

The Christian Positions of Malvecino and de La Veracruz Hills in the Siege of Alcalá la Vieja: A Visibility Study

Las posiciones cristianas de los cerros de Malvecino y de La Veracruz en el asedio de Alcalá la Vieja: Un estudio de visibilidad

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Abstract

The study of conflicts through the use of the archaeology is becoming a usual research field because it is a good way to provide information which is missing in the written sources. This is the situation for the siege of Alcalá la Vieja (Alcalá de Henares), which took place in 1118. The present paper seeks to address how to solve this problem with an interdisciplinary study, combining historical and archaeological information with the use of new technologies, specifically, geographic information systems. In this context, we tried to analyze the places where the Christian army established its main camp and also where, apparently, they built a temporary castle to besiege the Muslim fortress.

Key words:

geographic information systems, landscape archaeology, Middle Ages, military history, warfare.

Resumen

El estudio de los conflictos a través del uso de la arqueología se está convirtiendo cada día en un campo de estudio usual porque es una buena forma de aportar información que está ausente en las fuentes escritas. Esta es la situación existente en el asedio de Alcalá la Vieja (Alcalá de Henares), el cual tuvo lugar en 1118. El presente artículo busca abordar como solucionar este problema con un estudio interdisciplinar, combinando información histórica y arqueológica con el uso de nuevas tecnologías, específicamente, los sistemas de información geográfica. En este contexto, intentamos analizar los lugares donde el ejército cristiano estableció su campamento principal y también donde, aparentemente, construyó un castillo temporal para asediar la fortaleza musulmana.

Palabras clave:

sistemas de información geográfica, arqueología del paisaje, Edad Media, historia militar, guerra.

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1. INTRODUCTION

The fortress of Alcalá la Vieja (Qal‘at ‘Abd al-Salam) (Fig. 1) is located at an enclave watching over the route between today’s Toledo and Zaragoza. The place to build it was perfect because they had a great visibility of the area, it was situated near to the Henares river, providing them a source of water, and besides, it was protected by natural defenses. The two sides of the castle oriented to the North, had two vertical cliffs where the access to the fortress was completely impossible.

It has been argued that the outlying neighborhood was gradually depopulated until abandoned in the fourteenth century. The fortress was probably finally abandoned towards the sixteenth century.

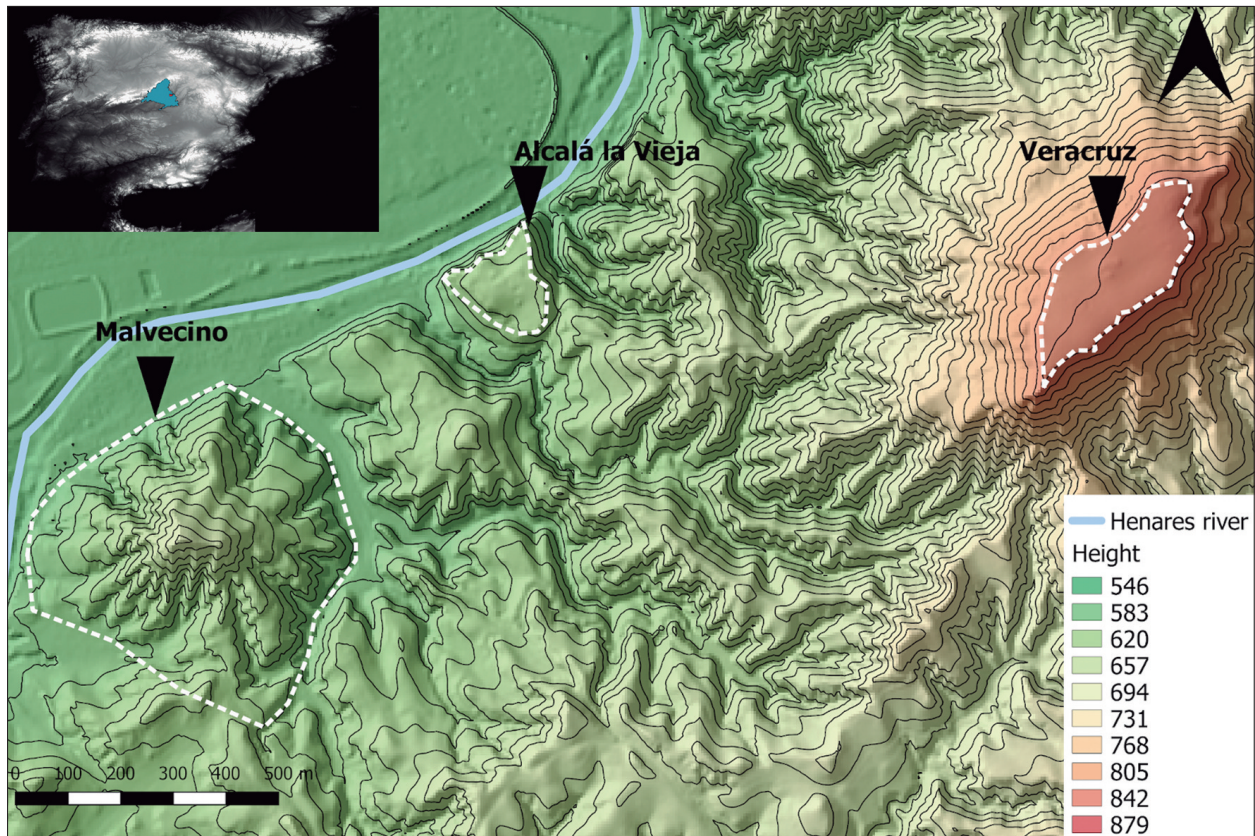
Only 472 meters away we find the base of the Malvecino hill, an elevation that rise reaching an altitude of 698 meters. This hill has different terraces, some of them natural, others resulting from recent replanting work. Archaeological remains and features were documented according

to the archaeological map of the Autonomous Community of Madrid. Those remains were from several periods of time, showing a continuous occupation of that location in different ages.

Two archaeological surveys were taken, the first prospection was conducted by Dimas Fernández-Galiano, and he confirmed the presence of materials and structures in Malvecino (Fernández-Galiano & Garcés-Toledano, 1990), however, they were not located in the exploration undertaken in 1989-1990 by Sebastián Rascón and Antonio Méndez.³

Ever since Juan Zozaya (1983: 411-529) started his archaeological explorations back in the 1960s in the fortress of Alcalá la Vieja, there have been different archaeological campaigns inside the fortress (López, Presas, Serrano & Torra, 2009, 2011 & 2013). These studies established a continuous occupation since the Al-Andalus period; however, the building date could never be

Figure 1. Location of Alcalá la Vieja, Malvecino and Veracruz. Derivative work from MDT5 2015 CC-BY scene.es



³ Rascón Marqués, S. & Méndez Madariaga, A. (1990): Carta Arqueológica de la Comunidad de Madrid. Base de Datos de Bienes del Patrimonio Histórico. Museo Arqueológico Regional, Comunidad de Madrid.

specified. They could confirm its occupation in previous periods with structures belonging to recent pre-history and the Carpetan era.

The Alcalá la Vieja stronghold was part of the defensive system of the middle frontier. This defense, together with those of Guadalajara, Talamanca, Paracuellos, Maqueda, and Madrid, was an essential point in the Al-Andalus protection system.

The siege took place in 1118 between the Christian army commanded by the archbishop of Toledo Don Bernardo de Sedirac, and the Muslim troops in Alcalá la Vieja. Don Bernardo established two military posts: Veracruz hill and Malvecino hill. At the latter location, he ordered to deploy trebuchets to besiege Qal'at 'Abd al-Salam by shooting rocks. His troops tried to assault the stronghold several times but failed: the Muslim troops fought bravely and mounted a notable defense. A mysterious turn of events followed. According to tradition, a miracle happened, the Muslims abandoned the fortress and the Christians were able to get in the castle.

Following the Christian conquest in 1118, the fortress was transferred to the Christians and in 1129 King Alfonso VII and Doña Berenguela assigned this territory to the archbishop of Toledo, Don Raimundo (Fita, 1885).

2. THE CHRISTIAN POSITIONS IN THE WRITTEN SOURCES

When we started this research in 2016, we found a problem in the historical written sources (Echevarría, 1990: 631). That issue was that the explanation of the siege development and all the factors related to this conflict, was too short and brief, being a problem for us to locate maneuvers and actions on the field. It could be the consequence of an absence of firsthand testimonies or direct evidence. Consequently, authors of secondary sources had to fill those gaps in the texts to explain what happened there in 1118. For this reason, we had to use them to study the siege of Alcalá la Vieja and know the Christian positions in this medieval conflict which is the aim of this paper.

The closest written source, chronologically speaking, to the historical fact, is *De Rebus Hispaniae*⁴ (HRH), written by the archbishop

Don Rodrigo Jiménez de Rada. In that text, the author mentions the conquest of the Muslim fortress of Qal'at 'Abd al-Salam and he alludes to the construction of a castle in a hill to control the moor stronghold of Alcalá la Vieja (HRH Capítulo XXVIII). The elevation mentioned by Jiménez de Rada was Malvecino hill.

On the other hand, subsequent authors emphasize the location of a Christian post in the hill that we have just mentioned. Furthermore, the scholar Miguel de Portilla y Esquivel (1725:148) gives detailed information about that place, for example, explaining its military role and the remains that he saw there during his visit. It is necessary to highlight that this canon mentions the existence of a second Christian position in this siege, concretely in the Veracruz hill. He explains that this other post was far away from the castle of Alcalá la Vieja and the siege would not be possible from there, even with the use of powder.

On his behalf, Ambrosio de Morales says in his work, *Opúsculos castellanos*, that Don Bernardo de Sedirac commanded to build a fortress (de Morales, 1793: 59) in a nearby elevation to the fortress, where they deployed the trebuchets to siege it. This information coincides exactly with the Jiménez de Rada's explanation, previously mentioned.

After reading Esteban Azaña's work (1882: 127-128), we found practically the same mentions about the two Christian places around the stronghold of Qal'at 'Abd al-Salam. That information would reinforce the presence of those posts during the siege carried out by the archbishop of Toledo, Don Bernardo de Sedirac in the twelfth century. Although the clearest reference to it is in Alcalá la Vieja, ensayo histórico o apuntes para una monografía de aquel castillo, written by Jose Demetrio Calleja, where the apostolic vicar says (1897: 18) that the Christian troops established their tents in Veracruz hill, today called Eccehomo hill. Furthermore, he indicates the existence of an advanced post in Malvecino, like the rest of scholars.

As we indicated before, the data provided about the military engagement by the written sources was too succinct, making more complicated to understand what happened during

⁴ <http://fondosdigitales.us.es/fondos/>

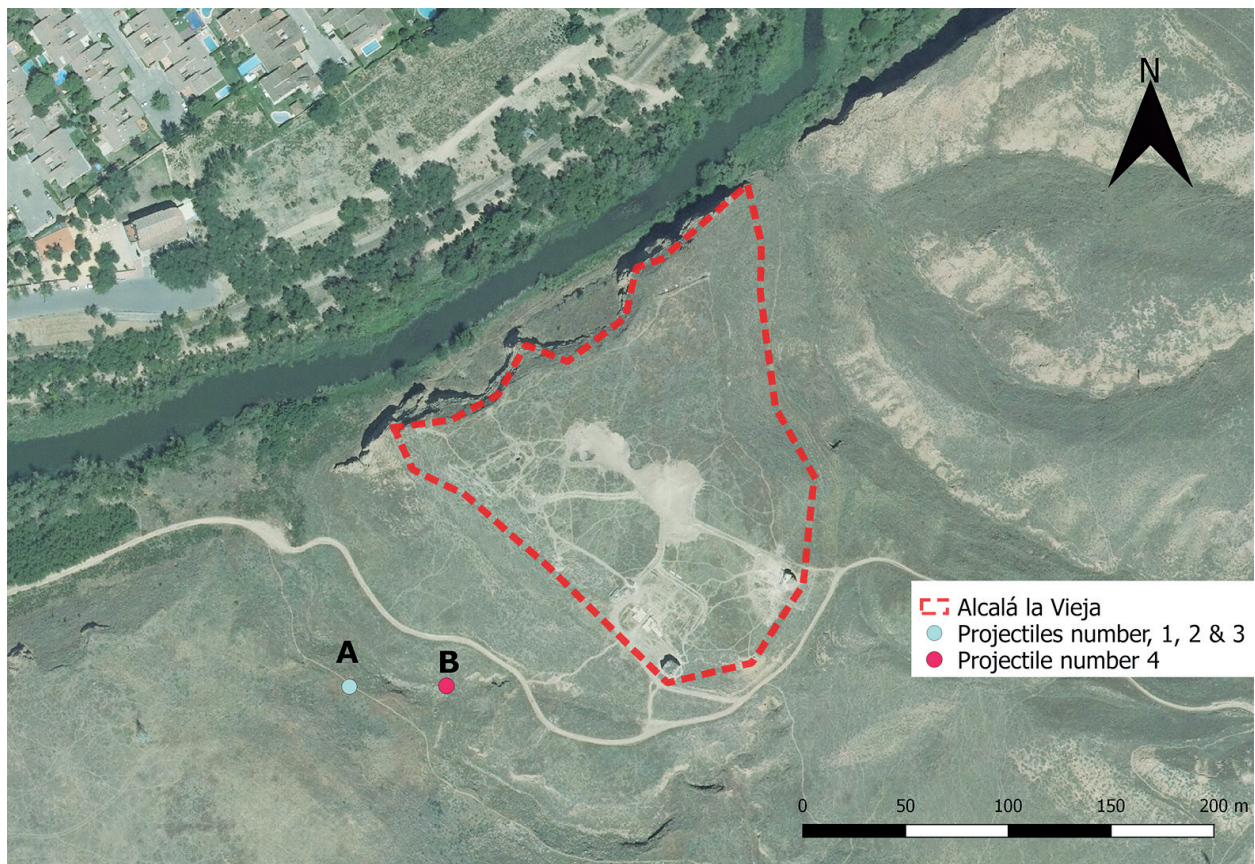


Figure 2. Location of trebuchet projectiles. Derivative work from OrtoPNOA 2014 CC-BY scene.es

this conflict and also to know their shapes, possible structures, and disposition in those sites. This problem affects the information relating to our object of study: the Christian positions. In order to get a deeper knowledge, we consulted more recent sources because they could give us a new perspective.

3. ARTIFACTS ASSOCIATED TO THE SIEGE CONTEXT

The existence of artifacts related to the siege context is minimum, due to the lack of interest in the analysis of this military conflict through battlefield archaeology for years, and also to the difficulty of finding these types of artifacts. Furthermore, the discovery of materials associated to a conflict is complicated because these sites had a limited length in time: hours, days, or months. In addition to this, the number of artifacts would be a small part of the total amount because armies tried to recover weapons and other elements after the engagement. However, in our case, it is possible to show some signs that prove the existence of a conflict in this place during the XII century.

Previous scholars and archaeologists mentioned the presence of structures in Malvecino and Veracruz hills that had to play a role during this event in 1118. Ana Echevarría (1990: 638) mentions the construction of a temporary castle, and the presence of wall and pottery remains from the Middle Ages in Malvecino hill. On their behalf, Leopoldo Torres (1959: 165-166) and Miguel de Portilla y Esquivel (1725: 148) also alluded to the location of that defensive structure in that location. Written sources also indicate that the main Christian camp was established in Veracruz hill but, unfortunately, any archaeological artifact or feature associated to this conflict has not been discovered yet.

Several archaeological works were carried out in that area, which were able to prove the existence of a medieval settlement in Malvecino. During the seventies (1976), and after an archaeological prospection led by D. Fernández-Galiano, wall and construction remains were found in Malvecino. Sadly, those elements were gone several years later because Sebastián Rascón and Antonio Méndez surveyed

ID NUMBER	DIMENSIONS	WEIGHT
MAR-CE2017/42-1	33.5 x 30.5 cm.	50.8 kg.
MAR-CE2017/42-2	34 x 29.5 cm.	47.6 kg.
MAR-CE2017/42-3	28 x 29.5 cm.	32.8 kg.
MAR-CE2017/42-4	35 x 29.5 cm.	58.6 kg.

Figure 3. Projectiles' features.

the place in 1990 and they could not find them. However, Manuel Retuerce (2014: 39) mentioned the presence of a settlement dating back to the Early Middle Ages. Manuel Retuerce, based on surface, location, construction materials, pottery, etc., indicated that the type was a settlement, a village on high ground.

All this data reflects medieval occupation in that specific location before the siege, and it is possible that Christian troops could use those

structures during the siege of the fortress.

Recently, in 2017, four trebuchet projectiles (Fig. 2.) were found very close to the Muslim fortress of Qal'at 'Abd al-Salam. Three of them were located in the location that we called A, and the other in point B. Thanks to the Museo Arqueológico Regional de la Comunidad de Madrid and Miguel Contreras, we were able to study these important materials for our investigation.

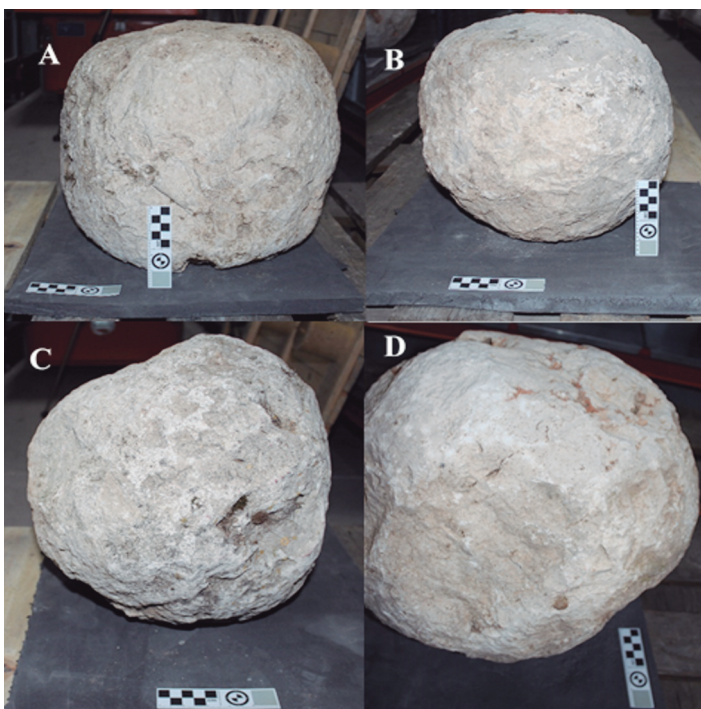


Figure 4. Trebuchet projectiles found around Alcalá la Vieja. Photographs: Rafael Montalvo Laguna.

Those stone projectiles (Fig. 4) were made using the same type of material, limestone. This type of rock is good for carving because it is “soft” and thanks to it, the process to make them was faster and easier. In our ongoing research, we found several limestone sources around the area, and some of them were very close to the Christian camp in Veracruz hill. Regarding materials, we can say they were looking for a certain raw material with specific features or characteristics but probably, their knowledge about rocks and stones could have been limited because of different weights. Those different weights may mean different rock compositions.

After studying them, we saw that they had similar dimensions (Fig. 3) with small differences between them. However, the situation was completely different if we talked about weights where those differences between these projectiles were bigger. Obviously, these facts provided us interesting data because thanks to it, it was

possible to know more about medieval warfare. For example, similarities between dimensions are really helpful to understand that “mason” soldiers wanted projectiles with certain measurements. Comparisons are clearer on a chart with the dimensions and weights for each projectile:

As you can see in this table, the dimensions are basically the same. We decided to measure them to have the longest and shortest parts and only one projectile presented a different size, projectile number three (MAR-CE2017/42-3). It is the smallest one but it is not a strange situation, because in some medieval sieges, where other projectiles had been found after digging, some of those artifacts had smaller measurements. In our case, we can determine, after calculating the average, that the standard size was 34 x 29.75 cm.

The discovery was very important because it is specially complicated to find artifacts associated to siege engines due to their materials being perishable, most of it wood. The most common situation, is to find metal objects or, like in our case, stone or rock projectiles.

4. THE SIGNIFICANCE OF THE POSITION AND VISIBILITY STUDIES IN LANDSCAPE ARCHAEOLOGY

The study a historical conflict needs to use elements from other disciplines to understand what occurred in that place. We are alluding to the necessity of using concepts of the military world because a strategical perspective can give a completely different view about the military engagement: battle, siege, etc. For our research, we believe that there are two key concepts to know why the archbishop Don Bernardo de Sedirac decided to establish his posts in Veracruz and Malvecino hill. Those factors would be a better topographical position and the visibility that they had.

From a strategical perception, we could say that the control of a good topographical position is mandatory to carry out a correct siege. If the attackers established their camp or post in a higher place, they would have a better control over the enemy location. The reason is that the enemy's maneuvers would be compromised, complicating their defense. All this comes from a basic idea in the art of war: the visibility. A simple concept like the capacity of seeing your enemy could give a bigger percentage to win a conflict. The explanation is simple: if the attacking army is situated in an elevation higher than the defenders, it will watch them all the time and they will cut

the communications and support lines during the siege.

Furthermore, we should add to the significance of controlling a better topographical position another important element: the presence of natural defenses in the designated place. The use of the environment to establish a position, historically speaking, is not new because peoples from previous ages to the Middle Ages used this system to determine the place where they would build their settlement. Apparently, it could not seem something completely necessary but during a siege, the attackers could be attacked by the besieged army or by support troops. For this reason, the attacking troops will fortify their position using quick construction techniques, like trenches, ditches or clay wall, and here it is where the natural defenses play an essential role. Thanks to the use of those defenses given by the landscape, the construction of the manmade defensive structures could be done in a shorter period of time.

In order to understand better the significance of the visibility, we decided to analyze how the watchtower's visibility system worked in the medieval times to extrapolate it to the siege of Alcala la Vieja and evaluate the selection of the two Christian positions.

The establishment of medieval watchtowers had an obvious goal: the control of the territory to prevent being attacked by surprise. (Martínez 2003: 80; Lafuente, 2011: 131) The visual domination of a specific area or region required to put these surveillance structures in specific places. For this reason, the towers were situated in strategical locations (Martínez, 2003: 81), speaking from a geographical and visual point of view. It is common to find them in hills and other high places because the perspective is better from an elevation than from the plain (Pacheco, 2004: 499), and also because these high locations usually have natural defenses which help to the watchers to be safe. (Torres & Benítez de Lugo 2014: 271, 273) In order to carry out a complete control of a determined area, these military constructions should have a great visibility, covering the whole space around it, and especially important components in the landscape, like paths, valleys, rivers, etc. However, sometimes they had orographical barriers, avoiding a complete vision.

The guidelines to determine the place for a watchtower are connected to the same concepts that we have stated before about the significance

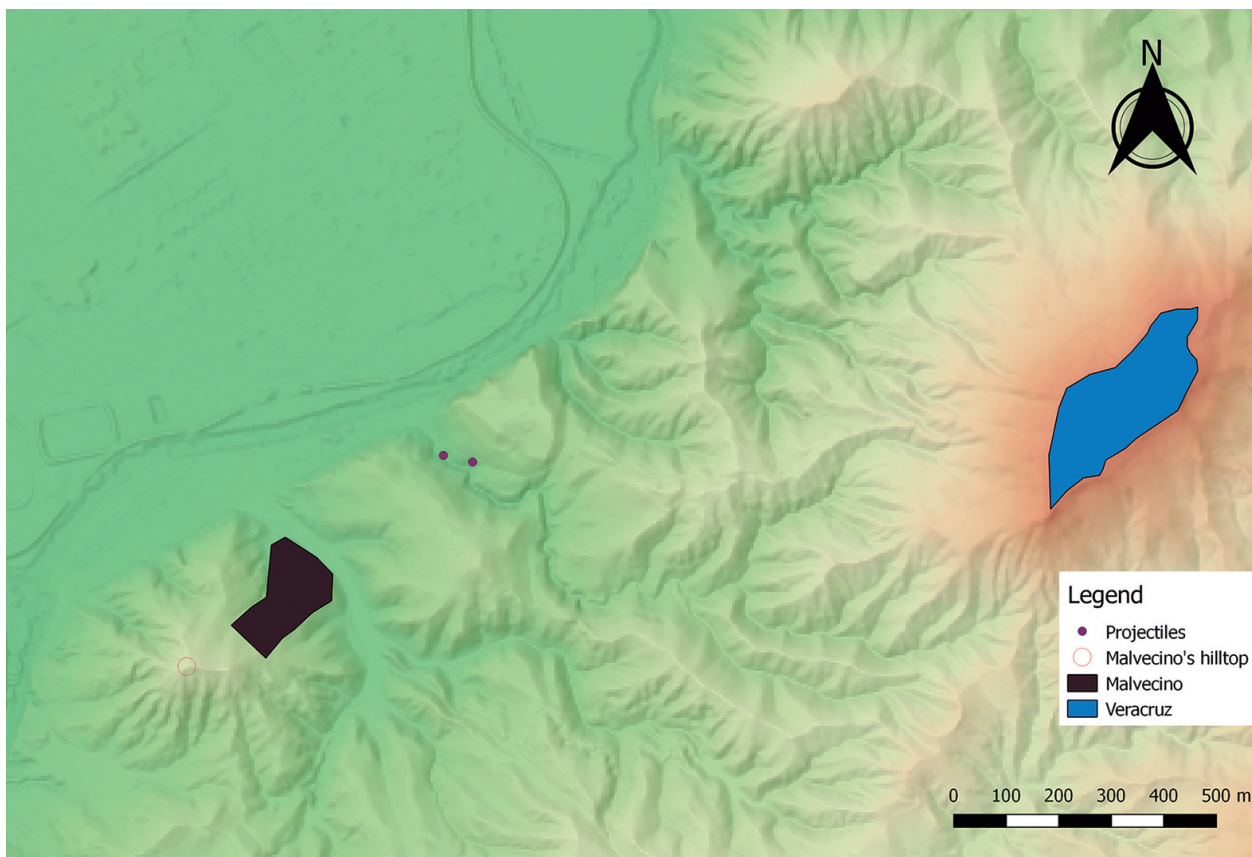


Figure 5. Study areas in Malvecino and Veracruz. Derivative work from MDT5 2015 CC-BY scene.es

of the selection of a topographical position. Nevertheless, we will mention a new factor that we have not indicated previously: the intervisibility.

This element was mandatory in this defensive system because the *atalayas* (Spanish term derived from the Arabic for watchtower) required of a communication between them and the quickest way to do it was through the visibility between several positions. The methods used to send messages were basically visual: fire, smoke or mirrors (Martínez, 2003: 82; Lafuente, 2011: 171; Agüera, Molina & Carrillo, 2017: 309-310) to send information. We believe that communication between military positions during a conflict should have used the same methods.

After the analysis of this information, we decided to extrapolate the data to our case to get a theoretical explanation before carrying out the study through geographic information systems. Apparently, Malvecino and Veracruz hill fulfill the requirements to siege the Muslim fortress in the correct way. The first requisite was a better topographical position, including a bigger height and natural defenses. As we will explain later, the

two Christian locations meet both. As a consequence, the visibility and the visual control over the stronghold would be good but to prove that it is necessary to analyze several factors using a G.I.S. software. (Martínez, Malalana & Sáez, 1997).

5. METHODOLOGY TO CALCULATE THE VISIBILITY AND INTERVISIBILITY IN MALVECINO AND VERACRUZ HILL

The main objective of this study is to show the ongoing research on the analysis of the siege of Alcala la Vieja to give a complete explanation of the Christian deployment and the course of the siege and the subsequent battle. In a previous work (Ramírez & Laguna, 2017), we carried out a simplified analysis of the visibility from the two Christian positions in Malvecino and Veracruz hill and a complete study of the historical sources (texts, maps, photographs, and paintings). With that paper, we wanted to get a preliminary perspective about this medieval conflict and also about the visibility from those places to understand the battle development. Therefore, we decided to propose an improving study but, obviously, using

previous works as the baseline (Hunyadi, 2012; Zafiris & Brokou: 2002).

In order to analyze the visibility and intervisibility from these locations, it was necessary to use a common methodology utilizing the same factors or elements. For this goal, our main tool was the opensource G.I.S. software called QGIS 2.16.3. In order to calculate the visibility from Malvecino and Veracruz hill, it was necessary to carry out several tasks: delimitation of the places' area to know the exact space for our analysis, determine the number of observers situated in those locations and their heights.

Delimitation

The first part of this study was the delimitation of the two Christian places (Fig. 5) because we needed to circumscribe the area from which we wanted to know what soldiers could see during the siege of Alcalá la Vieja.

In the geographic information systems, according to Renfrew & Bahn (2016: 94-95), "the data may be held in vector format, as points, lines, and polygons, or they may be stored as a grid of cells, or raster format." For our purpose, we needed to use the first type to create a shapefile. The company of ArcGIS' website gives more information about this format which is important to understand why we selected it. They say that "a shapefile is a simple, nontopological format for storing the geometric location and attribute information of geographic features."⁵

All the geographic information systems provide us a simple, but useful, tool to be able to do it. We proceed to create a shape layer, concretely a polygon. Accordant with ArcGIS Resource Center's website, "a polygon is a two-dimensional surface stored as a sequence of points defining its exterior bounding ring and 0 or more interior rings. Polygons by definition are always simple. Most often they define parcels of land, water bodies, and other features that have a spatial extent."⁶ The reason to select this specific type of shapefile was that we needed to establish the boundaries around the site when we would place the observers.

Furthermore, it was necessary to select the same coordinates system for them, in our case ETRS89. We put several points until the polygon completely

covered the space that we wanted for our purpose. This process was used as much in Malvecino as Veracruz hill and it was demarcated over a DEM (Digital Elevation Model) with 5 meters grid spacing from the Centro Nacional de Información Geográfica⁷. In addition to these delimitations, we selected a small area in Malvecino's hilltop because we thought that it could be a good place to deploy soldiers to control the area around it.

Observers and height

After completing the first phase of the procedure, the next step was to determine the number of viewers (20) from each place and their position. Surely, this was one of the more complicated parts of this research because, unfortunately, we did not know the exact number of soldiers during that conflict and we did not have any kind of information about how many troops were assigned to guard the zone. The exiguity of data about the battle development was a complication for us, but, obviously, it allows to delve into those gaps in the historical written sources.

In this case, the only possible solution to keep working was the use of estimations. Evidently, the selection of a specific number of people must go with other factors which we will explain subsequently. These aspects would be the area to cover and the orientation. The Christian troops did not only watch the Muslim castle of Alcalá la Vieja because they had to protect their own position and that implied the surveillance of their own places. Determine the location (Fig. 6) of Christian watchers in Veracruz hill is relatively simple because we talk about a hillock. The summit is completely flat and it is surrounded by steep slopes and vertical walls. The access to the top is possible only through one path. With this information, we thought that Christian could deploy their soldiers around the edge or walk around it to report any suspicious movement. Using these parameters, we decided to establish their location around the perimeter with a separation of fifty meters between them. We chose this measurement between the watchers to avoid situating them too close to each other; also to represent the idea of the soldier's patrolling route.

⁵ <http://desktop.arcgis.com/en/arcmap/10.3/manage-data/shapefiles/what-is-a-shapefile.htm>

⁶ <http://help.arcgis.com/en/geodatabase/10.0/sdk/arcsde/concepts/geometry/shapes/types.htm>

⁷ http://centrodedescargas.cnig.es/CentroDescargas/locale?request_locale=en

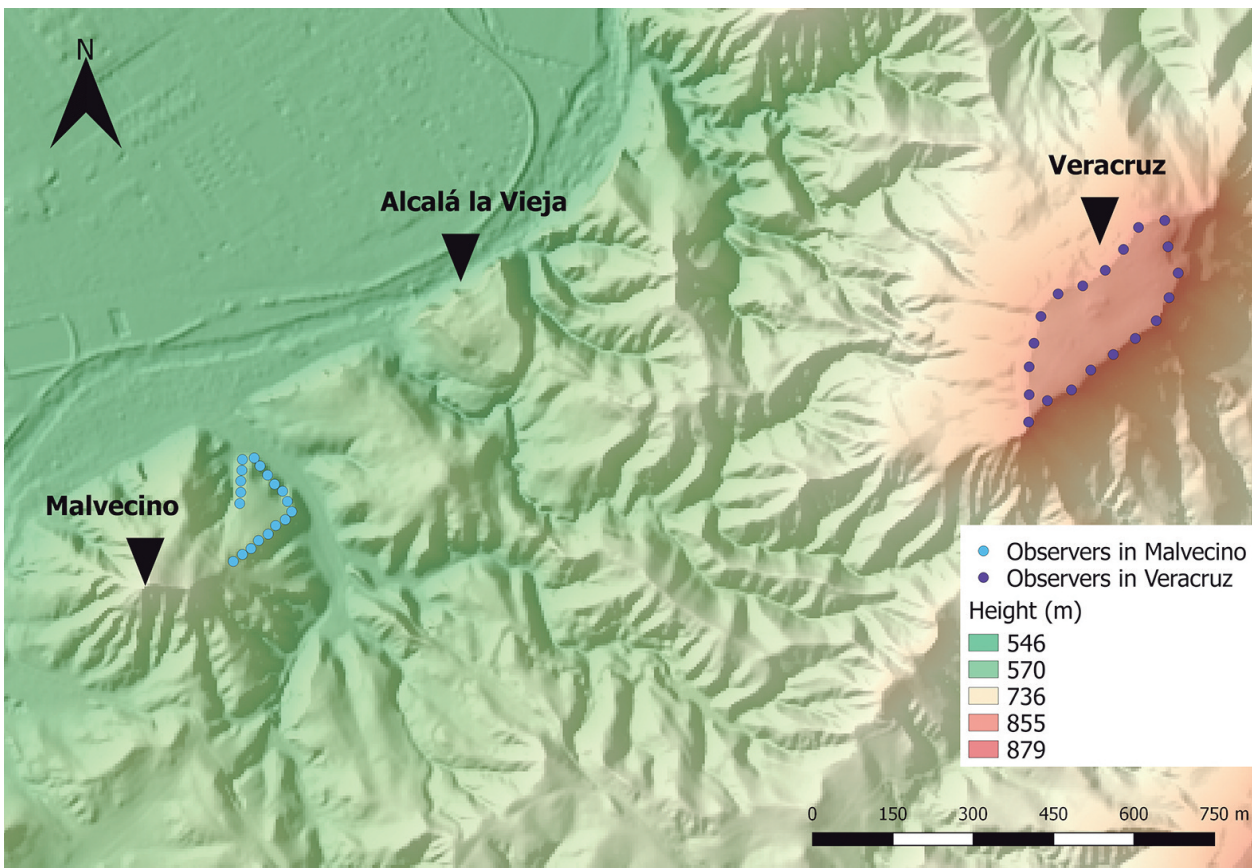


Figure 6. Locations of observers in Malvecino and Veracruz. Derivative work from MDT5 2015 CC-BY scene.es

When we had to determine the place for each viewer in Malvecino hill, we had to deal with the orography and the shape. Like Eccehomo hill, this position had natural defenses too, such as cliffs and vertical clay walls. However, there are two unprotected areas in this elevation. One of them is a narrow route in the south face of the elevation, and the other defenseless zone is oriented to the Moorish keep. According to the written sources, the archbishop of Toledo, Don Bernardo de Sedirac commanded to build a temporary castle (Palacios, 2006: 43) there and it should be situated in the second area that we have just referred to. In our opinion, it would be the best location to harbor the Christian soldiers and the fortress because it is practically flat and the extension is enough for that purpose. Furthermore, the summit could be used to watch the enemy and the surroundings thanks to the excellent visibility from it.

However, proposing the location for the observers is more complicated because the orography, and therefore the surface, is not as uniform as Veracruz. After analyzing and visiting this place, we came to the conclusion that the situation of Christian viewers should be in those

areas previously described. The distribution patterns had to follow the same criteria that we used for the other elevation: troops deployed in specific places or soldiers walking around the perimeter.

In order to carry out the positioning of the watchers, we uploaded a database with the coordinates for each place because we wanted to select specific points for each observer. Additionally, the software allows us to select the number of points that we want to use and the minimum distance between them, avoiding points too close to each other, through the tool Random points in layer bounds. Nevertheless, the distribution of them was not useful for our purposes because the software did not place all of them in the edge and that would modify the results. In consequence, we opted for creating several shape layers, specifically points, to place the observers. The number of viewers for Malvecino was twenty, separated by twenty meters, and for Veracruz, we decided to use the same quantity but with a distance of fifty meters between them, as we mentioned before, because it has a bigger extension.

INDIVIDUAL	CHRONOLOGY	HEIGHT
1 (grave 4)	X	1,66 m
2 (grave 5)	X	1,65 m
3 (grave 18)	X	1,54 m
Average	-	1,61 m

Figure 7. Heights from men in the necropolis of San Vicente de Potes and average.

The next parameter to keep in mind to study the visibility is the viewer's height. In order to determine it, we calculated the average from previous osteological studies where they measured the length of different bones to know the height. Cristina Vega Maeso, Eduardo Carmona Ballesterro & María Abellán Villastrigo (2008: 44) show data about this parameter from the necropolis in the church of San Vicente de Potes (Cantabria). We selected the information (Fig. 7) related to buried men to be able to extrapolate to our case. Only

three adult men provided results to the authors, which are compiled in the table below.

Through their work, we got real information about men's height in the Middle Ages, nevertheless, it was necessary to increase and check data from different researches. The comparison with the results obtained from other archaeological sites could give us a better perspective about it and also, we could use a real value and not estimations. P. A. Barrio and G. J. Trancho (2017: 40) collected the results about the

SITE	CHRONOLOGY	HEIGHT
La Olmeda	VIII-XIII	1,63 cm
Santa María de Hito	IX-XII	1,65 cm
Iglesia de Sant Pere	IX-XIII	1,58 cm
Monasterio de Suso	X-XI	1,68 cm
Ordoñana	X-XIV	1,64 cm
Santa Eulalia	X-XV	1,62 cm
San Juan de Momoitio	XI-XIII	1,64 cm
Sepúlveda	XII-XIV	1,64 cm
Palat del Rey	XII-XVIII	1,65 cm
Average	-	1,636 cm

Figure 8. Height average for men from different places and total average.

calculation of height average in Middle times in the Iberian Peninsula from different investigations. Those analyses studied Christian, Jew and Muslim human remains with diverse chronology but for our aim, we selected Christian individuals and they had to belong to the same period of time. As you can see in the table (Fig. 8) the chronology covers a wide period of time for most of the cases but it would not affect to our study because we only needed an approximation to the reality of that moment of the history in the Iberian Peninsula.

After analyzing this information and calculating the average, the final result was very similar between both studies. With this data, we proposed a height of 1,62 m. for each watcher in both Christian positions, because it was the median height obtained after calculating the average from both tables. However, we had to deal with another parameter in Malvecino, at least in the area situated at the foot of the hill. That factor was the height for the temporary castle's defensive structures, specifically the wall or palisade that they supposedly built there to protect that space.

As we said in other papers, we agreed with the historical written sources about the construction of a temporary castle in Malvecino for several reasons: the first one, it has the best characteristic for that purpose (surface, extension, and orientation), and the second motive is that according to previous archaeological works, materials, and structures from medieval times were found by the archaeologists during the fieldwork. Lamentably, all of them have disappeared, making our task more complicated. This situation impeded to give exact values, or at least approximated, of the wall's height. According to Enrique Delgado Rodríguez, member of our research team and expert in medieval castrametation, it is impossible to give data about the measurements and the most likely scenario would be a post with a trench and an embankment, created with the earth extracted during the excavation, modifying the main idea that we previously had which was created the information from archaeological reports. This bank could be used as a high position and defense against projectiles. Furthermore, it could have a small palisade protecting the place but there would not be a structure with a parapet walk. Only further archaeological research could give more information about this but at this moment we are working with the written sources.

With these data, as well as a radius of 3000 meters, we proceeded to calculate the visibility with the tool called viewshed analysis provided by

QGIS and these were the results that we obtained.

The aim of this calculation was to get the area covered by watchers from several positions inside the delimitation. This operation is called cumulative visibility and it is an accurate approach to the real view and these were the final results that we obtained.

Intervisibility

The aim of this analysis was to determine the visual connection from the Christian posts of Malvecino hill and Eccehomo hill. With this purpose in mind, we analyzed all the factors related to this element like the intervisibility between them. We decided that the best procedure for this aspect was to extrapolate the watchtowers' system because like we previously mentioned there could be similarities between our case and this defensive scheme.

The establishment of a camp and a temporary castle to siege a fortress, and relatively close, would imply a communication system between them to send messages using an encoded method. This form would be better and faster than send a soldier to deliver the information from one position to another. As we stated, the observers in a watchtower used fire, smoke or mirrors for that purpose, and in our opinion, the Christians should have used the same techniques during the siege of Qal'at 'Abd al-Salam in 1118 in order to give orders from one position to another.

We opted for calculating the intervisibility using the tool provided by QGIS 2.16 to know whether it was possible to communicate from these locations. In order to do that, we used the same parameters: 3000 meters radius and 1,62 meters height.

In an attempt to get a complete knowledge, we opted for two ways to distribute the viewers due to the necessity of knowing the intervisibility. Through the use of this method, we were able to see the view from a group of points in different places and from one point located in the ideal site of each of them. The second option was the easiest way to have a general idea about what they were capable of seeing or not, and with the values used, this was the result.

6. RESULTS

The outcomes generated after modelling the visibility abilities highlighted that the Christian troops (Fig. 9), situated in Veracruz hill, had an excellent control from that place, covering a big

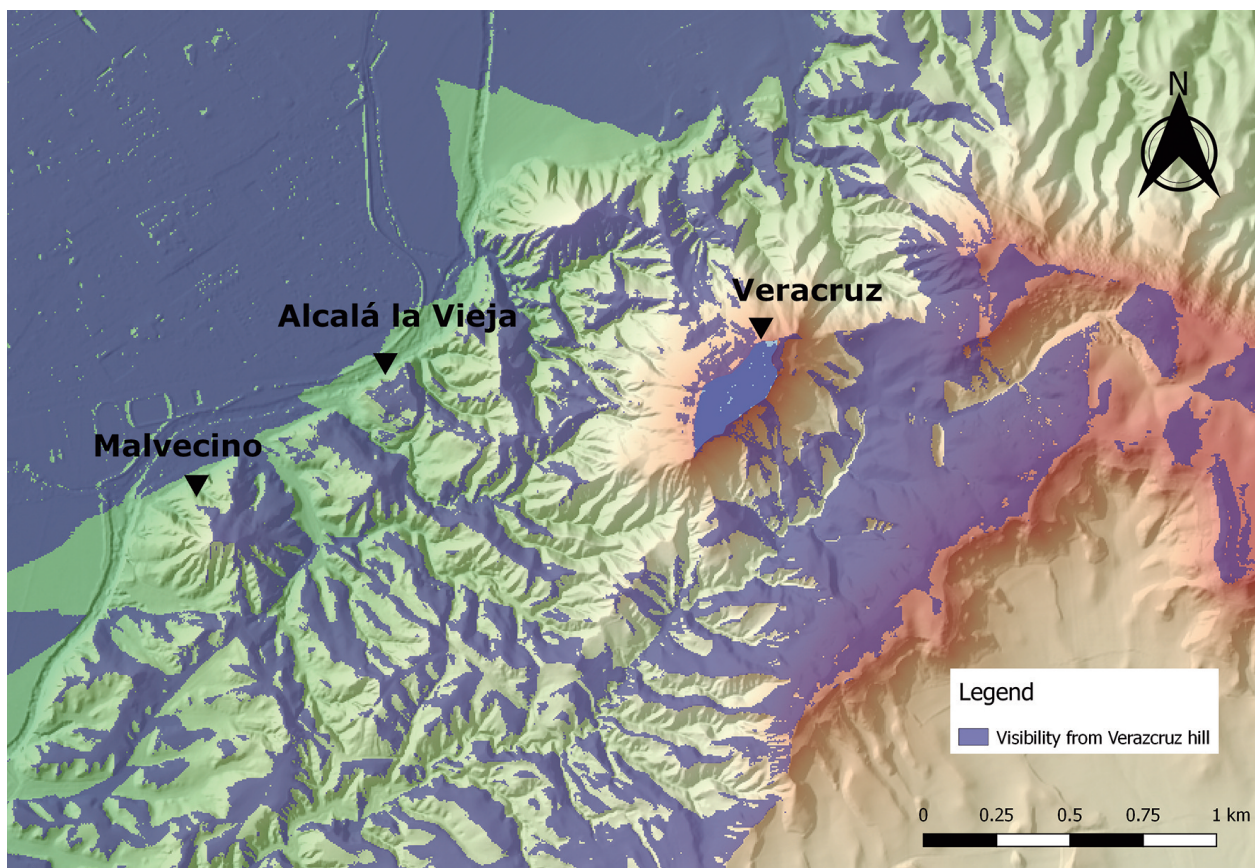


Figure 9. Visibility from Veracruz hill. Derivative work from MDT5 2015 CC-BY scene.es

area from there. The cumulative visibility layer created by the software shows that they would be able to watch the Moorish castle of Alcalá la Vieja. Additionally, those soldiers would see any movement around their position because cover the main paths in the area. This finding offers an important evidence for corroborating the brief information provided by the secondary sources about the deployments in this conflict. Furthermore, Christians troops in Eccehomo hill, the current name, could control the rest of elevations situated around the main positions in the siege area (Malvecino, Los Catalanes and Alcalá la Vieja). The most remarkable result to emerge from the data is that the visibility obtained shows something obvious: the selection of Veracruz hill was not random. When Don Bernardo de Sedirac decided to start the siege had to study the environment to find the best and safest places to erect the Christian posts. And this is what the GIS software is showing us with it.

By itself, the data obtained using QGIS 2.16 about Malvecino (Fig. 10) presents differences in relation to the previous image, which is completely normal because the viewers were situated in the

lower part of the hill and that would impede to have a total view of the area. The space that they could watch during the siege was small if we compare with the visibility from Veracruz, however they would visually control several key locations for them, like the fortress of Alcalá la Vieja, the plateau in front of them called Los Catalanes where Muslims built their neighborhood, the hills, and paths in their right flank, the plain and river in their left flank, and the highest hills in the area. Despite being in a lower location, the selection of that area was very wisely. Probably, this visibility is the consequence of an intentioned deployment. We could understand it as the goal of controlling short distances and the nearby surroundings because they had soldiers in other positions to watch faraway places. Additionally, those troops should have deployed because we saw death angles in the visibility layer, one of them in a critical location: their rearguard.

For these reasons, we decided to carry out one more analysis of the view from Malvecino (Fig. 11) but now we positioned the observers in a different place. That location was the hilltop which is a small flat area in the highest place and they

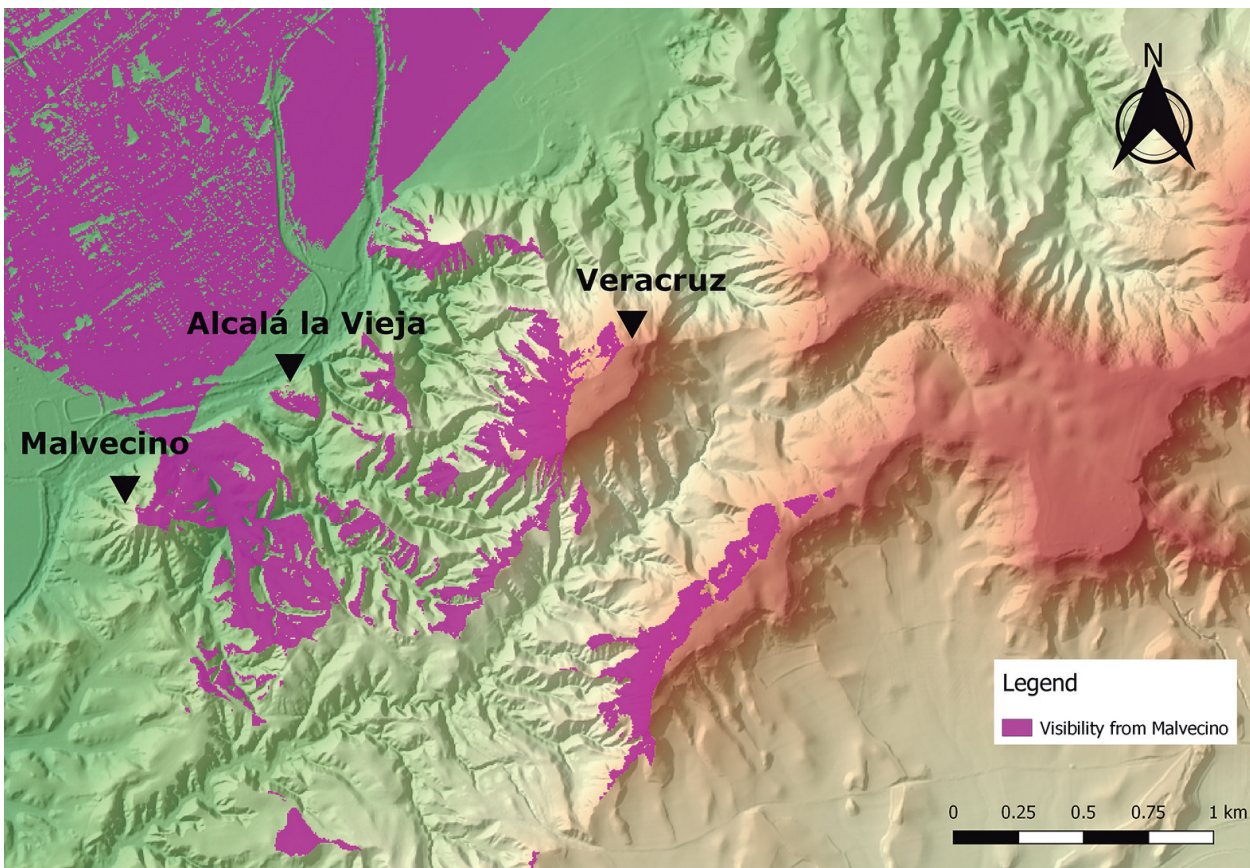


Figure 10. Visibility from Malvecino hill. Derivative work from MDT5 2015 CC-BY scne.es

could have a better visibility. We followed the same previous process that we used, placing the watchers around the perimeter to simulate the round that they should have made. In this case, the number of points was fifteen with a separation of two meters between them because the available zone in the hilltop was very small.

Once that we established the points and we uploaded all the information, the software created this new layer where we can perfectly see that the visibility from the top covers a bigger extension of terrain than the figure 3. From these positions, they could watch the places that they did not see from the lower part of the hill. The combination of both layers shows a total control of the area from the Christian post in Malvecino hill.

According to these results, we are capable of confirming that the information from the historical written sources may be correct because all of them talked about two Christian posts (one camp and one temporary castle). The selection of these places was very smart because they covered practically the whole area, not only the castle but paths, hills, valleys, river, etc. And this meant to cut the communications and support lines, avoiding the

arrival of enemy's troops from other regions in the area, and of course the access to food and water, two key elements in the siege development. Nevertheless, the archaeological study of both locations would reveal more information about it.

Regarding the intervisibility, figure 12 displays it exists from the location that we selected in Veracruz hill and the other positions in Malvecino's hilltop and hillside. Those points are separated by a distance of 1.681,7 meters and 1.470,8 meters respectively. With this part of the analysis, we can confirm that in case they were situated in those places, the messages exchange could be possible.

To allow us to know the vision from more locations in each research area, we carried out an intervisibility study more complicated, and in order to do that, we decided to use points that we previously created to determine the visibility from Veracruz hill and Malvecino's hillside and hilltop (Fig. 13). The criteria were exactly the same but the results were exponentially increased because we worked with a bigger number of watchers.

As we did before, the observation points were located in Veracruz hill because it was the highest

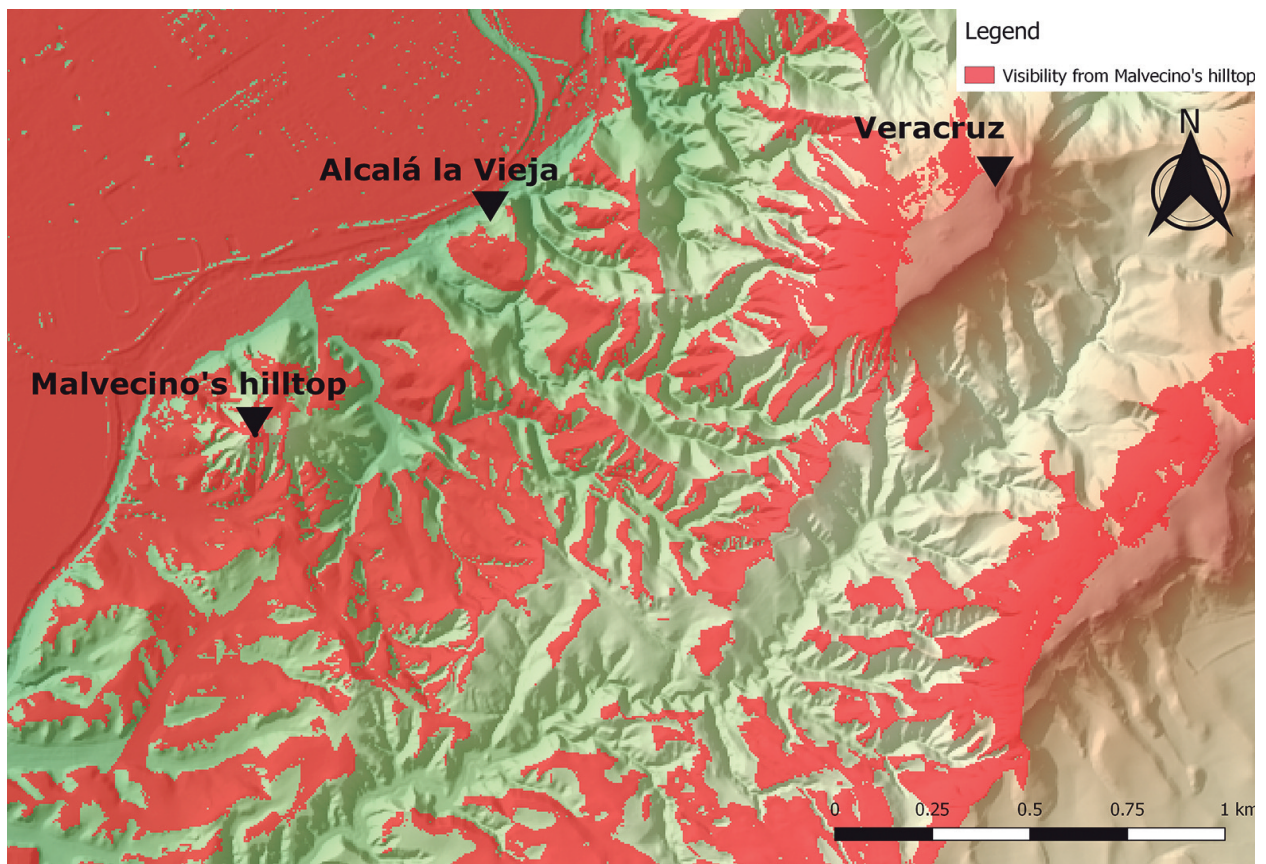


Figure 11. Visibility from Malvecino's hilltop. Derivative work from MDT5 2015 CC-BY scene.es

hill in the area and also where the archbishop established the main camp, and the target points were in Malvecino's positions. The geographic information systems processed the information and the results were a total of 380 intervisibility studies between Veracruz and Malvecino's hillside. Obviously, all of them were not positive and to distinguish them from the negatives we worked with the attribute table. With the tool filter/select features using form, we commanded the software to show the positive or true intervisibilities, obtaining 124 positive results. On its behalf, the same study, but now using the hilltop as a target, provided us a number of 300

features and after filtering, the amount was reduced to 117.

In an effort to know the intervisibility from each point in Veracruz to the different locations in Malvecino, we filtered the positive results previously obtained with the same method. In both cases, we found that the same number of viewers (nine) in Veracruz had a positive intervisibility with several watchers in the other elevation. And those watchers were the numbers 1, 2, 3, 4, 5, 6, 8, 9 and 10 (Fig. 14). All of them oriented to the Muslim fortress, the temporary castle and the siege area.

The number of visibilities that confirmed our theory was appreciable, however, given that our

VERACRUZ	MALVECINO'S HILLTOP	VISIBLE	DISTANCE
1	1	True	1681,7
VERACRUZ	MALVECINO'S HILLSIDE	VISIBLE	DISTANCE
1	1	True	1470,8

Figure 12. Results obtained after calculating the intervisibility from the ideal point.

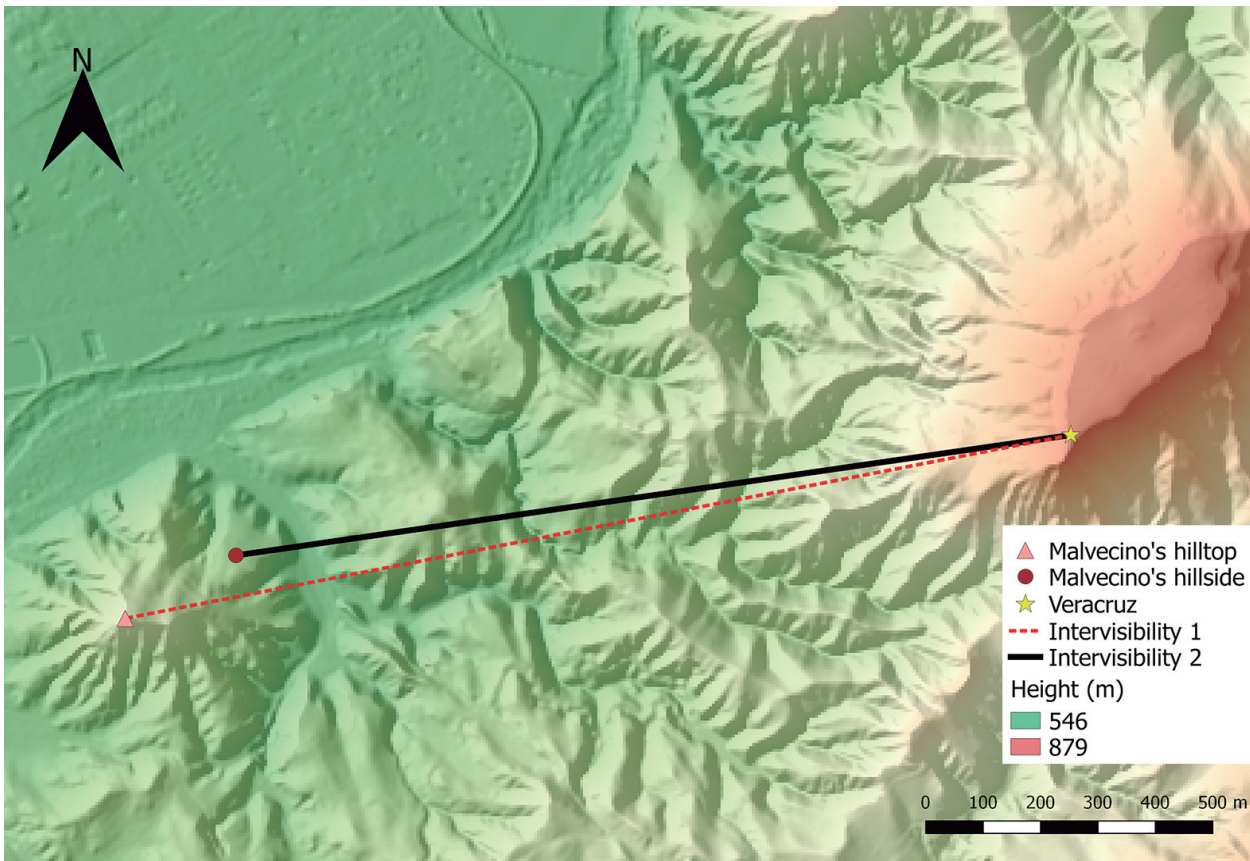


Figure 13. Intervisibility from one point located in each study area. Derivative work from MDT5 2015 CC-BY scene.s

findings are based on a limited number of observers, the results from such analyses should consequently be treated with caution because different places with other coordinates would modify the data that we have shown.

give a coherent speech to this historical fact. However, their work was not enough to understand the siege and as a consequence to comprehend the reason to establish the two Christian positions. This paper has highlighted the importance of

7. CONCLUSION

Our work has led us to conclude that the study of the Christian positions in this medieval siege, using the information in the historical, was not possible. The main reason is that the data is provided by secondary sources, because there is not any historical narration from the moment of the military engagement. People who wrote those descriptions should have found the same problem than us and they tried to solve it filling those gaps to

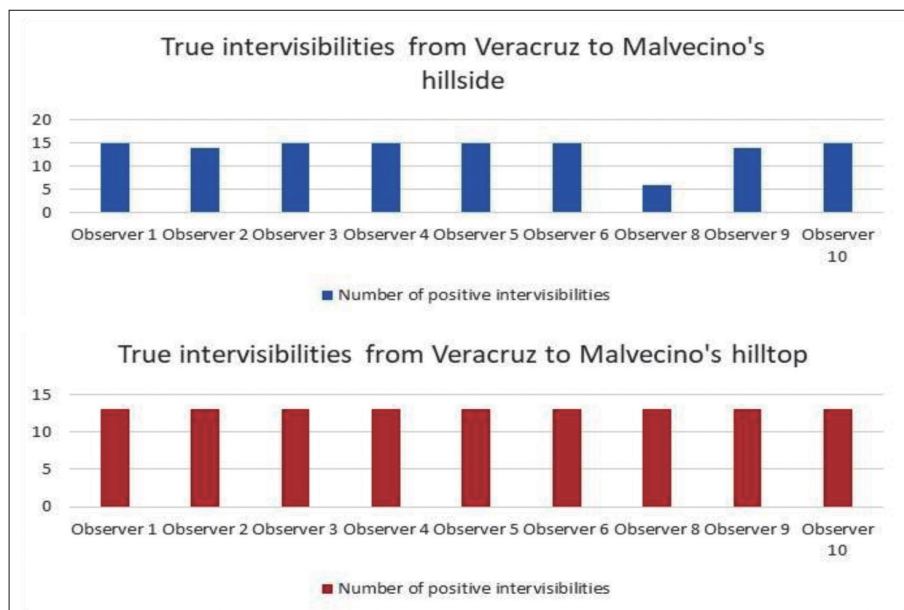


Figure 14. True intervisibilities from Veracruz to Malvecino's hillside and hilltop.

interdisciplinary studies, using new technologies in medieval studies.

The evidence from this study suggests that the short and brief description provided by the historical written sources about the Christian deployment may be correct. The findings from this research indicate that the archbishop of Toledo, Don Bernardo the Sedirac, who commanded the Christian army to conquest the Muslim stronghold of Alcalá la Vieja, selected very well both places. From those locations, they could observe the enemy's maneuvers and also, they would be able to communicate between the Christian posts using standardized methods in the Middle Ages, which were used to send messages in the watchtowers' system and it would be likely that they had the same procedures.

We have obtained satisfactory results showing that the use of the geographic information systems is the only way to fill the gaps in the historical written sources. In this case, we carried out a more complex visibility study than in previous works, using the archaeological information to know the watcher's height and historical concepts from the watchtowers to understand the way of communicating that they could use. This combination of sources opens new research paths and allows us to get a deeper knowledge about this medieval siege.

We know that the analysis was limited in several ways. First, the necessary information about the temporary castle situated in Malvecino, to know what type of defensive structure there could be. Only archaeology would shed new light on this aspect; and second, the landscape. When we did this study, the GIS software worked with current files (terrain, hydrography, etc.) because we do not know how the environment was. Maybe, at that moment there were elements blocking the watcher's view or perhaps, now we have them in our landscape. It is very important to keep in our mind that the result was obtained using the terrain that exists currently. Nevertheless, we believe our work could be a starting point for future investigations about military deployments in medieval warfare.

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