Original Study

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The Shrines of *Gadir* (Cadiz, Spain) as References for Navigation. GIS Visibility Analysis

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Abstract: This work analyses the influence of the visibility factor on the configuration of the archaic landscape of the Phoenician city of *Gadir* (Cadiz, Southern Spain) using the three shrines mentioned by classic sources as a reference. Theoretical or cumulative viewshed analyses are the methods used to investigate the visibility relationships each of the shrines has with the sea and the surrounding territory, as well as with each other. Based on these analyses a series of theoretical interpretations regarding the function of these shrines as references for navigation in Antiquity are established.

Keywords: Phoenicians; Temples; Ancient navigation; Visibility Analysis

1 Introduction

According to classical tradition (Vell. Pat., *Hist. Rom.*, I: 2, 1–3; Str., III, 5, 5; Mel., III, 6, 46; Ps.-Arist., *De mirabil. ausc*. 134), the Tyrians founded *Gadir* in the Western Mediterranean, under the modern city of Cádiz (SW Spain) (Fig. 1), about 80 years after the fall of Troy (Fernández-Camacho, 2012).

As for ancient topography, the classical authors agree in describing an archipelago. According to Pliny (*N.H.*, IV, 36, 120), the Phoenician city was founded on a small island (named *Erytheia*, *Afrodisias* or Isle of Juno), facing North and dedicated to Marine Venus (Avienus, *O.M.*, 309, 314–317), the Phoenician *Astarte*. A strip of sea separated it from an elongated, larger island, which Timeus referred to as *Kotinoussa* (Plin., *N.H.*, IV, 4, 119–120). Two temples were erected on this island, one to the North, dedicated to *Kronos* (originally *Baal-Hammon*), and the other to the South, dedicated to *Herakles* (the Phoenician *Melqart*). The third island, known as *Antipolis*, corresponds to the modern town of San Fernando (Fig. 2).

Archaeology in Cadiz has tried for years to clarify the location of the coastal shrines devoted to the three most influential divinities of the Tyrian Pantheon cited in the classical sources.

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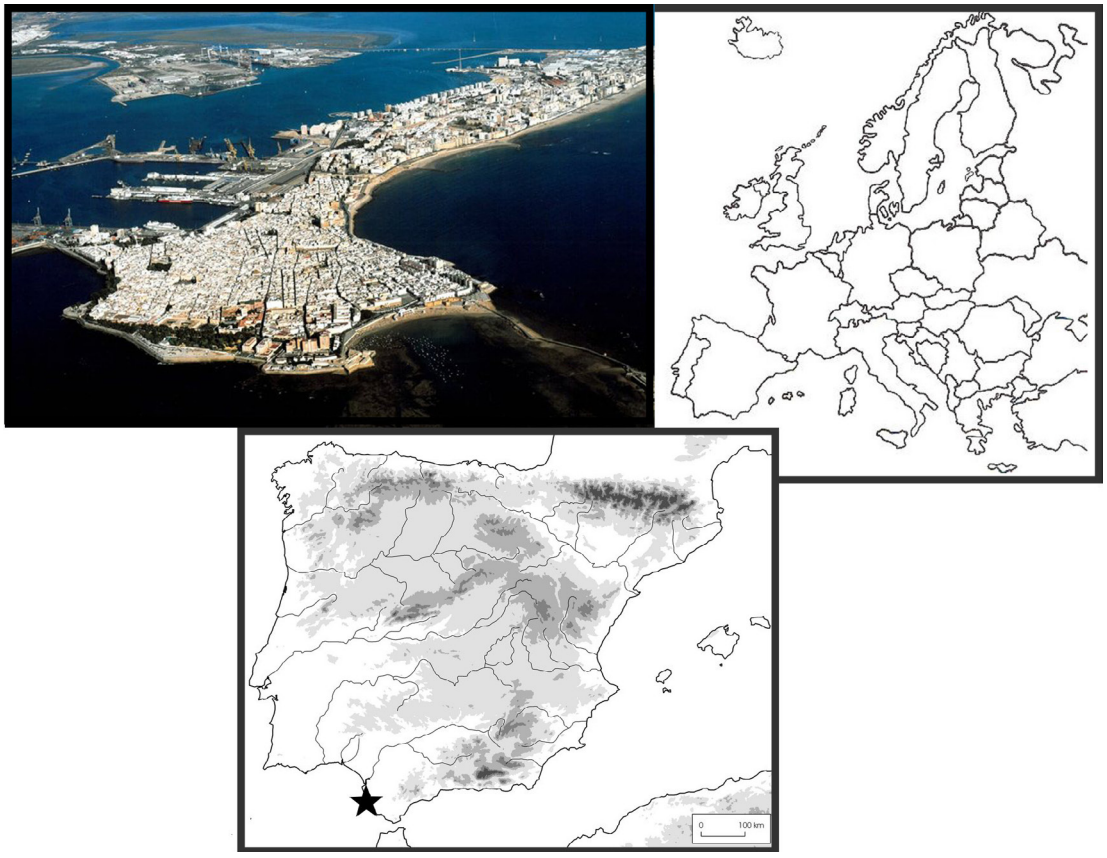

Figure 1. Geographical situation of Cadiz with respect to Europe and the Iberian Peninsula.

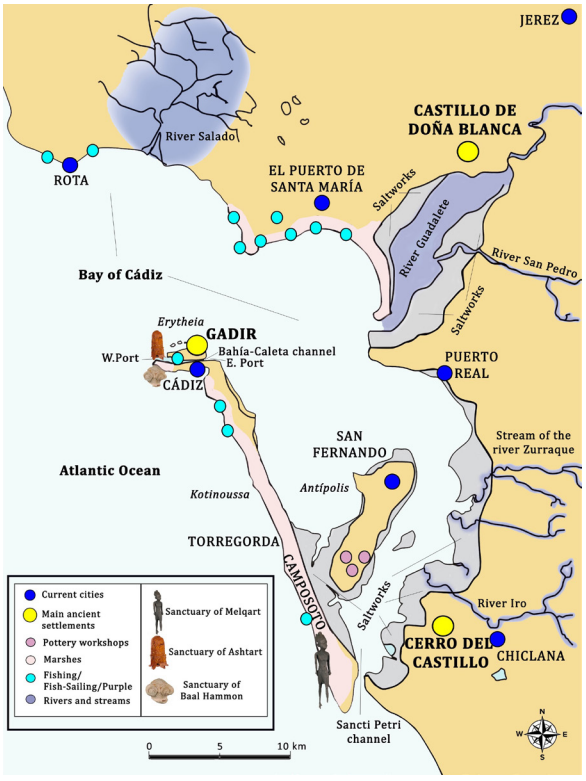

Figure 2. The Bay of Cadiz in Phoenician-Punic times (map based on Sáez-Romero, 2014, Fig. 4).

According to Strabo (III, 5, 3), *Gadir* housed three temples (an updated status of the issues with references to the classical texts in: Marín-Ceballos, 2011). The shrine consecrated to *Melqart,* was erected at the southernmost point of the long island (*Kotinoussa*), on the present-day islet of Sancti Petri. This shrine was later reconverted into the temple of *Hercules Gaditanus*, enjoying wide fame throughout the Mediterranean.

A second shrine was dedicated to the Phoenician goddess *Astarte*, who became *Marine Venus* in Roman times. According to Pliny (*N.H.*, IV, 120) it was located on a little island dedicated to Aphrodite (*Erytheia*), possibly situated near the present-day Santa Catalina Castle.

Finally, historiography locates the shrine of *Kronos* (Plin., *N.H.*, IV, 120), heir of the Phoenician *Baal-Hammon*, in the area of the San Sebastian Castle, at the northernmost point of *Kotinoussa*, where a proto-Aeolic capital was discovered (Marín-Ceballos & Jiménez-Flores, 2011).

At present, classical references have been reinforced by: the *Reshef* of Egyptian iconography found in the Sancti Petri channel, next to the *Melqart* shrine (Jiménez-Ávila, 2013); by votive and ritual material discovered at the Punta del Nao (reef attached to the Santa Catalina Castle (Ferrer-Albelda, 2002, pp. 196, 201); and by the structures found most recently on the island of San Sebastian (Maya-Torcelly et al., 2014).

Our aim is to study, for the first time, the spatial relationship between the three coastline shrines of *Gadir*; their geographic locations having been deliberately chosen to allow the buildings to fulfil their multiple functions. We are particularly interested in their function as a guide for navigation, where the visibility factor plays a relevant role. This aspect must also be studied independently under the concept of "Maritime Cultural Landscape". This term was introduced by Christer Westerdahl (1986) and is defined as, "the whole network of sailing routes, old as well as new, with ports and harbours along the coast, and its related constructions and remains of human activity, underwater as well as terrestrial". According to Westerdahl, the definition of "Maritime Cultural Landscape" must be analyzed from two perspectives: topographical and cultural (Westerdahl, 2006, p. 334). A topographical perspective reflects on maritime elements that are identified on the coast, from anthropic signs directly related to the sea to the geographic condition of the area being taken into consideration. Culture is understood in a more ritual and symbolic sense of the utilization or cognitive appropriation of the littoral (Vaz-Freire, 2014, p. 145), alternatively described by Tunddenham in the following formula: physical landscape + cultural landscape (2010, p. 7).

Our purpose is to use multidisciplinary methods to approach a subject that was initially studied at the beginning of the 20th century and still remains open. However, due to the lack of architectural remains of shrines, the visibility analysis cannot, at this moment, offer any data other than the proposal of a theoretical model.

2 Methodological Proposal

2.1 The "Maritime Archaeological Landscape" of Gadir and Its Shrines

The finds linked to the shrines of *Gadir* are all of underwater origin, doubtless due to the fact that in the western colonies these divinities acquired a maritime character and became protectors of navigation (Marín Ceballos, 2011, pp. 213, 216–220). The Phoenicians habitually consecrated promontories, islets and river mouths to their gods. Putting these places under the protection of the divinity ensured their necessary neutrality as stopover points and, with that, the protection of the sailors. Moreover, the coastal shrines served as navigational waypoints (Mateos, 2006). Thus, the importance of their geographic location in places of reference for the sailors (Ruiz-de-Arbulo, 1999, p. 18). This is a characteristic identified by the islet of Sancti Petri, as well as those of San Sebastian and the Punta del Nao area, in accordance with the location hypotheses of the three gadirite temple-shrines mentioned in the historiographical tradition.

With a view to confirming or rejecting these hypotheses, our intention is to analyse the strategic location of the three shrines and the spatial relationship between them and with the landscape under the concept of "visual control" (understood as "visual quality" Cerezo, 2016, pp. 661–668) by means of a "joint study" (a first attempt: Mateos, 2006). At present, only an individual study of each shrine, together with the most

spectacular archaeological objects related to the same (although they are decontextualised findings), has been carried out (Ferrer-Albelda, 2002; Marín-Ceballos, 2011; Marín-Ceballos & Jiménez-Flores, 2011; Maya-Torcelly et al., 2011 amongst others).

The analysis begins by examining the importance of the spatial component in archaeological research and, in particular, of the way in which the societies and their individuals organise the space they inhabit. Extrapolated to a maritime coastal area, we find ourselves before a city dedicated to its condition as a maritime port and defined by that fact. This space is characterised by the interaction between a terrestrial and a maritime landscape, the joint study of which defines the society inhabiting it. This is because the maritime landscape should not be studied in an isolated manner, given that is an extension of the terrestrial landscape (Cerezo, 2016, pp. 66–77). In this respect, it is also necessary to include in the study the concept of "Landscape Archaeology", as it is understood in the framework of the dialectical relationship between the society and the natural environment, according to certain patterns that it is possible to analyse from the archaeological perspective (Grau, 2011, p. 124). One of the ways to carry out this analysis is through the use of Geographic Information Systems (GIS), as will be demonstrated below.

For its part, the "Visual landscape" is defined as the articulation of the visual properties generated by a specific spatial configuration (Llobera, 2003, pp. 30–31). This concept is fundamental in order to gain a richer and multidimensional understanding of the territorial patterns of past societies. Likewise, visual control can serve either to determine the security limits of a community and its resources in the face of other hostile communities, to reinforce its hierarchical structure/internal stratification, or to act as a symbol of prestige based on power relationships. (García-Sanjuán et al., 2006, pp. 182–183).

In fact, visibility is a factor that contributes to underlining the monumentality, rank and perceptibility of sacred and/or monumental sites and, therefore, conveys an ideological message of presence, appropriation or power. This is what must have happened when the Tyrians built a temple dedicated to *Melqart*, thus legitimising the foundation of *Gadir* (Ruiz-Mata, 2018, pp. 265, 275–276, 280; López-Castro, 2018, p. 80). As patron and protector of sailors, temples dedicated to the Phoenician god Melqart were also erected at the principal stopover points on the westbound route (Cyprus, Malta, Sardinia, etc) (Aubet, 2009, p. 239; López-Castro, 2018, p. 86).

The Cadiz shrine is situated at the entrance to the Bay of Cadiz, on the southern border of the territory controlled by the City of *Gadir*. From this location, it would act as a form of "reception" for sailors arriving from the Mediterranean (Ruiz-Mata, 2018, p. 276). Likewise, its geographical position would allow the building to be visible from the rest of nearby settlements and from the open sea. This would be one of those sites specialising in visual control such as watchtowers, look-out towers or lighthouses. Sancti Petri Castle still performs the latter function. From this point of view it would, therefore, be interesting to calculate the "visibility or visual prominence", understood as the ability of a natural or artificial element to be appreciated in the distance (Criado-Boado, 1999, p. 34).

Once the first of the temples had been built, another two shrines were erected and dedicated to the gods that form the triad of Tyre together with *Melqart*: *Astarte* and *Baal Hammon* (Marín-Ceballos, 2011, p. 213). These shrines were built in geographical locations between which there is a certain visual association. A determining factor when building a specific monument had to be the possibility of contemplating, or visually dominating, other pre-existing constructions from it (Wheatley, 1996, p. 92). In this case, it is not unreasonable to think of a visual confluence between the three shrines. We must remember that *Astarte*, without ever being the sovereign of the sea, is a goddess linked to it by her origins and her marital ties with *Melqart* (López-Amador & Ruiz-Gil, 2010, pp. 271–281). One of the attributes acquired by this divinity in the western colonies is that of protector of sailors (Pérez-López, 1998; Ferrer-Albelda, 2002, p. 202; Marín-Ceballos, 2011, p. 217). This is a port, seafaring and oracular cult that follows a common pattern in all the coastal shrines dedicated to this divinity. They are situated far from the urban area, at a height above sea level, in a dominant position from which they visually controlled the navigation routes, serving, at the same time, as a symbol of power and dominion over the territory; as well as a reference point for navigation. This is the case of the coastal shrines consecrated to *Astarte* in Kition (Cyprus), Tas Silg (Malta), Erice (Sicily) and Gorham's cave in Gibraltar, amongst others (Gómez-Bellard & Vidal, 1999; Marín-Ceballos, 2011, pp. 117–218).

The sanctuary of *Baal-Hammon*, a divinity characteristic of the Punic period, could have been erected at a later time and incorporated that aspect of power and legitimacy (Ruiz-Mata, 1999, p. 300). Various classical authors refer to the existence of a series of places along the Iberian coastline that would have been dedicated to *Kronos*/Saturn, in addition to the *Kronion* mentioned in *Gadir*. All of them are located on the coast, on prominent geographical features of the same (Marín-Ceballos, 1992, pp. 9–14). These may be islands, capes or high rocks. This is the case of the *Promunturium quod Saturni dicitur* (Plin. *N.H.*, III, 19) generally identified with the Cabo de Palos, the *Insula Pelagia Sacra Saturno* (Avienus, *O.M.*, 164–165) identified with the island of Berlanga and the *Cautes Sacra Saturni* (Avienus, *O.M.*, 215–216) referring to the Punta de Sagres, among others.

The identification of *Kronos*/Saturn with the Phoenician *Baal-Hammon* makes it possible to consider that these places were consecrated by Punic sailors who frequented these coasts from at least the fifth century B.C. (Ruiz-Mata, 1999, p. 300). However, the archaeological works carried out recently indicate that the site was already occupied at the very least towards the end of the seventh century B.C. (Maya-Torcelly et al., 2014). It is true that *Baal-Hammon* has no known attributes as a god of navigation, but his association with *Baal-Saphon* in an epigraph from Tyre may be significant (Marín-Ceballos, 1992, p. 12). In this sense, there are authors who interpret this inscription as a reference to two divinities that act as the patrons of navigation in the two extremes of the Mediterranean (Pérez-López, 1998; Marín-Ceballos, 1992, pp. 9–14).

In any case, this third sumptuary complex also formed part of the maritime landscape that was *Gadir* and, therefore, both its visual association with the other sanctuaries and the visual control it itself exercised can be analyzed.

2.2 Possibilities and Limitations of Visibility Analyses

For this GIS viewshed analysis we have used a raster "Digital Terrain Model" (DTM). In fact, the aim of the calculation is to define which cells are visible from the cell that constitutes the specific viewpoint within the maximum established perimeter of vision. Once the point of origin of the viewer is marked, the algorithm calculates a new binary raster map where cells with value 1 are visible from the viewpoint while cells with value 0 are invisible (Wheatley & Gillings, 2002, pp. 201–216). The existence or absence of intervisibility is therefore calculated, i.e., the existence of an uninterrupted line or radius of visibility (*line-of-sight*), between the viewer's cell and each and every other cell included in the theoretical maximum viewshed.

However, Geographic Information Systems, despite being sophisticated tools that enable us to manage and analyse spatial information, are not exempt from problems and difficulties. Specifically, for the proposed visibility analysis we come across a series of limitations that render any results fundamentally theoretical (table 1).

Table 1. Methodology.

Objective GIS Analysis	Proposals For Studies	Variables and problems in the analysis	Issues to be considered
Visibility and perceptibility analysis under theoretical models	• Theoretical or Potential Viewshed • Visual association • *Line-of-sight* • Visual prominence • Visual control	• Viewer height: 4 metre offset proposal • Maximum Vision Limit: There are no fixed criteria for the human radiu Water sheet as a distortion factor	• Terrain: to have an accurate cartography • Changing dynamics of visible landscapes over time

The most obvious problem lies in the absence of structural archaeological elements that show the shape and height of these sanctuaries. Moreover, when calculating the viewshed for each of them, it is necessary to establish the height of the viewer point (in this case, the shrine itself added to the height of the observer); empirical information that we do not possess. Even so, we have, based on parallels (Gómez-Bellard & Vidal, 1999; Mateos, 2006), chosen to establish their height at an average value of 4 metres, together with an average height of 1.60 metres. Obviously, the result will always be approximate, never real.

On the other hand, even with an approximate height, the body of water present throughout the Bay of Cadiz constitutes an important distortion factor of the visual interaction patterns that might have existed between the sanctuaries, since the coastline has varied with the passage of time. In fact, the morphology of the city itself has undergone a profound transformation (Niveau-de-Villedary, 2015, 2018) and the archipelago formed by at least three islands in ancient times is, today, a peninsula welded to the continent. In this sense, it is necessary to carry out the study of the coastline of the Bay of Cadiz during the Phoenician period. This study can be done by means of the georeferentiation of historical cartography and from the data obtained from previous geomorphological and archaeological works carried out along the coast of Cadiz, (Gallardo et al., 2000; Gracia-Prieto et al., 2000; Alonso-Villalobos et al., 2004; Arteaga et al., 2008; Zamora-López & Sáez-Romero, 2014; Sáez-Romero & Carrero-Ramírez, 2016); aspects that are currently being worked on (work in progress within the framework of the doctoral thesis of one of the signatories NLS).

Finally, we shall also have to consider the set of variable atmospheric factors that determine matters such as air transparency since, depending on the day and time, the points indicated will be more visible or not, just as its viewshed will be more or less extensive. A GIS analysis of the data can be carried out using a tool called, "Diffuse Visibility" (Cerezo, 2016, pp. 692–693), aspects of which are also being examined in more depth as part of the research underway.

Therefore, due to the limitations outlined, we will focus on a "Theoretical or Potential Viewshed" analysis, defined as the "data set of the locations or points of a territory that are visible from a specific viewpoint, given a maximum distance of view and based solely on the topography" (García-Sanjuán et al., 2006, pp. 184–185). That is to say, without taking into account the other conditioning factors already mentioned above. This means that we should maintain a certain amount of caution when interpreting the results, although these limitations do not prevent us from extracting some valuable readings from them, especially bearing in mind that they have already been successfully applied for the analysis of other Mediterranean sanctuaries and cultural landscapes (Soetens et al., 2001; Papantoniou & Bourogiannis, 2018; Papantoniou & Kyriakou, 2018).

3 Results of the Experimental Visibility Analysis Study

3.1 Theoretical Analysis

The area chosen to carry out this study includes, as we have seen, three possible constructions or temple-shrines (fig. 2). These are distributed following a linear route of approximately 20 km from the islet of Sancti Petri, and cover the entire coastline of the present-day isthmus as far as the islet of San Sebastian and the adjacent cliff of Punta del Nao. The DTM on which this study is based has been prepared as a result of the digitalization of sheets 05–1061, 05–1062, 05–1068 and 05–1069, obtained from the Institute of Cartography of Andalusia's 1:10,000 topographic cartography (available in digital *raster* format). Each pixel of this raster presents, on the one side, a value i.e., an altitude; and, on the another, a pixel size of 05, given that the smaller the pixel the more resolution we will obtain.

In this raster of the Bay of Cadiz, the maritime space that surrounds it lacks values or data which, in principle, prevents calculations from being carried out from the sites that are currently located in these areas of marine domain. To deal with this, this surrounding area has been assigned level 0, which means that we have had to add the value 0 to that sheet of water thus recognising the submerged sites, as is the case of the one located at Punta del Nao. Subsequently, point *shapefiles* have been placed at the three sanctuary sites, which have been given an average theoretical height of 5.60 m. (calculated using the approximate height of the sanctuary plus the average height of the human observer, the latter having been established at 1.60 m.). The vegetation, on the other hand does not suppose any outstanding disrupting factor given that this is shrub vegetation typical of the heart of pine and oak forests and of the Thermo-Mediterranean scrubland of wild olives and mastics, characteristic of the zone, that is not modified by anthropic factors. (Arcila-Garrido & Fernández-Enríquez, 2015, p. 212).

In the case of the Temple of *Melqart*, situated on the islet of Sancti Petri, the theoretical or potential viewshed i.e., that strictly based on topography and *lines-of-sight*, achieves an important visual preponderance (fig. 3), this being understood as the capacity of a natural or artificial element to be appreciated in the distance (Criado-Boado, 1999, p. 34). This temple would have a viewshed oriented preferably towards the west i.e., the open ocean. However, it has a considerable draft towards the east in the interior of the Bay which, at least from a theoretical point of view, visually associates it with the Phoenician fortification of Cerro del Castillo (Chiclana de la Frontera) (Bueno & Cerpa, 2008, pp. 169–200). The visual connection with the rest of the sanctuaries is also verified, since both the Punta del Nao (shrine of *Astarte*) and the San Sebastian Castle (shrine of *Baal Hammon*) form a part of the *line-of-sight,* or intervisibility, of the potential theoretical viewshed of the possible temple of *Melqart*.

With regards to the second of the points under examination, the shrine of *Baal-Hammon*, the theoretical maritime preponderance that we can determine by means of this calculation is most likely exaggerated and does not correspond to reality (fig. 4).

However, the form and orientation of its viewshed, distributed mainly towards the open sea area, does correspond to reality, as evidenced by the fact that a lighthouse is currently located there. On the other hand, the viewshed carried out from the third of the sanctuaries (the one dedicated to *Astarte*) (fig. 5), penetrates more towards the interior of the Bay, thus leaving the entire maritime zone of the hinterland formed by Gadir (the port areas, as well as the facilities related to the fishing industry and commercial activity) under the protection of their main gods. Also outstanding (and we do not think it coincidental) is the fact that the maximum limit of this theoretical viewshed reaches the site of Castillo de Doña Blanca situated on the mainland next to the old mouth of the Guadalete River, that forms one of the three main nuclei of population (together with the Cerro del Castillo in Chiclana and the Teatro Comico in the city of Cadiz) making up this polynuclear city that must have been *Gadir* in Phoenician times (Ruiz-Mata, 2018, p. 249–280).

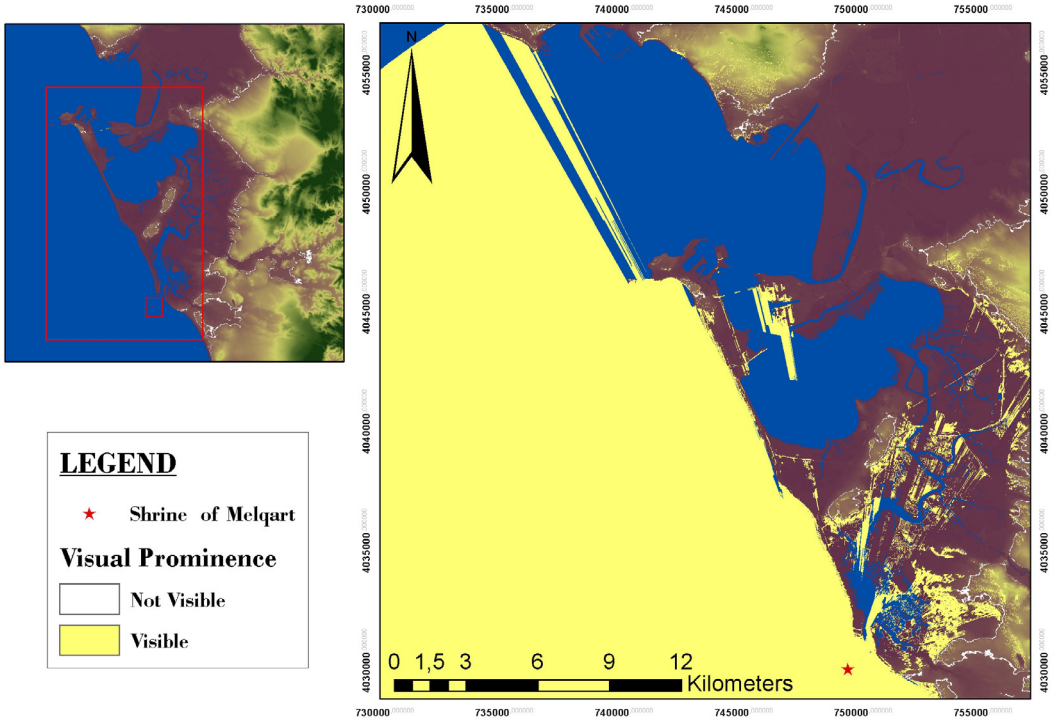

Figure 3. Projection of the GIS analysed viewshed of the temple of *Melqart* (right). On the left, detail of the orientation and shape of this viewshed integrated into the morphology of the archipelago in Phoenician times. ©Authors.

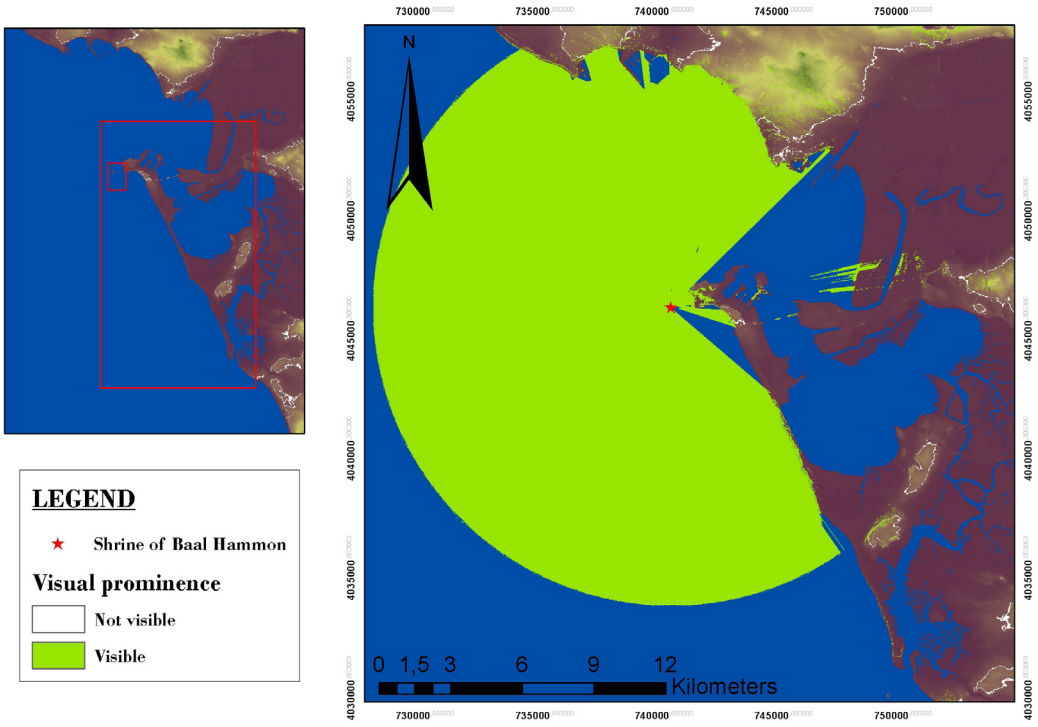

Figure 4. Theoretical or potential viewshed of the presumed shrine of *Baal Hammon*/San Sebastian Castle (right). Expansion of the same to beyond the islet of Sancti Petri and part of the continental interior (left). ©Authors.

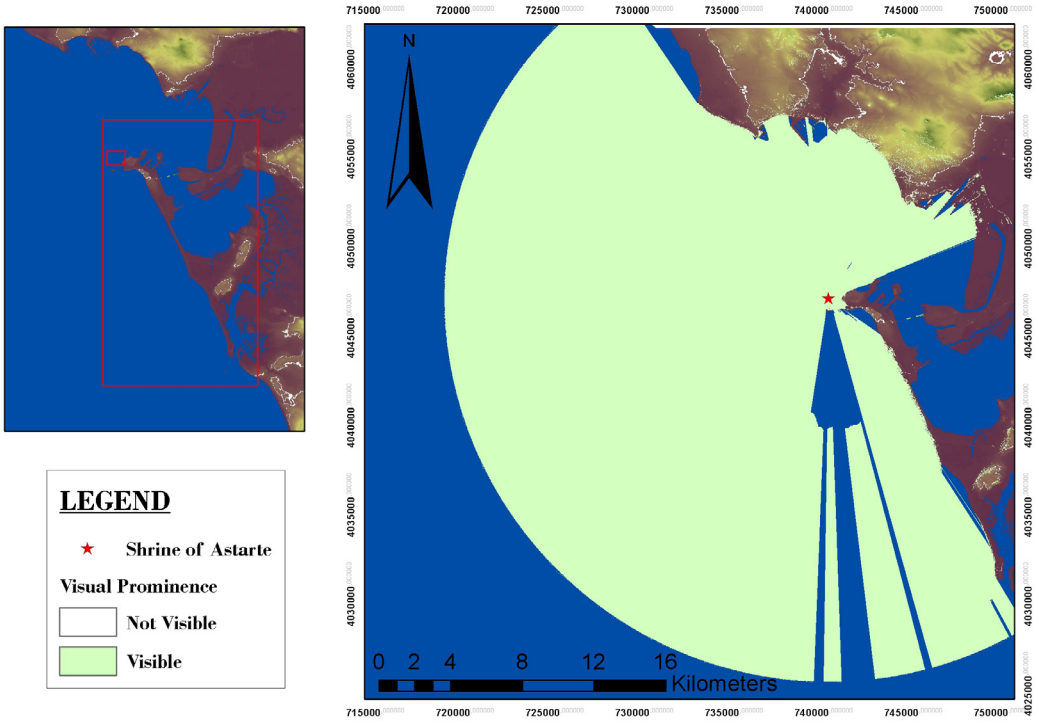

Figure 5. Analysed theoretical viewshed for the shrine of *Astarte*/Punta del Nao. Projection of this viewshed extended towards the mainland. ©Authors.

3.2 Practical Experimental Analysis

After the theoretical analysis and, to verify its reliability, we proceeded to check the degree of visibility currently presented by these geographical locations.

The complete definition of "Maritime Cultural Landscape" encompasses three areas: the physical environment, its relationship with society, and the cognitive impression (Cerezo, 2016, pp. 17–19). In relation to the latter, we understand the "Cognitive Maritime Cultural Landscape" as the perception of man of the maritime landscape and the representation of that relationship, which is known as *seascape* (Ford, 2011, p. 4). Therefore, the Maritime Landscape exists to the extent that the human perceives it and interprets it but, in turn, the human forms, by definition, part of the landscape culture and its identity (Cerezo, 2016, p. 18; Del Mastro-Ochoa, 2017, pp. 11–52).

Based on these premises, a brief study of real visibility was carried out, taking into account that the viewer height and the topography of the area would not be real and, even more importantly, considering that the modern buildings hinder the visual amplitude that would have existed in past historical moments. The results were positive despite these factors.

We chose to establish the viewpoints only at the Sancti Petri Castle (temple of *Melqart*) and the Punta del Nao (shrine of *Astarte*) because, at present, the road that leads to the island of San Sebastian (shrine of *Baal-Hammon*) is not passable. The aspects to be taken into account for the choice of days were: 1) seasonality, since in antiquity navigation was preferably carried out between March and October due to the inclement weather; 2) the direction and strength of the winds, seeking the transparency of the air; and 3) the dominant tide, because the low tide allowed us to get inside the rocky crags located at the foot of each castle.

The visit to the Sancti Petri Castle and its cliffs took place on a day of low tide (fig. 6), with a gentle west wind, but with a certain amount of humidity and mist in the air, which did not favour optimal visibility (table 2).

Figure 6. View of the Sancti Petri Castle from the Punta del Boqueron at low tide. ©Castillo Sancti Petri.

With a view to achieving the highest precision it was considered opportune to take the visibility patterns from different points on the islet itself (Points 1, 2 & 3: in the south, north and edge of the rocky strip, respectively), as well as from two of the most prominent areas of the sandy coastline (Points 4 & 5: Camposoto & Torregorda) (Zamora-López & Sáez-Romero, 2014) (fig. 7).

Table 2. Visibility study at Sancti Petri.

Location	Points chosen	UTM coordinates	Time	Cloud cover	Wind	Temperature	Humidity	Swell & Tides	Visibilty table	Comparative visibility
Sancti Petri 14/06/2018	1. CSP-South Side	29 S 749363.00 m E 4029593.00 m N	10:11	4%	Local west wind	17 º- 24 º C	60–65 %	SSE 150º Low tide	14 km	**Toward N.:** Misty day. Torregorda is observed and the buildings of Cadiz, among them San Sebastián Castle (but only the outline), are intuited.
	2. CSP-North Side	29 S 749363.00 m E 4029730.00 m N	10:20							
	3. CSP-Arihuela	29 S 748910.00 m E 4030876.00 m N	11:18							
Intermediate point 1: Camposoto 14/06/2018	Camposoto beach	29 S 748115.00 m E 4035008.00 m N	12:30	4%	Local west wind	17 º- 24 º C	60–65 %	SSE 150º High tide	14 km	**Toward S.:** Sancti Petri Castle is clearly visible. **Toward N.:** The Torregorda outcrop is observed The San Sebastian castle can be sensed
Intermediate point 2: Torregorda 14/06/2018	Torregorda/Next to the military area enclosure	29 S 746092.00 m E 4046555.00 m N	13:00	4%	Local west wind	17 º- 24 º C	60–65 %	SSE 150º High tide	14 km	**Toward S.:** We cannot see Sancti Petri because it is impossible to advance due to the military fencing. **Toward N.:** San Sebastian castle can be observed in greater detail

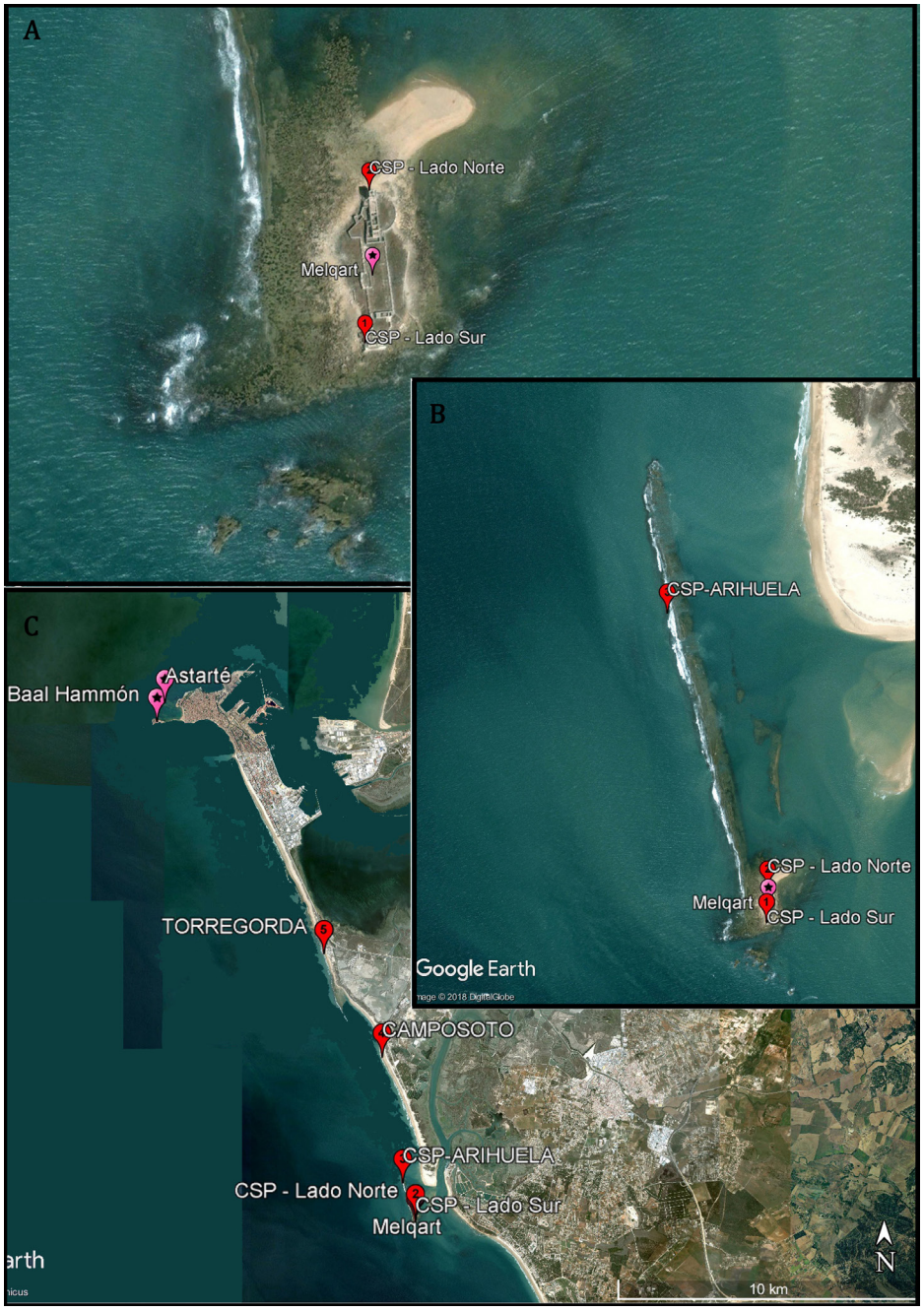

Figure 7. Spatial markers of the five points of the experimental visibility study of the shrine of *Melqart*. **A.** Situation of point 1 (CSP-South Side), point 2 (CSP-North Side) and the shrine itself. **B.** Markers of the three points closest to Sancti Petri Castle: CSP-South Side, CSP-North Side, CSP-Arihuela (point 3). **C.** Position of the five reference sites used in the study: point 1 (CSP-South Side), point 2 (CSP-North Side), point 3 (CSP-Arihuela), point 4 (Camposoto) and point 5 (Torregorda) (Source: Google Earth. Own edition).

From the viewer's first three position points (CSP-South Side, CSP-North Side & CSP-Arihuela), it is verified that the visual range oriented in different projections is extensive (fig. 8–10), it even being possible to create a visual association with point 4 (Camposoto) (fig. 10 B).

In fact, a second visual check from the latter also showed us that Sancti Petri Castle was in sight (fig. 11). However, visual access towards Sancti Petri was impossible from point 5 (Torregorda) because of a modern military enclosure (fig. 12).

Figure 8. Experimental visualisation from Sancti Petri Castle-point 1 (CSP-South Side). **A.** Towards the S. **B.** Towards the open sea (W.). **C.** Towards the N. **D.** Towards the mainland (E.). ©Authors.

Figure 9. Experimental study from Sancti Petri Castle-point 2 (CSP-North Side). **A.** Towards the Castle (S.). **B.** Towards the mainland (E.). **C.** Towards the open sea (W.). ©Authors.

Figure 10. Visibility from Sancti Petri Castle-point 3 (CSP-Arihuela/reef edge). **A.** Sancti Petri Castle can be observed to the S. **B.** Camposoto-point 4 can be visualised towards to N.E. ©Authors.

Figure 11. Study of the visibility from Camposoto-point 4. **A.** By facing S. Sancti Petri Castle can be observed. **B.** Detail of the Castle. **C.** Visibility towards the N. San Sebastian Castle. ©Authors.

Figure 12. Study of the visibility from Torregorda-point 5. Military enclosure (S.). ©Authors.

To sum up, our interpretation of the results of the GIS based "Theoretical Viewshed" analysis of this temple responds to a clear and evident intervisibility with the other shrines, even despite the unfavourable weather conditions (fig. 13).

However, the weather conditions were much more favourable on the day chosen for the check from Punta del Nao. The visual shots were taken from three different points on the crag, each one at a different time: 1) at the so-called Roca de or Piedra Rota del Tiburón, 2) at the tip of Punta del Nao and 3) inside the channel/Aculadero. (fig. 14, table 3).

Table 3. Visibility study at the Punta del Nao.

Location	Points chosen	UTM coordinates	Time	Cloud cover	Wind	Temperature	Humidity	Swell & Tides	Visibilty table	Comparative visibility
Punta del Nao 16/05/2018	1. Piedra Rota del Tiburón	29 S 740624. 32 m E 4046602.37m N	09:10	2%	Local west wind	18 º- 21 º C	59–54 %	SSE 150º Low tide	15 km	**Toward E.:** -C. Doña Blanca -C. de San Cristóbal **Toward N.:** -Fishing & saltings factories -Rota Naval Base **Toward S.:** -S. Sebastian Inside the cannel **Toward W.:** -Open sea
	2. Tip P.N	29 S 740304.00 m E 4046546.00m N	09:41							
	3. Aculadero/ inside the Channel	29 S 740438.00 m E 4046435.00m N	09:58							

The cloud cover was 3%, with a humidity of 59–54% and a west wind that reached an angle of 114º at a speed of 10 km/h. From the first viewpoint, turning the eyes towards the east, towards the mainland in the interior of the Bay, the necropolis of Las Cumbres in the Sierra de San Cristobal can be observed, as can part of the Castillo de Doña Blanca settlement, the great northern continental urban nucleus located at the foot of the sierra (Ruiz-Mata, 1999 & 2018) (fig. 15–16).

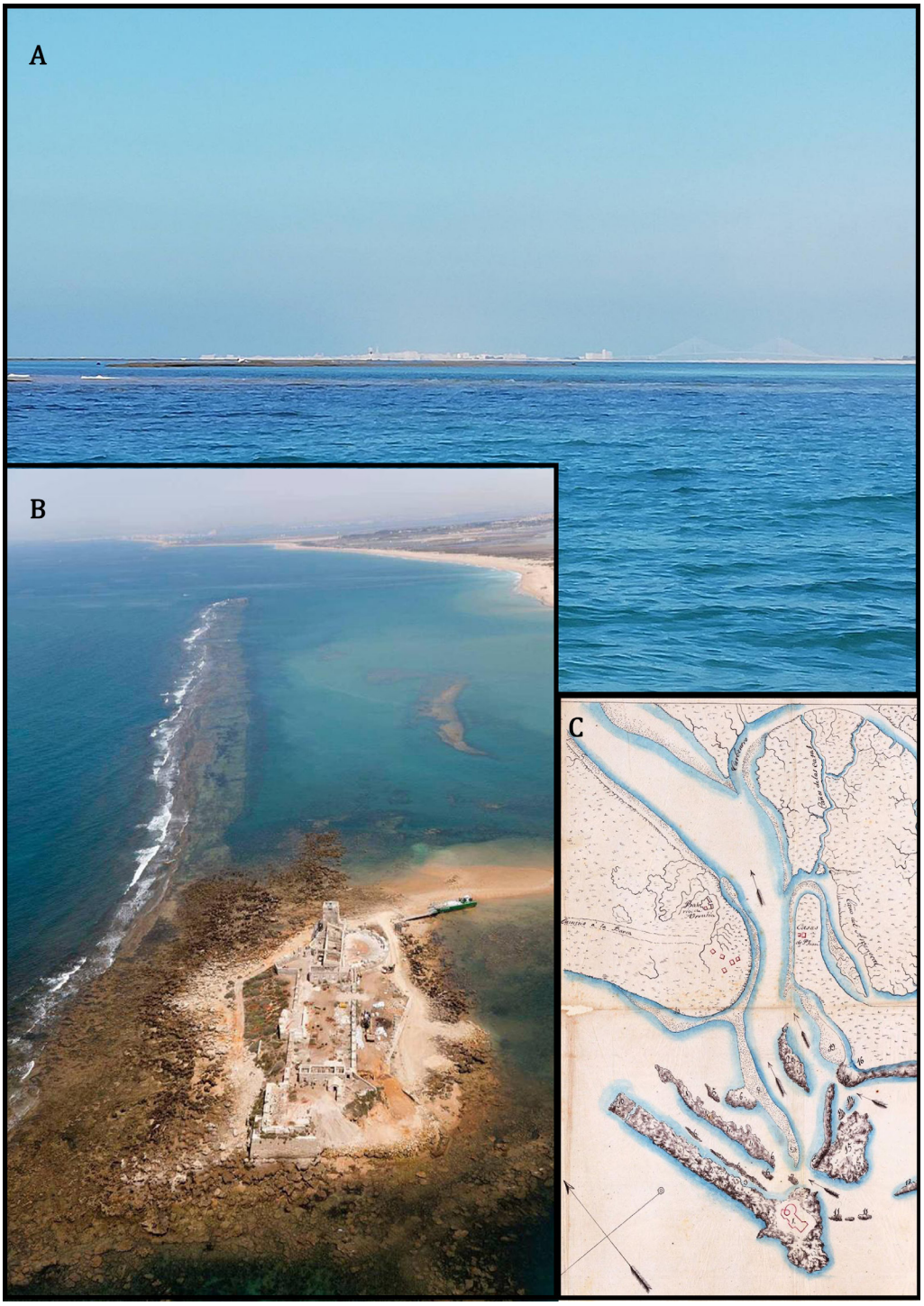

Figure 13. A-B. Visual projection from Sancti Petri Castle towards the N. ©Authors. **C.** Historical map of the Islet of Sancti Petri. Comandancia de Ingenieros ©Archivo Histórico Provincial de Cádiz.

Figure 14. Experimental study of the Punta del Nao. Viewpoints on the present day map of Cadiz (Source: Google Earth. Own edition).

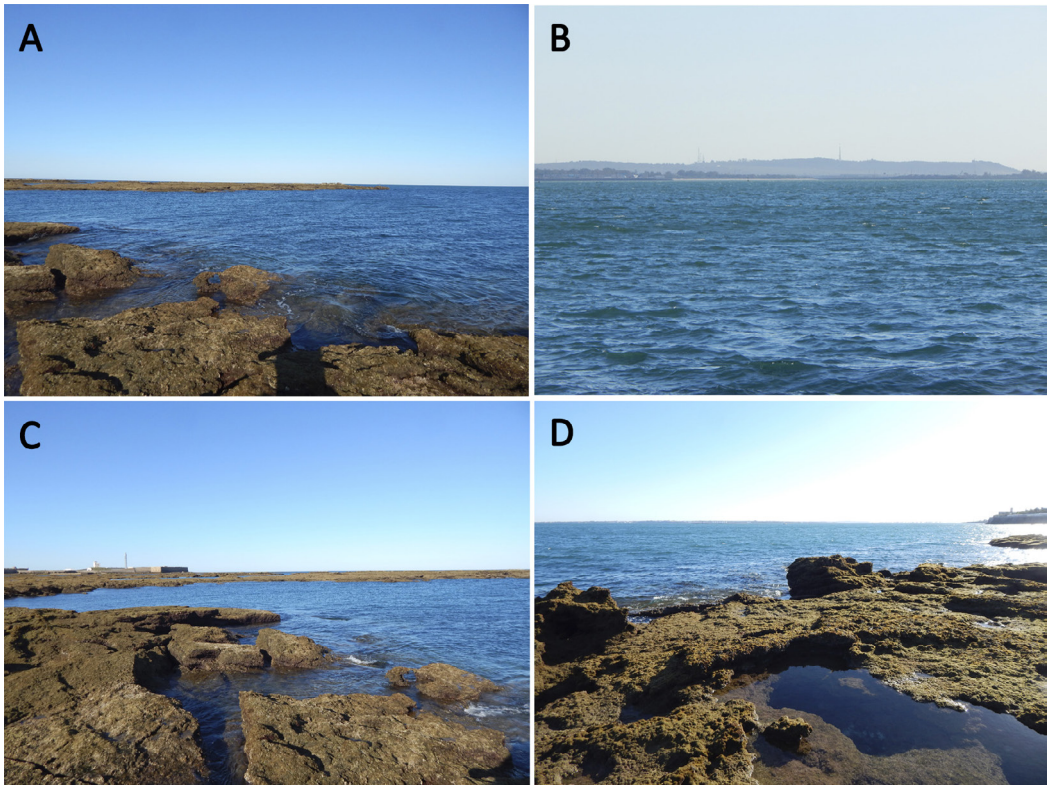

Figure 15. Range of visibility from the Punta del Nao-point 1. **A.** Towards the tip of the Punta del Nao. **B.** Towards the interior of the Bay where, in the distance, the Sierra de San Cristobal can be observed. The necropolis of Las Cumbres and the Castillo de Doña Blanca settlement are situated at the foot of this sierra. **C.** Towards San Sebastian Castle. **D.** Towards the interior of the Bay and part of the modern city of Cadiz. ©Authors.

Figure 16. Detail of the good visibility from the "Piedra Rota del Tiburón" towards the continental interior. ©Authors.

On the other hand, from point number 2 towards the west, the view opens out towards the Atlantic Ocean, while to the north the visual range reaches the present-day town of Rota and the North American military naval base located next to the same (fig. 17–18). In Phoenician-Punic times (at least from the 7th century BC onwards) this continental coastal strip was dotted with fishing facilities and salting factories (Sáez-Romero, 2014).

Finally, the position of the Aculadero zone-point 3, offers a detailed view of the La Caleta channel and San Sebastian Castle or Sanctuary of *Baal-Hammon* (fig. 19).

After this study and despite not knowing the height that the shrine of Astarte would have reached, the observations support the GIS based theoretical quantitative data provided. As was to be expected, the neighbouring San Sebastian Castle is perfectly visible. The same does not apply to that of Sancti Petri, a fact partly conditioned by the present-day buildings of the city, since the theoretical GIS analysis does recognise the existence of intervisibility between both points.

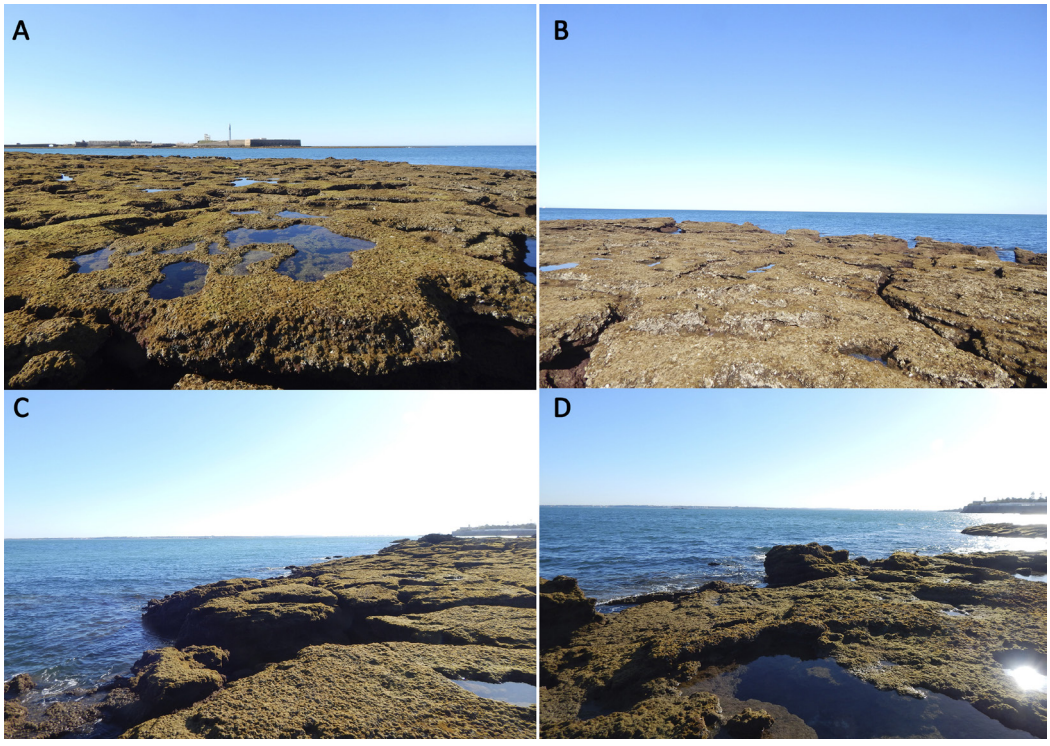

Figure 17. Experimental study from the Punta del Nao-point 1. **A-B.** Towards the interior of the channel and San Sebastian Castle. **C.** Towards the open sea. **D.** Towards the interior of the Bay. ©Authors.

Figure 18. Visualisation of Rota from the Punta del Nao-point 2. ©Authors.

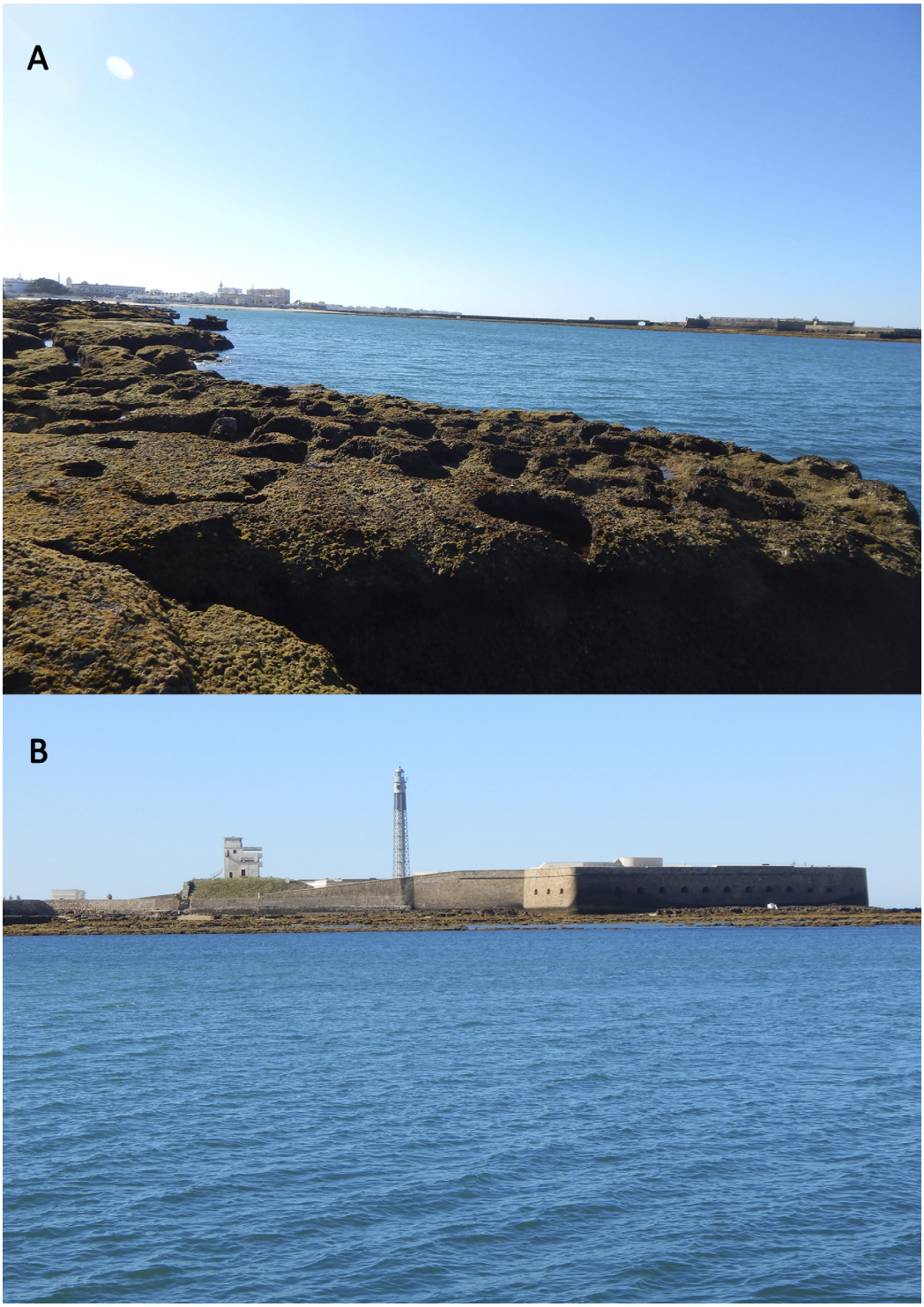

Figure 19. Punta del Nao-point 3. **A.** Towards the interior of the entrance channel to the La Caleta beach with San Sebastian Castle in the background. **B.** Detail of San Sebastian Castle. ©Authors.

4 Discussion

The realization of this experimental estimate leads us to reflect on the possibilities offered by the study of the "Cognitive Maritime Cultural Landscape", which is not limited to the interpretation of material remains

or field research, but also extends to the study of "Intangible Cultural Heritage", which includes both the territory under study and the past societies that occupied it (Cerezo, 2016, p. 19).

Our experience leads us to insist on the convenience of comparing the theoretical GIS results by means of personal checks *in situ* in the different areas under study, aimed at specifying the perception that a past society would have had of its environment. In this sense, within the analysis of the "Cognitive Maritime Cultural Landscape", the strictly archaeological studies can be completed by, for example, examining the toponyms related to the key areas for navigation using ancient nautical charts or oral tradition itself. In the maritime Cultural Landscape approach, aspects of popular tradition are essential, by religiosity and legends and invariably reflect what man thought and still thinks about his maritime life experiences (Ilves, 2004, p. 164).

Any attempt to determine whether the visual landscape formed by the individual viewsheds of the shrines has a cultural pattern would, for the time being, be ambitious. In the absence of reliable data, we cannot affirm whether there existed, on the part of the Phoenician population, a conscious strategy for creating a visual landscape that might explain the variability in the spatial planning of the group of gadirite temples. It is true that the distribution of both the shrines – should this be the case – and the settlements points to this. The overall analysis of the GIS based theoretical viewshed of the three shrines shows the "Accumulated visibility", understood to be the sum of the visibility from various positions, in this case from the three shrines**,** with a great predominance over the open sea and the interior of the Bay (fig. 20); a fact that justifies the maritime-coastal character of these shrines.

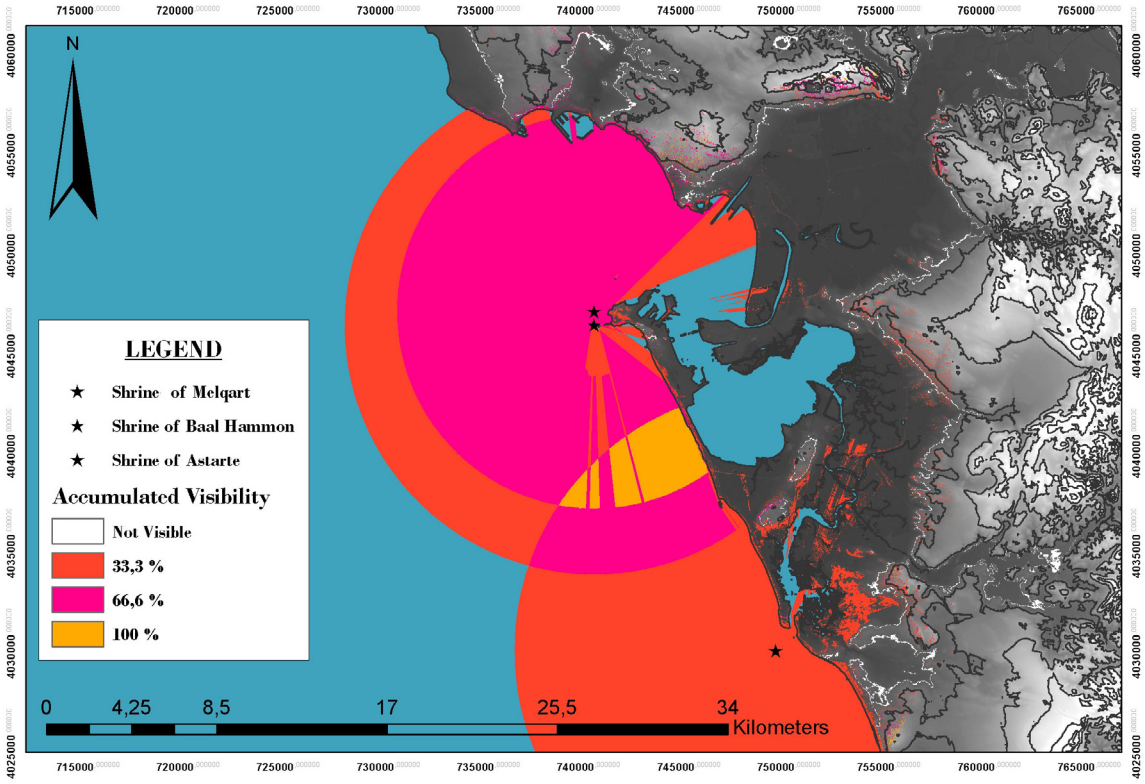

Figure 20. Representation of the analysis of visual association between the three shrines. Their visual control over the mainland and the sea can be observed. ©Authors.

It would, however, be possible to differentiate between nautical navigational references and the points of reference in the port area. This means that the orientation marking the viewshed from the islet of Sancti Petri (shrine of *Melqart*) tells us that the boats positioned in the open sea would visualise this point. However, a

vessel situated in the interior of the bay, where there would also be port areas and anchorages related to the continental settlements, would have no visual connection with the said shrine. Therefore, should its role have been to serve as a reference for navigation we ask ourselves whether it was merely a nautical reference. On the other hand, the same does not occur with the projected visibility from the Punta del Nao, since the fact that it penetrates towards the interior of the bay indicates that, besides being visible by vessels coming from the open sea from different directions, it could indicate both the port areas and external anchorages (coastal strip exposed to the open sea) and the areas inside the bay (*Erytheia* and *Antipolis*, as well as Doña Blanca and the Guadalete estuary).

As a hypothesis, if, as some scholars have recently suggested, the boats entered the gadirite territory from the south, through the Sancti Petri channel (Escacena, 2018, pp. 146–150), the main point of reference would be the shrine of *Melqart*. If, on the hand, following traditional theses, the entrance to the bay were to have been made from the north going around the archipelago, the three sanctuaries (and their gods) would have fulfilled the function of showing the way. The first to be sighted is the shrine of *Melqart*, god of the city and protector of sailors who would have to be thanked for the success of the campaign; followed, after leaving the first behind, by the appearance of the sanctuary of *Baal-Hammon/Kronos*, (associated in ancient times with *Baal-Saphon*, as a result of the integration of the metropolis into the colony) and, finally, the shrine of *Astarte*. The proximity of these last two shrines could be explained because they functioned as entrance "columns" to the outer port of the island nucleus of *Gadir*, situated on the present day at La Caleta beach, which they flank; or by the need to mark two key points for navigation on the route to the interior of the bay from the north, which bordered the island of *Erytheia* and made it necessary to overcome the obstacles of the reefs on which both sanctuaries are situated.

Finally, we should not fail to underline the fact that the degree of certainty reached with this analysis is still hypothetical. The difficulty of this study is mainly due to the lack of relevant information. The basic aspects for carrying out this GIS Visibility Analysis with the closest possible approximation to reality are the height of the temples-shrines and the morphology and topography of the area. Along with the rest of atmospheric factors such as atmospheric dispersion, dust in suspension or the visual accuracy of the observer (Cerezo, 2016, p. 691). For the time being we lack both these data.

Does all this invalidate the usefulness of the method? Probably not: a viewshed map derived from intervisibility lines established from a DTM does not represent a real visibility, considering the different aspects. But it is also true that, regardless of the conditioning aspects, intervisibility between two points is impossible if there is no topographic *line-of-sight* (Wheatley, 1996, p. 98). Therefore, while the information regarding the evolution of the coastline, the structural characteristics of the shrines, such as their height and, the meteorological factors of the moment are not available, it is more appropriate to speak only of, "Theoretical or Potential Viewshed" analysis.

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