walls of these buildings, leaning against the rock, also play the role of the city walls or its ramparts (sectors G and F in green colour). On either side of the entrance, we can distinguish two long walls that surround the residential area and tighten the space between the city and the few extramural buildings that may have served as homes for the city's guards (the military). This is an artificial ditch built for defensive reasons. We can imagine that it was closed by means of a door of which there are no traces left.

Following this fortified ditch, we come to a small square marked by the presence of the so-called Mastio. On the south side of the Mastio, there were three roads facing south that were probably drivable. They initially had parallel roads that converged in the lower part of the city at a small crossroads. These roads divided the acropolis into four large blocks (insulae B, C, D and E) which together with insulae A, F and G made up the urban fabric.

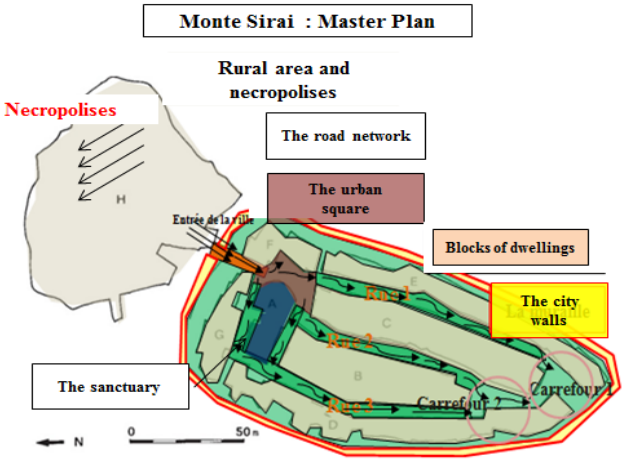



Figure 7: Practical organization of Monti Sirai city (Source: Author based on a plan of (Guirguis, 2008a))

Figure 8: Functional organization of Monti Sirai city (Source: Author based on aerial perspective (Bartoloni,2004))

Without considering the four islands (insulae E, F, G and D in green ) on the borders of the city, the city-acropolis is composed of two other long islands formed by a double row of houses (insulae B and C in yellow), each one giving onto a different road and a central insulae A related to the political and religious centre (the sanctuary). In total, there are seven insulae in this urban grid where the houses each had a single entrance from the street.

If we compare the structure of the city from the physical and morphological point of view with its organization of practices and configurations of places, we will better decipher its urban organization:It should be noted from the outset that the Punic city of Monte Sirai owes its specific spatial structure mainly to its topography, which was built and erected on a hill that emerges in the coastal plain and allows it to be clearly distinguished and seen even from a great distance. This city-acropolis, serving by its strategic position of ultimate refuge to the populations during the attacks, appears as a long bubble truly oval/elliptic crossed in its centre by a long way (street 2). Geometrically, the latter constitutes an axis of symmetry of the agglomeration.

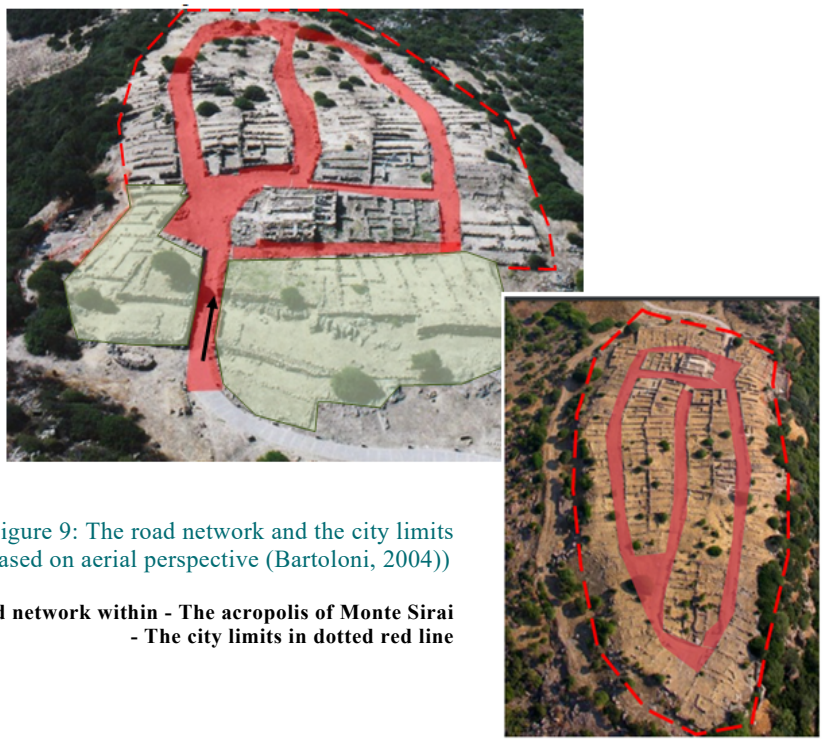


Figure 9: The road network and the city limits
(Source: Author based on aerial perspective (Bartoloni, 2004))

**- In red the road network within - The acropolis of Monte Sirai**
**- The city limits in dotted red line**


Figure 10: Map of the acropolis of Monte Sirai with the functional subdivisions
(Source: Author based on a plan of (Guirguis, 2008a))

Following the limits of the dwelling blocks, we find ourselves facing a plan made up of three homothetic concentric ellipses, each of whose two diameters passes through the axis of symmetry of the city (street 2). Thus, the urban area develops in three concentric ellipses, namely:

- The first ellipse corresponds to the own limits of the agglomeration defined by the constructible limits of the hill and redefined by the construction of a citadel which delimits symbolically and separates the city of the living (intra-muros) from that of the dead (extra muros) .

- The second ellipse corresponds to the houses (blocks E, D, G and F) leaning against the citadel, this ellipse is delimited by two streets 1 and 3 .

- The third ellipse corresponds to the central element of this urban composition. This conformation is split and subdivided by an alley (a) into two parts: part 1 corresponding to the dwellings of the two central sectors (block B and C) and part 2 to the sanctuary and the public square in front of it.

In spite of its relatively eccentric and collateral position, this second part constitutes the heart of the composition, and is, par excellence, the zone of convergence of all the main roads of the grid (1, 2 and 3) and of the fortified alley that provides the only access to the city. This place, by the concentration of the religious service and the public place dedicated to the commercial and politico-cultural activity (exchange and gathering) constitutes a central place of a preponderant role. It is the heart of the agglomeration and its centre of political and religious power.

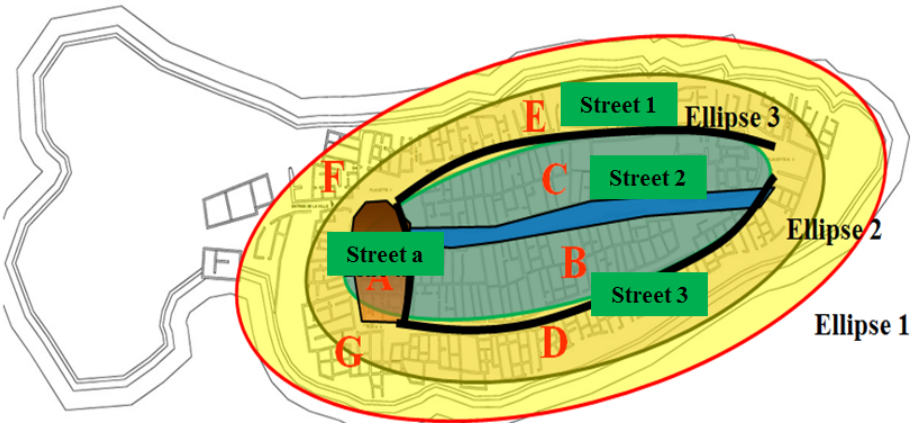



Figure 11: Structure and urban morphology of the city of Monte Sirai
(Source: Author based on a plan of (Guirguis, 2008a))

## 2.5 DISCUSSION

In spite of the differences in the nature of the implantation of the two Phoenician-Punic cities and especially the constraints which result from it ( implantation on a dominant hill (a rough topography) for Monte Sirai and implantation on a peninsula for the case of Kerkouane (limits imposed by the level of the sea), we admit, at this level of the analysis, the existence of striking resemblance:

1) From a practical organization point of view, the two cities are divided into two main zones: a rural extra-mural zone and an urban intra-mural zone. The latter presents in both cases the same structuring elements with some differences in terms of quantity and form.

2) From a geometric and physiognomic point of view, and despite the imperatives of the topography that impose, at least in the case of Monte Sirai, a specific spatial structure linked to the limits of the building land, we notice that both settlements have adapted, schematically, the same model of spatial organization.

3) A plan with flexible concentric forms which gave the radioconcentric plan for the case of Kekrouane and another hybrid and mixed for the case of Monte Sirai which dismembers the same principles of organization: the orthogonality of the road network, the hierarchical arrangement of the structuring sectors and the existence of a nucleus/urban centre constituting the heart of the whole composition. This core is marked in the territory by the intersection of the two main roads of the city of Kerkouane and by the overlapping of the three roads that constitute the road network of the city of Monte Sirai with a recessed arrangement, in relation to this core, of all the residential areas.

4) From the point of view of practices and physical conformations, the two urban fabrics (Monte Sirai and Kerkouane) present the same functional components: a defensive system (walls, fortification, gate and control towers), blocks of dwellings organized in insulae, a well-structured and traced road network, public squares, a religious monument in the centre of the fabric.

To this end, these two settlements seem to belong to that group of rare geometric cities that are perfectly ordered and whose physical form could be characterized by geometric means and that have the appearance as if they were made of a single piece.

Ideally, we can also imagine a harmonious distribution in space of the key urban functions (living, working, recreating and exchanging, circulating) so that none of them hinders the other, a kind of segregation of functions that spatially separates the sectors dedicated to these functions (residential areas, sectors dedicated to economic activities and trade, public space for exchange and gathering). Only a comparative morphosyntactic study would be able to confirm or deny this idea.

## 3 VERIFICATION OF THE MORPHIC IDENTITY OF THE PHOENICIAN AND PUNIC SETTLEMENTS

Because within the physical spaces, we also find social structures conveyed by cultural emblems and whereas the architectural and physical elements (buildings and monuments) often have a more lasting impact and influence on the production of the city than the historical, cultural, social or economic conditions that also underlie them. This is why it must be studied objectively and subjectively taking into account physical and cognitive considerations by analysing its social and societal structure in their relationship with spatial, physical and architectural data.

Therefore, and in order to develop and explain the necessary differentiation of places and spaces in order to identify the proper logic of the two agglomerations of this research, it is significant to define a theoretical framework that can combine the two social and architectural structures in order to take advantage of the specificity of the egalitarian relationships of reciprocity between their different characteristics.

Subsequently, we start from the premise that the Phoenician Punic settlement is a socio-spatial object. In order to understand it, to analyse it and to search for a certain distinctive logic and the components of its morphic system, it is necessary to admit the existence of a close bilateral relationship that unites the spatial structure (the physical environment) to the social. Thus, our dissection and interpretation of this morphic logic will be based on the use of the tools of the space syntax.

Space syntax provides useful means to apprehend spatial complexity and to objectively describe, study and measure the spatial configurations of built and urban environments. It is precisely in the context of the need for an approach to urban and architectural form that combines the formal strength and social nature of these forms that this approach has developed and been widely used in the study of urban structures.

To begin with, we consider each settlement as an interface between two categories of social relationships: the relationship between inhabitants-inhabitants (local properties) and that between inhabitants and visitors (global properties). It is these two types of relationships that impact the urban form of the system and give each settlement its global and local properties, thus establishing its cultural genotype. Thus, the purpose of this analysis is to capture and decipher these relationships and to see how the arrangement of these interfaces shapes, forges and controls these relationships[21].

Among the different methods that the analysis of space syntax (also called configurational analysis) has developed, the architectural reality is considered according to a certain number of basic concepts such as: the movement towards and inside a building or a space as well as the control that one exercises over it, the functional occupation of the internal zones, the patterns of encounter/avoidance between residents and visitors and, by extension, the type of underlying social organization. It is therefore a question of highlighting the interface(s) (i.e. the spatial relationship(s) between the two major groups of users mentioned above). This interface(s) being the key element of the program, i.e. the spatial dimension of the organization of a building, its configuration (Hillier,1996).

To this end,, we use two tools to represent and analyse the urban spatial structure and test its relationship with the movements of pedestrians, whether they are inhabitants or visitors (as a foreigners) : the two techniques are the axial map and the convex map (the visibility graph) and this by means of the Depthmap 10 software developed by Alasdair Turner of UCL. Both types of analysis focus on the spatial configuration from the point of view of accessibility and visibility:

1. The axial analysis forms the basis of the computer modelling technique from which it is possible to quantitatively estimate the potential for movement as a function of activity distribution (accessibility and movement with its two components movement-destination and movement-passage). It seems, also, to generate the field of encounter and thus to evaluate the social interactions with their public and private components, as well as the local-spatial and global-transpatial ones, in the sense that axiality is the fundamental means of the intelligibility of an urban system (the urban fabric or the neighbourhood) for outsiders.
2. The convex map (here obtained by VGA analysis) proves to be indicative of the way in which the inhabitants of this urban fabric controlled the potential encounter field.

Each of these two representations will then be analysed relationally in relation to its own structure, in relation to the buildings, the entrances of the houses and in relation to all the access points of the said agglomeration from outside. The two representations will also be compared to

[21] More than a simple notion of place or positioning, interior and exterior evoke here two distinct social 'factions'. On the first hand, the inhabitants, on the other hand, the visitors. The former are those whose social identity, as individuals, is integrated in the layout of the building space and who can therefore exercise a certain control and have privileged access to it. The latter can be defined as having a temporary potential access to the building, under the control of the residents and a social identity generally manifested in a collective way (Hillier, 1996 and Hanson, 1998).

each other, and finally the results obtained for each settlement will be compared in an approach that aims to extract a common pattern:

- An underlying morphological genotype of the urban form of the Phoenician-Punic settlements already evoked by Strabo.

## 4 THE AXIAL ANALYSIS OF THE TWO PHOENICIAN-PUNIC SETTLEMENTS: COMPARATIVE APPROACH

An axial map is a representation of the continuous structure of the open space. For the process of its preparation, we consider as background the limits of the two urban areas studied, that is, the intramural areas constituted by the network of streets, squares and buildings. Since the aim of this research is to study not only the urban environment but this public environment in its relation with the built, semi-private and private one related to the habitat then we will enrich the plan with all the interior dispositions of the mainly domestic buildings and their accesses that we intentionally keep open. It should also be noted that in the space syntax analysis, namely in the visual study , the existence of doors will be treated in a special way. If their existence is documented, their location and characteristics will be briefly discussed. It is obvious that doors contribute to the management of access and circulation control, just as they can influence the visual perception inside a building. Nevertheless, it must be kept in mind that a "closed door" is not very different from an open or half-open door. A closed door is indeed felt as a potential opening and not as a solid wall". Finally, we proceed to export the map in dxf format to the Depthmap software. It should be noted that the axial map can be obtained by highlighting all the axial lines that cover the open space of the urban area, but it can also be represented by a graph reflecting the main axial lines, taking into account the limit of visibility and the maximum distance that can be covered on foot[22].

Once the morphology representation has been created and edited, the syntactic measurements of spatial features will be performed globally and locally, step by step, and can be analysed. Hillier and others have used the axial representation of space to compute analytic graph measures, where each axial line represents a node in the graph and each intersection between lines represents a vertex. Hillier's theory of pedestrian movement is that the priority routes for pedestrian movement in such circumstances will depend on the morphological characteristics of the streets themselves. This is the theoretical basis for the use of road simplicity measures in movement

[22] The idea of an 'all line' map is to represent the longest sight lines between two intervisible building vertices. The idea of an interesting alternative concept, a 'fewest line' axial map The idea of an interesting alternative concept, a "fewest line" axial map, was presented in the introduction to Hillier and Hanson's "Social Logic of Space" as a minimal set of the shortest and longest lines of sight that cover certain large convex spaces (Hillier and Hanson, 1984) except that it has the limitation that the sampling of lines of sight depends entirely on the complexity of the polygons used in the processing. This means that any graph based on the '***fewest line***' map is 'weighted' towards areas that have complicated facades or polygons (Hillier and Penn 1992). To this end, we will experiment with both types of maps, limiting ourselves in what follows to reporting on the maps that expose all axial lines, which are more complete and less weighted.

patterns. "If we define an urban street network as a system of lines linking some set of origins and destinations, and to the extent that movement can occur from all origins to all destinations, then movement along the lines making up the network will be substantially determined by extrinsic measures of those lines." (Hillier, 1998)

- Six morphic indicators or first-degree syntactic measures will be used in parallel on the two subject settlements:

| | |
|---|---|
| **a) Connectivity[23] (number of existing connections of each street in the system)**<br>**b) Depth (or Mean Depth )**<br>**c) HH integration[24] (topological relationship between all streets in the system)** | **d) Length of axial lines (line length)**<br>**e) Entropy[25]**<br>**f) Control[26]** |

**The intelligibility[27] of the Urban system as a measure of the second degree of accessibility**

[23] Connectivity is a static syntactic property that measures the number of connections a space can have with other spaces in its environment. In other words, it is the number of existing connections of each street with the other streets in the system. For the axial analysis, the axial lines are assimilated to connections and their intersections to nodes. It allows highlighting the tendency of some spaces to cluster locally: it is a measure directly related to the inter-visibility of spaces.

[24] Integration is a standard global measure that is essentially a normalized version of mean depth (Turner and Penn, 1999, Tuner, 2001, Turner et al., 2001). It is very important because it correlates well with pedestrian movement counts, as noted in the introduction (Hillier et al., 1993). Below we propose the 'HH' integration value map: normalization proposed by Hillier and Hanson and obtained by dividing the value obtained by a number called the d-value, which is intended to account for the fact that as the graphs in the axial map grow, they also become less integrated due to the way the lines intersect.

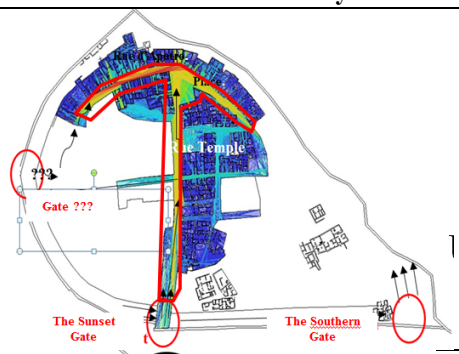
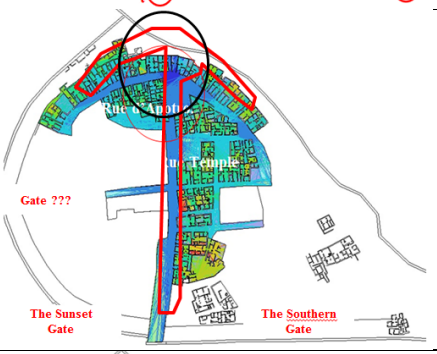
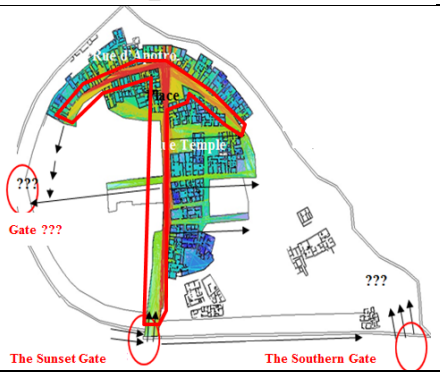
[25] Entropy is this measure of the distribution of a node's locations in terms of their depth rather than the depth itself. Thus, if many locations are visually close to a node, the visual depth of that node is skewed and the entropy is low. If the visual depth is more evenly distributed, the entropy is higher.

[26] Control is that local measure that assesses the degree to which a space controls access to its immediate neighbors by taking into account the number of alternative connections that each of these neighbors undertakes. This measure selects the controlling spaces that Turner has designated as control spaces (Turner, 2003).

[27] In the rules of spatial syntax, the intelligibility of an urban system means how the spaces that make it up are perceived; it is defined as the degree of what can be seen and experienced locally in the system. How these spaces are connected and whether or not they are integrated into the spatial system under consideration. A spatial structure is intelligible when what is seen correctly informs what is not seen.

Table 1: Axial Analysis of the two settlements – Comparative Approach

- +

| | Kerkouane City | Monte Siai City |
|---|---|---|
| The connectivity |  |  |
| The Depth |  |  |
| The integratio |  |  |

Starting the axial analysis with connectivity, mean depth and integration and projecting the results to the level of the practical organization drawings of the two settlements

We notice that these morphic indicators are in perfect agreement and in both cases of study to:

- Demonstrate the existence of two zones in the two urban structures that function in two opposite ways: an urban dichotomy:

1. An area with a high connectivity and integration, with a low average depth: it is the urban core of the city (streets and main arteries, crossings and junctions; strategic clearances where we find religious facilities (the temple of Astarte in the case of Monte Sirai and the sanctuary in the case of kerkouane) and squares and plazas that constitute a kind of space of gathering, social and commercial exchanges
2. An area with a low connectivity and integration, with a fairly high average depth: this is the purely residential area

- Deduce an urban dichotomy marked by :

1. Zone 1 with high connectivity , low average depth and high integration

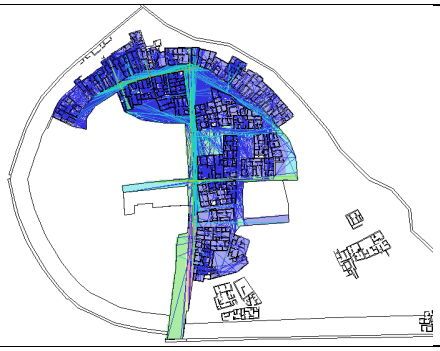
- This is the connected, integrated and easily surveyed urban core of the city

2. Zone 2 with low connectivity, high average depth and low integration,

- It is the deep and segregated residential zone

Table 2: Axial Analysis of the two settlements – Comparative Approach


| | Kerkouane City | Monte Siai City |
|---|---|---|
| The control |   |   |
| The entropy |   |   |

| | | |
|---|---|---|
| **The choice** |  |  |

By examining the **control** and **entropy** graphs, these two indicators confirm the urban dichotomy within the two Phoenician and Punic urban structures:

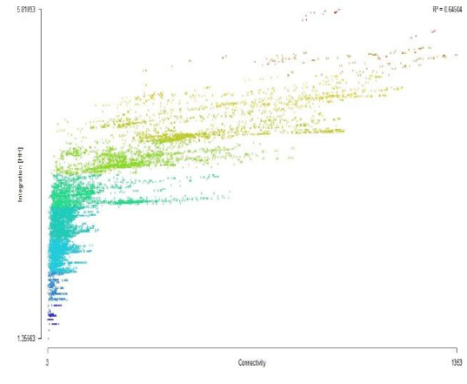
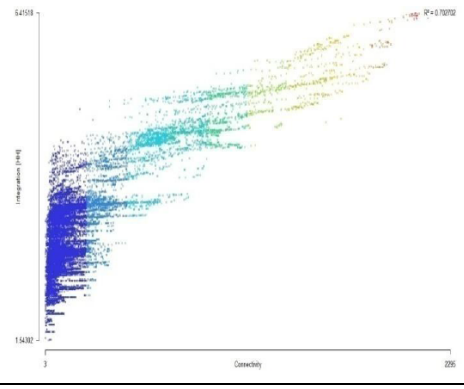
They show an urban core (the main road network and the public squares) constituting the main accessibility space but also the potential meeting field and the field of social and commercial exchange.

- **This core is also endowed with quite important control values.**

For the entropy, the mainly residential areas, are endowed with a high entropy which shows the informational ambivalence and the difficulty of access for the case of kerkouane but in the case of Monte Sirai, we notice that all the agglomeration is endowed with a high entropy which reflects the informational uncertainty, the difficulty of access and ambiguity established in this system.

This informational uncertainty and this difficulty of access is confirmed by the morphic indicator the choice which presents too limited values

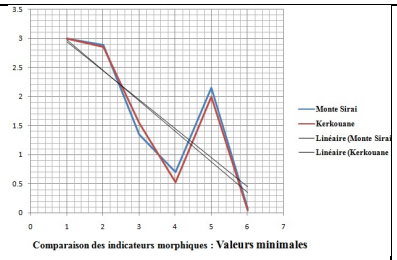
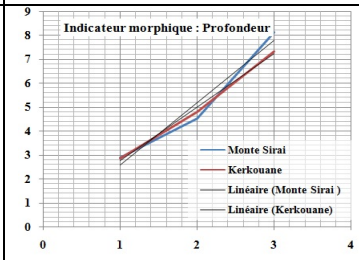
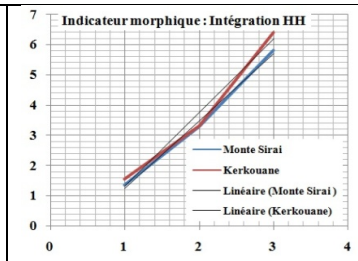
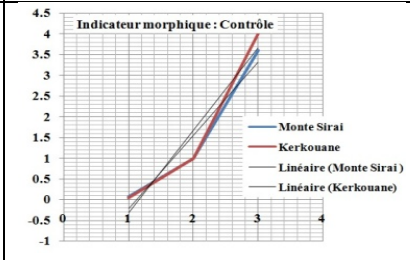
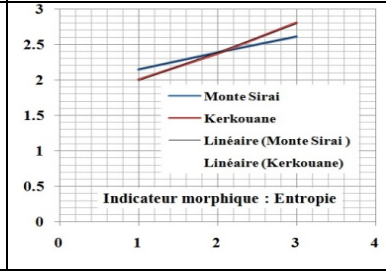
Table 3: Axial Analysis of the two settlements – Comparative Approach

| | Graph of intelligibility within Kerkouane $R^2$=0.68 | Graph of the intelligibility within Monte Sirai $R^2$=0.65 |
|---|---|---|
| **Urban system intelligibility** |  |  |

More concretely in the axial map, the value of intelligibility is calculated by the degree of linear correlation between the connectivity and the overall integration value (Hillier and Hanson, 1984).

Thus, the two diagrams of intelligibility relative to the two cities that are presented in the table, show, in both cases, fairly significant correlations between integration and connectivity: intelligibility values of $R^2$=0.65 for the case of Monte Sirai and $R^2$=0.6 for the case of Kerkouane. To this effect, we can confirm the intelligibility of these two agglomerations with almost equal values but which are between 0.5 and 0.75: thus the intelligibility in the urban systems of Kerkouane and Monte Sirai is important without being excessive, which refers to systems that are accessible

Table 4: Comparison of Axial Morphic indicators in the two agglomerations in terms of minimum, average and maximum values

<table>
<tr><td>Connectivity : (Vmin;Vmoy;Vmax)</td><td> 
</td><td rowspan="2">➢ The decortication of the morphic indicators shows results that are almost identical in both cases and that provide information on the configuration of these urban spaces, their hierarchy, their depth, accessibility and intelligibility, the distribution and frequentation of spaces, control, etc.</td></tr>
<tr><td>Depth: (Vmin;Vmoy;Vmax)</td><td> 
</td></tr>
<tr><td>Integration [HH]: (Vmin;Vmoy;Vmax)</td><td> 
</td><td rowspan="3">➢ These agglomerations are characterized by a spatial hierarchy of their own.<br>➢<br>➢ They are deep and segregated in their residential areas, with an informational uncertainty and ambivalence, and a difficulty of access.<br><br>➢ They are also endowed with permeability and accessibility in their public and shared urban core, reflecting a hierarchical and strongly arranged road network. Visibility and movement are strongly controlled and the choice is limited.</td></tr>
<tr><td>Control: (Vmin;Vmoy;Vmax)</td><td> 
</td></tr>
<tr><td>Entropy : (Vmin;Vmoy;Vmax)</td><td> 
</td></tr>
</table>

## 5 THE VISIBILITY ANALYSIS VGA OF THE TWO SETTLEMENTS: COMPARATIVE APPROACH

The representations based on visibility, which is a kind of visual accessibility since every space that cannot be seen cannot be equally accessible and usable, take into consideration the analyses of the different fields of visibility that the spatial system offers and use the computer tool. They evolve since the elaboration by the development of the notion of the isovist following the works of Benedikt (Benedikt ,1979).the first approach of the use of the graphic analysis of visibility in the spatial syntax returns to Turner and Penn (Turner and Penn ,1999).

It differs from physical accessibility analyses (the axial map) in that it does not divide the environment into sectors, but rather takes into account all points in the environment. This analysis allows, through the computer tool, to calculate several configurational properties, from the different isovists that form the spatial corpus. It presents on a plane, the different components of space, where each portion of it is assigned a spectral range of color from indigo for low values through blue, cyan, green, yellow, orange, red to magenta for high values[28] (Turner, 2001).

For the process of preparation of the VGA representation for the two settlements subject of our study, we consider as study areas, similar to the axial map, the two areas limited by and defined within the walls (we consider that the urban area is limited to the intramural area). Like the axial map, we will keep in the plan to be exported in dxf format on Depthmap all the interior arrangements of the domestic buildings and their open accesses to guarantee and establish contacts with public spaces. Usually, we talk about visibility, through the notion of visual defense, depth (of visibility and accessibility) through the hierarchy of building entrance, visual control and accessibility. Once the morphology representation has been created and edited, a number of configuration measures, can be calculated and analysed. Each of these measures is given a name beginning with visual 'Visual', this is justified by the fact that VGA measures must be distinguished from metric and axial measures, which will be calculated later. The visual syntactic measures and the derived measures will be operated globally and locally and can be analyzed. They will be used in a statistical table to provide clues for interpreting manifestations of spatial perception, such as pathfinding, movement and space use.

- Six morphic indicators or first-degree visual syntactic measures will be used in parallel on the two subject settlements of the study[29] :

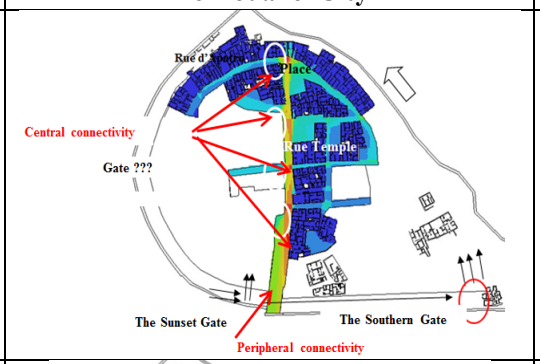
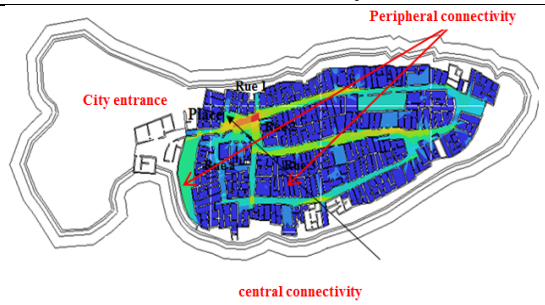
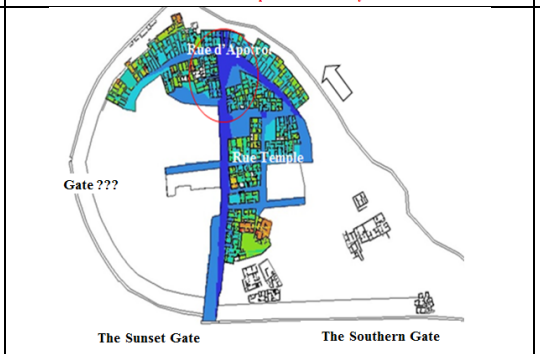
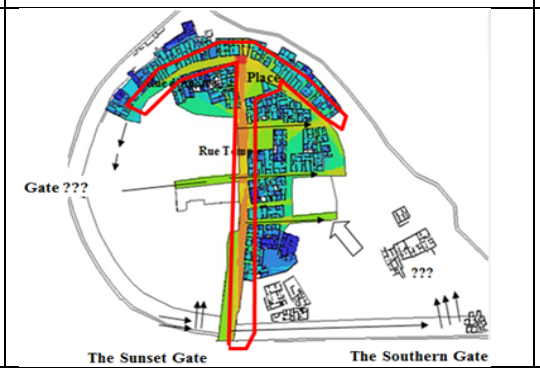
[28] A. Turner - A. Penn, Making Isovists Syntaxique : Isovist Integration Analysis, in: Actes du 2e symposium international sur la syntaxe de l'espace, Brasilia 1999 http://www.vr.ac.uk/publications/turner 1999-000.htm (25.10.2008), et AM Turner - OS Doxa - A. Penn, From Isovists to Visibility Graphs: A Methodology for the Analysis of Architectural Space, Environment and Planning B 28, 2001, 103 – 121.

[29] The graph of the VGA visibility analysis designates the spaces with the most visual connections in red, the other spaces are classified according to a gradient spectral range of colors. The spaces colored in indigo (purplish blue) are the spaces with very limited visibility.

**a) Visual connectivity**
**b) Visual depth,**
**c) Visual integration,**
**d) Visual control[30],**
**e) The visual entropy[31],**
**f) The clustering coefficient,**

Table 5: Visibility Analysis of the two settlements - Comparative Approach

- +

| | Kerkouane City | Monte Siai City |
|---|---|---|
| The connectivity |  |  |
| The visual depth |  |  |
| The Visual integration |  |  |

[30] Visual control is that local measure that selects visually controlling spaces that can see more. Turner named these spaces as control (Turner, 2003). These are strategic locations because they are difficult to control. It gives the values of the locations that have visual control.
[31] L'entropie visuelle est une mesure globale qui indique la façon dont un système est ordonné à partir d'un emplacement, c'est-à-dire qu'elles fournissent des informations globales disponibles à partir de cet emplacement.

The VGA analysis allows the description of the analyzed agglomerations and defines their morphic logic. It reveals that:

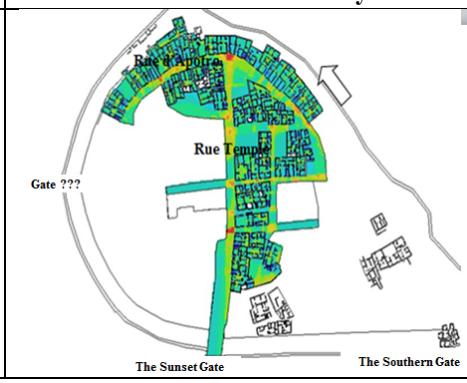
**The connectivity**, at the level of the two settlements, is of two types:
- It is central with as well connected spaces (important visual connections) the areas located at the level of public spaces open to the community and located near collective facilities (the two public squares) as well as at the level of public spaces of spatial distribution (the structuring nodes); thus creating an urban centre of social and commercial activity of gathering and meeting.
- It is peripheral and affects in this case the accesses of each agglomeration (access to Monte Sirai and the sunset gate of Kerkouane) and the road axes, whether they are punctual or linear.

**The visual depth** at the level of the two settlements confirms the results of the axial analysis and show that the very deep spaces in terms of visibility are those leading to the houses. The shallowest spaces, i.e. the most accessible ones (colored indigo) from the point of view of visual fields, are located at the level of the spaces that are, visually, the best connected. These results reaffirm the impermeability of the human settlements studied and their limited accessibility.

**The visual integration results** of the two settlements show that the shallowest spaces are the most integrated. These are found at certain nodes located along the busiest roads and include the gathering spaces (nodes and plazas). They show that these settlements are predominantly segregated and that this segregation increases each time one goes from the urban centre to the periphery and from the entrance of the settlement to its depths. Just as it increases the further one moves away from the community squares and facilities.

Table 6: Visibility Analysis of the two settlements - Comparative Approach

- +

| | Kerkouane City | Monte Siai City |
|---|---|---|
| The visual control |   |   |


**The visual control results** in Monte Sirai and Kerkouane shows that control is strong in most areas. This can be interpreted by the will to visually control the visitors of these settlements even when they are in public, common and open areas.

The results of **the visual entropy** at the level of these fabrics, show that the spaces with high visual entropy are of two types. Spaces of the first type are located in the most remote areas of the urban area. They are the most remote spaces that are least open to traffic and visitors. The second type of spaces is those with low entropy and is located in the centre of the agglomeration near religious and public services/equipment.

**The clustering coefficient (CC)** results show the intervisibility relationships of the different spaces and their degree of importance. They thus reveal the quality of the visual network that each fabric constitutes and the quality of the resulting neighbourhood relationships. In the case of the two agglomerations, the spaces that have a large visual field of their own, which are the shallowest and most integrated, often have a limited coefficient clustering. This means that they can be used to go where their route leads but cannot be used to see the rest of the agglomeration.

[32] It is interesting to note that the CC colors the plan in a very similar way to the visual integration, only with reversed tones visually highlighting the most integrated locations with blue.

## 6 DISCUSSION

Regarding the residential areas and the dwellings, we have been able to note that concerning the visual depth, the areas that show the maximum values are located inside the houses (values approaching 10 for the case of Kerkouane and 12 for the case of Monte Sirai).For the visual integration, the graphs have shown that these same areas (the interiors of the houses) display a supreme segregation (integration values approaching 1 in both cases). For visual control, the front houses (which can be defined by areas belonging to the public domain or the street but which juxtapose house entrances or thresholds) are important visual control spaces (first degree controlling spaces). The visual entropy graphs revealed a zone with a predominantly residential vocation (the interior distribution spaces) marked by a visual informational insufficiency that makes it difficult to access. This same area shows very high coefficient clustering values, which means highly developed intervisibility relations and extremely close neighbourhood relations. This state of affairs, which is particularly true for all the residential spaces in the two agglomerations, confirms, testifies to and reinforces the private aspect and the strong control of these areas.

The morphological study of the two Phoenician-Punic settlements by the application of the spatial syntax allowed two morphosyntactic representations of the two urban fabrics (the axial analysis and the VGA analysis. Each of these representations was then analysed in relation to its own structure, in relation to the built-up areas and house entrances, but also in relation to the different access points to the urban area from the outside.  The two representations were then compared with each other.

The results of the comparison between the representations of the two settlements demonstrated and revealed, through several morphic indicators, that these settlements have a common morphic logic: a true morphic identity.

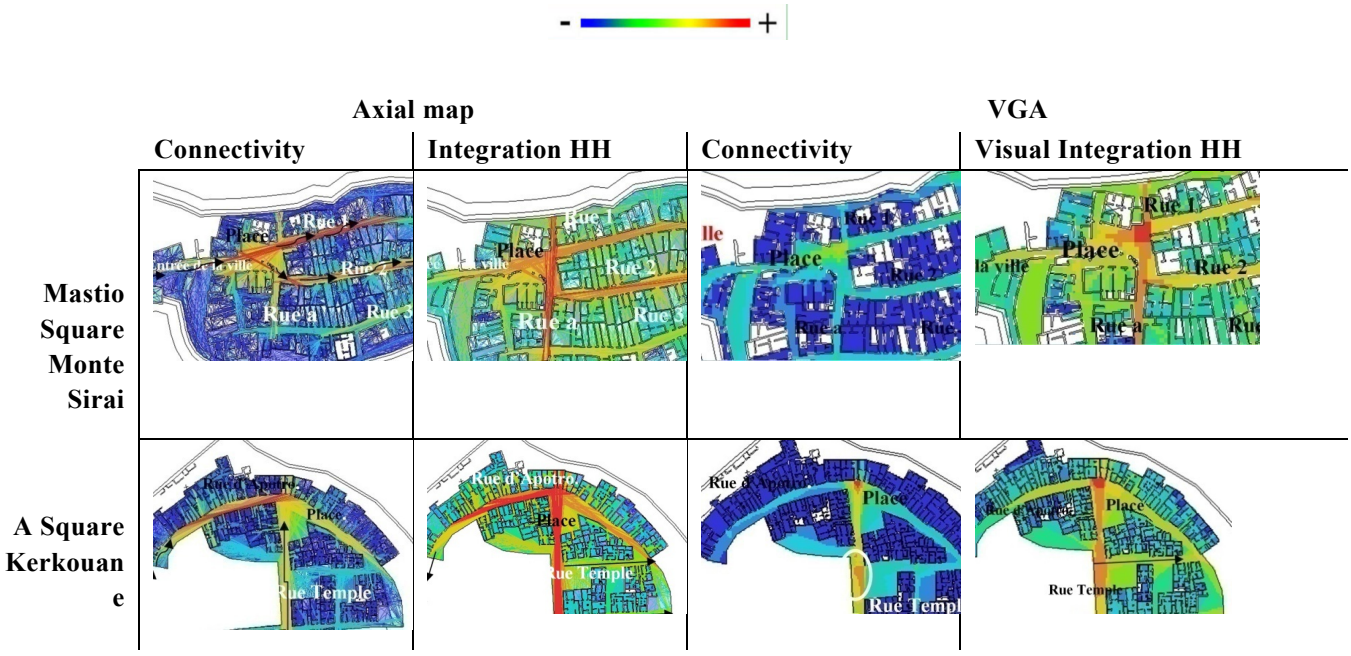
The axial analysis and visibility of these clusters, highlight, through the graphs and numerical data obtained, regularities and syntactic recurrences clear and precise. These show that within these settlements, the way in which certain spatial arrangements are made, the relationship between potential circulation paths, their depths, the intervisibility that exists there, or even the prescriptions relating to the location of this or that type of space, present a structural redundancy symptomatic of an underlying morphological genotype of the urban form which as one might expect is a function of this Phoenician and Punic culture.

Indeed, the analysis of these settlements has revealed the existence of an urban hierarchy (shared public centre + 'repulsive' residential periphery) that is not easily discernible but once detected, is confirmed by all morphic indicators. This hierarchy is reinforced by:

- The existence of an attractive, attractive and accessible urban centre (core) (A favoured area); marked by the greatest number of connections by too low depth values (axial and visual), by high integration values, by minimal entropy and cluster values. This center which gathers the public squares located near collective facilities such as the Mastio and the temple and open to the local community but also shared with foreigners visiting the place; displays quite important control values (axial and visual). This means that even when accessing their most sociable and shared parts, visitors to these settlements remain under visual control.
- The existence of a peripheral zone (which is immediately and/or remotely removed from the urban centre) with a mainly residential vocation, characterized by a reduced accessibility and permeability, expressed in particular by a high depth and segregation, by a visibility at the level of their internal distributions that is quite limited, by a control of movement, especially that of strangers, that is also very high at the level of the neighborhoods of their interior spaces and the relations of intervisibility.

If we engage a comparative study between the two main squares of the two agglomerations on the attractiveness, in terms of movement, the measures of the Mastio square in Monte Sirai show a notable difference between the measures of HH integration and connectivity taken in the perimeter of the city centre. We conclude that this plaza is more integrated in its surroundings than in the entire urban area. This can be explained by the importance of the number of lines crossing the square on the axial map and can be interpreted by the fact that the square is locally a movement space. On the other hand and concerning Kerkouane square A, the morphic measures also show a difference between the HH integration and connectivity measures but the square seems more integrated than connected, this could be interpreted by the fact that this square plays mainly the role of a gathering and exchange space dedicated to an economic activity such as the trade.

Table 6: Axial Map and Visibility Analysis of the main squares of two settlements – Comparative Approach




This hierarchical urban structuring can only be the fruit and the emanation of the genius of a whole community which knew how to adapt to different ways of implantation (a rocky and extremely uneven site and a seafront site with all the constraints of the latter). Thus the elaboration of such a dense and morphologically hierarchical and ordered urban system can neither be accidental nor involuntary nor the fruit of a chance, it is rather the expression of a

form of social behaviour which is reconquered in the way of life, the culture, the history and the traditions of this community.

## 7 CONCLUSION

In conclusion, through the regularities and the clear and precise syntactic recurrences raised, we can confirm the existence of a structural redundancy symptomatic of an underlying morphological genotype of the Phoenician and Punic urban form that displays a spatial order linked to the functioning of this society, an order based on an urban hierarchy that destines the majority of the spaces of each agglomeration to its inhabitants and limits the access of the foreign visitor to rigorously limited and strongly controlled places. An order that translates an urban system with compact and segregated spatial, topological and configurational properties. The presence of an urban dichotomy that is not easily perceptible but once detected, it is confirmed by all morphic indicators with an urban system divided into two zones and two orders (urban and residential):

- The existence of an urban centre (core), shared with the foreign visitors of the place, attractive, attractive, well accessible and integrated but subject to movement and visual control
- The existence of a residential area with a repulsive aspect, convex, segregated, relatively inaccessible and impervious, displaying a limited visibility at the level of their internal distributions and insufficient information

These agglomerations are the expression and the urban manifestation of this mixed Phoenician-Punic society and the result of its collective social code. They testify to a way of life that unfolds in the respect of its own physical environment. But they also express a concern for protection, defense and preservation of intimacy and private life, which explains the desire to repel the other, which is apparent in all the indicators studied, to control the exits and to filter visitors.

Consequently and in order to conclude this research, studying the spatial configuration of a certain number of models allows us to highlight some rules, some properties. The latter constitute in fact the generic rule underlying the space in question, its genotype. At the same time, each architecture has a particular physical realization of these rules: its phenotype. In other words, particular conditions (such as available materials and especially the topographical context, etc.) can contribute to give buildings built or urban spaces according to the same organizing principles (their genotype) a particular identity and a unique appearance (their phenotypes). Of course, it is utopian to believe that the analysis of spatial syntax will invariably bring its share of answers and that it will automatically allow a clear grasp of spatial patterns and related social realities. Within the framework of the study of the Phoenician and Punic architecture and urbanism, two major 'obstacles' hindered the progress of the analysis of the configuration.

The first obstacle was of a methodological nature and is extensively commented upon by Hanson (Hanson, 1998 ). It is mainly inherent to the method of analysis and the social factor is the main cause of it, considering the complexity of the relations which link a built space to the society which established it and in spite of the proven bipolarity of these relations, the difficulty of seizing the modalities of it, of fundamentally variable character which results from it a certain ambiguity due to the complexity of the social sphere and the variable manifestations of this last one, while the built environment generally possesses a more determined or fixed character:

« […] Finally, it would be foolish in the extreme to expect all aspects of society to imprint themselves directly on space in a simple 'cause and effect' relationship […] However, the pattern itself is usually capable of more than one interpretation […] It all depends on how you look at it […] The inherent ambiguities in the interpretation of human spatial patterning set limits to what can ultimately be known, but also open up a universe of what can be expressed through design. The problem of ambiguity encapsulates both space's greatest limitation and also its most liberating experiential dimension […] » (Hanson, 1998).

The second obstacle is related to the field of application of this method. Indeed, in the framework of archaeological research and in particular, in the study of the Phoenician and Punic world, architecture and society, which constitute the basis of the analysis of spatial syntax, are sometimes extremely difficult realities to apprehend. First of all, it should be remembered that the Phoenician and Punic architectural and urban testimonies, even if they are numerous, remain mostly incomplete. The analysis of spatial syntax is traditionally applied to coherent and clearly defined built examples. Obviously, its application to archaeological remains invites the researcher to be even more cautious (Hanson, 1998).

Therefore, a study of the Phoenician-Punic dwelling is will be essential to shed light on the original state and cultural character of this urban society.

## REFERENCES

Arfaoui W.(2018), 'Syntactic modelling of the city and dwelling in the Phoenician-Punic era in the central sphere of the Mediterranean', Doctoral Dissertation: 2 Volumes, 820 p. Director: Prof. Said Mazouz, Visiting Professor in architecture at the University of Carthage / Co-Director: Prof. Dhouib Mounir.

Amorim, L., Oiticica, D., Sales, M., Santos, P., Silva, G. G. (1981), Delfim Amorim - arquiteto. Recife: Instituto de Arquitetos do Brasil. Amorim, L. (1990) «Memória do Curso de Arquitetura e Urbanismo . Research report Departamento de Arquitetura e Urbanismo - UFPE.

Amorim, L. (1995) «A Cultural Reification of a Diagrammatic Idea - the introdution of modernity in Recife, Brasil. Pilot Study, Bartlett School of Graduate Studies, University College London.

Amorim, L. (1997) « The sectors paradigm understanding modern functionalism and its effects in configuring domestic space», Space Syntax first international symposium proceedings volume 2 - - Domestic space -London 1997.

Appien (1987), «Libyca; Histoire romaine», Text prepared and translated by Paul Goukowsky, Budé series, Les Belles Lettres, electronic edition (1997-2008)

Bafna S., (1999), 'The morphology of open plan residential designs: geometry and genotype in the work of Mies van der Rohe', in proceedings of the 2nd International Symposium on Space Syntax Eds M Major, L Amorim (University of Brasilia, Brasilia) pp 01.1 - 01.12

Bafna S., (2001), 'Geometrical intuitions of genotypes', in Proceedings of the Third International Space Syntax Symposium Eds J Peponis, J Wineman, S Bafna (Taubman College of Architecture and Urban Planning, Ann Arbor, MI) pp 20.1 -20.15

Bartoloni P. (2004) Monte Sirai (= Guide e Itinerari, 4), 2 ed., Sassari 2004.

Bondi S. F. (1975) «Gli scarabei di Monte Sirai, Saggi Fenici ṛ, Roma, pp. 73-98.

Bondi S. F. (1975) «L'espansione cartaginese in Italia, Cultura e Scuolaṛ, 56 , pp. 66-74.

Bondi S. F. (1975 ) «Ricerche fenicie a Roma, Bibbia e Orienteṛ, 17 , pp. 173-85

Bondi S. F. (1978) «Monte Sirai: un caposaldo fenicio nellřentroterra sardoṛ, Antiqua 9, pp. 22-28.

Bondi S. F. (1980a) «Nuove stele da Monte Sirai, Rivista di Studi Feniciṛ, 8 , 51-70.

Bondi S. F. (1980b) , « l"urbanisme et l"architecture », les phéniciens direction de lřédition S.Moscati, rééditions en format de poche, Paris, 1997, p311-348.

Ciasca, A (1992) «Mozia in Sicilia : un esempio di cinta urbana in area coloniale fenicia », Publications de l'École Française de Rome

Cintas P. (1970-1976) «Manuel d'Archeologie punique» Picard, Paris. 2 vols.

Dridi H. (2006) «Carthage et le monde punique» (Guide Belles Lettres des Civilisations), Paris, Les Belles Lettres, p288 / ISBN 2-251-41033-3.

Dridi H. (2015) «Une réflexion publiée dans ŘLa forme de la ville de lřAntiquité à la Renaissance» Actes du colloque publié sous la direction de Stéphane Bourdin, Michel Paoli et Anne Reltgen –Tallon, Presses universitaires de Rennes, 2015, p25.

Diodore de Sicile, (1865) «Bibliothèque historique» , 4 volumes , traduit du grec par Fred Hoffer, Edition électronique .

Diodore de Sicile, (1865) « Histoire universelle », 7 volumes, traduit du grec par L'Abbé Terrasson , Edition électronique .

Fantar, M.H. (1973) «Récents découvertes dans les domaines de l'archeologie et de l'épigraphie puniques». Bull. Arch. CTHS, 1971, VII (ns), pp. 241-264.

Fantar, M.H. (1984-1986) «Kerkouane, cité punique du Cap Bon. I et II», INA, (3 vols) INAA, Tunis,

Fantar, M.H. (1991) «Carthage, les lettres et les Arts». Tunis.

Fantar M.H. (1993a) «Carthage, approche d'une civilisation». Tunis, 2 vols.

Fantar M.H., (1997) « les Phéniciens et la Méditerranée» dans Liban l'autre rive, p.117

Fantar M.H. (2008) « L'identité carthaginoise est faite de couches multiples », Les Cahiers de Science & Vie, n°104, p. 25

Fantar M.H., (1999) «

Fantar M. (2015) « De l'urbanisme phénico-punique : quelques repères historiographiques et archéologiques », Actes du 2ème colloque international : Urbanisme et architecture en Méditerranée antique et médiévale à travers les sources archéologiques et littéraires, p91.

Guirguis M. (2005) «Storia degli studi e degli scavi a Sulky e a Monte Sirai: Rivista di studi fenici 33 (2005), pp. 13-30.

Guirguis M., (2010a) «Necropoli fenicia e punica di Monte Sirai. Indagini archeologiche 2005-2007» (= Studi di Storia Antica e Archeologia, 7), Ortacesus.

Guirguis M. (2009) «Indicatori di attività rituale e diversificazione dei corredi nella necropoli fenicia di Monte Sirai (Sardegna). La campagna di scavo 2006ŗ, in M. G. MELIS (a cura di), Atti del Convegno Nazionale dei Giovani Archeologi "Uomo e territorio: dinamiche di frequentazione e di sfruttamento delle risorse naturali nell"antichità" (Sassari 27-30 settembre 2006), Muros: 370-276.

Guirguis M. (2008a) «Nuovi dati dalla necropoli fenicia e punica di Monte Sirai (Sardegna): la tomba 248», dans J.

Guirguis M. (2008b) «Archeologia e archeometria a Monte Sirai. Diffrattometrie ai raggi X sui resti scheletrici della necropoli fenicia e punica (campagna di scavi 2007)ŗ, dans F. CENERINI, P. RUGGERI (a cura di), Epigrafia romana in Sardegna. Atti del I Convegno di studio, SantřAntioco 14-15 luglio 2007 (= Incontri insulari, 1), Roma: 233- 252.

Guirguis M. (2010) «PLA Orquín, R. in stampa Notizie preliminari sullo scavo del 2010 nellřacropoli et abitatione di Monte Sirai » M.B. COCCO - A. Gavini (a cura di), L'Africa romana XIX, Sassari 14-17 dicembre 2010, in stampa.

Gras M., Rouillard P. et Teixidor J., (1989) «L'Univers phénicien», Paris, Arthaud.

Gras, M. (2002) «Périples culturels entre Carthage, à la Grèce et la Sicile au VIIIe' siècle av. J. C. », En Ch. Muller y F. Prost (eds.) Identités et cultures dans le monde méditerranéen antique. Sorbonne, Paris, pp. 183-198.

Gras M. (1997) « Il Mediterraneo nell'eta arcaica». Fondazione Paestum, Paestum.

Gsell S. (1918) « L'État carthaginoise». HAAN, II. Hachette, Paris.

Gsell S. (1920b) « La civilisation carthaginoise». HAAN, IV. Hachette, Paris.

Hanson. J (1998) « Decoding homes and houses», Cambridge University Press, Cambridge.

Hillier B, Hanson J, Peponis J, Hudson J, Burdett R, 1983, « Space syntax, a different urban perspective» Architects Journal 178 47-63

Hillier B. et Hanson J. (1984) « The Social Logic of Space», Cambridge, Cambridge UniversityPress, 1984, 1e éd.,poche (ISBN 978-0-521-36784 4, LCCN 83015004)

Hillier. B et al (1984) « Space syntax, a different urban perspective», the architect's Journal, 30 Nov, pp.47-63;

Hillier. B, Hanson. J et Peponis. P (1984) « What do we mean by building function? » Designing for building utilisation, ed. Powell, Cooper, Lea, Spom, pp.61-72;

Hillier. B et Graham. H (dir) (1985) « Case study: la maison rustique an investigation of spatial organisation in french rural dwelling», London, University College, Barlett school of Architecture,

Hillier. B, Hanson. J et Graham. H (1987) « Ideas are in things: an application of the space syntax method to discovering house genotypes», in Environment and Planing B: Planing and Design, volume 14, pp.363-385;

Hillier. B (1987a) « La morphologie de l'espace urbain: L'évolution de l'approche syntaxique/» dans Arch et comport Arch. Behav., vol.3, n.3, p.205-216, traduit de l'anglais par Anne Noschis,

Hillier, B. (1987b) « Syntactic Analysis of Settlements », in "Architecture & Comportement », Vol. 3, N°.3, p 17-231, Londres .

Hillier. B (1996) « Space is the machine». A Configurational Theory of Architecture, Cambridge University Press, Cambridge (ISBN 978-0-521-64528-7).

Hillier B. and Penn A. (2004). « Rejoinder to Carlo Ratti». Environment and Planning B - Planning and Design, 487Ŕ499.

Hillier. B (2005) « Between social physics and phenomenology: Explorations towards an urban synthesis», dans Van Nes, A. (éd), Space Syntax 5th Interntional Symposium, Delft, p.3-23;
Isserlin B. S. J. (1972) «Some common features in Phoenician/Punic Town Planning» RSF, 1, pp. 135- 152.

Lancel S. (1990) « Problèmes dŕurbanisme de la Carthage punique, a la lumière des fouilles anciennes et récentes». Histoire et Archéologie de l'Afrique du Nord, IV Colloque International, Strasbourg 1988, PP• 9-30.

Lancel S. (1994 [1992]) «Cartago. Critica», Barcelona.

Lancel S. (1995) « la civilisation phénicienne et punique» . Manuel de recherche édité par Véronique Krings Ŕ chapitre 14bis: Vie des cités et urbanisme Patrim occident p371-p388

Lancel, S. (2000) « Carthage : de la colonie tyrienne à la mégapole hellénistique». En Ilbert, R., Nicolet, C. et Depaule, J.Ch. (eds.) Mégapoles méditerranéennes. EFR, Roma, pp. 506-534.

Lancel S., Thuillier J.P., 1979 «Rapport préliminaire sur la campagne de 1976 (niveaux puniques) », dans Lancel, S. (éd.), Byrsa I. Rapports préliminaires des fouilles (1974-1976). Mission Archéologique française à Carthage, Rome.

Lancel S., 1992, «Carthage, Paris.

Levin K. (1964) «Use of graphs to decide the optimum layout of the buildings» article consulté en ligne

Lynch K. (1960) « L'image de la Cité », trad. par Marie-Françoise Vénard et Jean-Louis Vénard de The Image of the City (1960), Paris,

Letesson Q. (2009) «Du phénotype au génotype, analyse de la syntaxe spatiale en architecture minoenne (MMIIIB-MRIB) », thèse de doctorat publiée, presses universitaires de Louvain, Belgique ,;

Mahjoubi A. et Fantar, M. (1966) «Une nouvelle inscription carthaginoise» . Atti dell'Accademia nazionale dei Lincei, CCCLXIII. Rendiconti deLla classe di scienze rnorali, storiche e fololoqiche, XXI, fasc.7- 12, pp. 20 1-209.

Moscati S. (1979), «Il mondo dei Fenici, Milano» v 2.

Moscati S. (1977), «I Cartaginesi in Italia (= Saggi, 89) », Milano, pp. 228-45.

Moscati S. (1972), «I Fenici e Cartagine (= Società e costume, 8) », Torino.

Rakob F. (1992) «L'habitat ancien et le système urbanistique», dans: A. Ennabli (éd.), Pour sauver Carthage. Exploration et conservation de la cité punique, romaine et byzantine, Paris / Tunis, UNESCO.

Rakob F. (2002) «Cathago. La topografia de Ia ciudad punica. Nuevas investigaciones». En Vegas, M. (eel.) Cartago fenicio-ptinica. Las excavaciones alemanas en Cartago (1975- 1997). CAM, 4, pp. 14-46.

Ramon J. (2012) «L'évolution urbaine et périurbaine de la ville punique dřIbiza, dans Le paysage périurbain en Méditerranée Occidentale, pendant la Protohistoire et l‟Antiquité. Actes du colloque international. Institut Catalan d‟Archéologie Classique, Tarragone, 6-8 mai 2009 , (édités par Carme Belarte (M.), ICREA /CAC et Plana Mallart (R.), Université Paul-Va-léry, Montpellier 3), Institut Català dřArqueo-logia Clàssica, Tarragona, p. 245-258.

Ramon J. (2013) « Les villes phéniciennes puniques de lřextrême occident méditerranéen et atlantique », Actes du 2 ème colloque international : Urbanisme et architecture en Méditerranée antique et médiévale à travers les sources archéologiques et littéraires, Tunis 2013, p.15

Pline l'Ancien, (1832) «Histoire naturelle de Pline», traduction par Ajasson de Grandsagne, Paris, Edition électronique

Polybe (1753), «Histoire de Polybe», traduite du grec par Dom Vincent Thuillier, Edition électronique

Strabon (1865), «Geographie», traduite par Amedée Tardieu, Paris , Librairie de la Hachette , Edition électronique

Yon M. (1995) «Vie des cités et urbanisme partim Orient, dans La civilisation phénicienne et punique. Manuel de recherche (édité par Krings V. , p. 362-369

Yon M. (1997), «La cite d'Ougarit sur le Tell de Ras Shamra» , Paris.