Drawings and Measures for the Knowledge and the Representation in the Eighteenth Century of the 'Isla Plana' (Alicante, Spain)

Andrés Martínez-Medina, Andrea Pirinu

Abstract

The historical cartography is an important documentary source for the knowledge of the places. An analysis of the representations of a territory in the medium and long term makes it possible to recognize its forms and its identity characters, understand the dynamics of transformation and preserve the memory of landscapes and architecture now definitively lost.
The study of the maps can lead to interesting results and offer a methodological contribution to the research if supported by a mastery of systems and tools for survey and drawing of the architecture and the territory. The use of the compass and astronomical measurements in support of a network of instrumental stations starting from the thirteenth century guide the territorial reconnaissance and the survey of the architectures. These procedures, widely tested during the sixteenth century, in the eighteenth century can rely on more precise equipment and are subject of a process of standardization of the methods of acquisition and graphic representation.
The eighteenth century's drawings made by military engineers for the description of the stretch of Spanish coast between Santa Pola and Alicante and for the project for a new fortified settlement in the 'Isla Plana' offer the opportunity to apply a research path focused on the analysis of the maps scientifically repeatable in other contexts.

Keywords: drawing and survey, historical maps, military engineers, Nueva Tabarca.

Surveying and drawing the territoty

Survey and representation of the territory have ancient origins and –over the centuries– are characterized by a constant improvement of methods and tools. In Europe since the thirteenth century (fig. 1) the introduction of the compass for the construction of nautical charts [Valerio 2012, p. 219] [1] starts a process of refinement whose results are evident in the quality of the Aragonese cartography of the Kingdom of Naples, from whose examination "it is evident the use of the compass in the survey operations or, at least, in the general orientation of the maps. What Leon Battista Alberti had proposed for the survey of Rome was applied by the Aragonese scientists to the topographic survey of an entire Kingdom" [Valerio 1993, p. 299] (fig. 2). This method, set to a polar coordinate system, at the beginning of the 16th century, is widely tested and in use in all of the main survey operations and urban planning [2].
In the sixteenth century the drawing acquires a great importance and the figure of the military engineer is able –through the direct knowledge of the places– to carry out an effective fortification work only after have visited the place and measured and evaluated through scientific methods the attitude of the territory to be modified and transformed.
The measuring instruments, based on the triangulation, will reach high precision in this era and will bring together in one the functions previously performed by several instruments.

CC BY-NC-ND

The possibilities of measurement are collected by Cristóbal de Rojas in his fortification treatise edited in the 1598 [3] (fig. 3); the Spanish engineer, to overcome the difficulties in the use of the triangulation [4] and the square, suggests the instrument used by Tiburcio Spannocchi [5]. The training of military engineers, mainly entrusted in the battlefields experience, during the Kingdom of Philip II of Spain, with the establishment in the 1583 of the Academia de Matemáticas in Madrid direct by the royal architect Juan de Herrera, could rely on the scholastic teaching of the art of fortification.

Under the aspect of representation, between the sixteenth and seventeenth centuries there is a gradual abandonment of the physical model [6], accompanied by the plan and the profile, which leads to a progressive standardization, with the use of graphic codes and geometric scales until then not always present. It will be France, starting from 1670 [Muñoz 2016, p. 35], to first establish a regulation, soon adopted in the production of maps and published in the treaties [7]; this initiative is linked to the need to define a unique language that could be understood by all and avoid misunderstandings and delays in the approval of projects [Gómez, López 2016, p. 40].

In Spain, as a consequence of the creation of the '*Cuerpo de Ingenieros del Estado*' in the 1711, the spread of this system was entrusted to military treaties [8] and institutions as specified by the *Real Ordenanza and Instrucción de 22 July 1739* for the teaching of mathematics at the *Academia of Barcelona* about to clearly draw with the use of colors and the use of the necessary graphics models [9].

This 'revolution' took place at the beginning of the eighteenth century, during the Kingdom of Philip V [10], when the restructuring of the training courses and the reorganization of the corps of engineers entrusted to Jorge Próspero Verboom (1665-1744) began. Another aspect that characterizes the XVIII century is the greater accuracy present in the drawings. In the eighteenth century there was a need for a precise identification of the territory and of the natural and anthropic elements that characterize it, as well as the urgency of greater precision; all of this with regard to the planimetric description, because the orography is still a difficult problem to solve from the point of view of survey and in terms of representation [11].

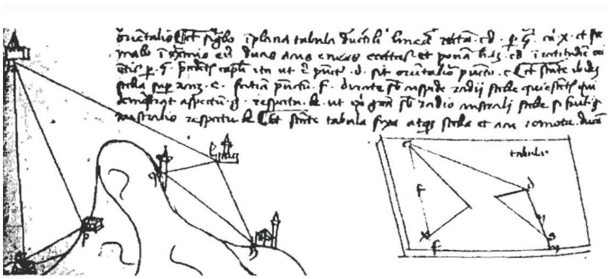
The diversity of graphic scales, the complexity of the projects and the growing dependence on geometric models, determine a generalized use of the pantometer (or proportional compass), which will be gradually abandoned and replaced by the graduated semicircle.

The instrumental equipment generally included praetorian tablets [12], used for surveying in small areas, levels of various shapes, quadrants or quarter circle for medium-sized measurements, graphometers. However, commonly used instruments equipped with compass, circle and alidade still gave errors of more than two degrees in the measurements, and only later, with the introduction of precision turning and threading, was possible to improve the performance of them [13].

In the *Real Ordenanza and Instrucción* of July 22, 1739 the instruments that must be present in the Academy are listed and among these the semicircle and the dial

Fig. 1. The so-called 'Carta Pisana' of the thirteenth century, Bibliothéque Nationale de France: <https://catalogue.bnf.fr/ark:/12148/cb406673515> (accessed 2020, June 20).

Fig. 2. Stations employed for survey operation as illustrated in the handbook 'De Trigono Balistario' f. 68v di G. Fontana [Battisti, Saccaro Battisti 1984, p. 17].

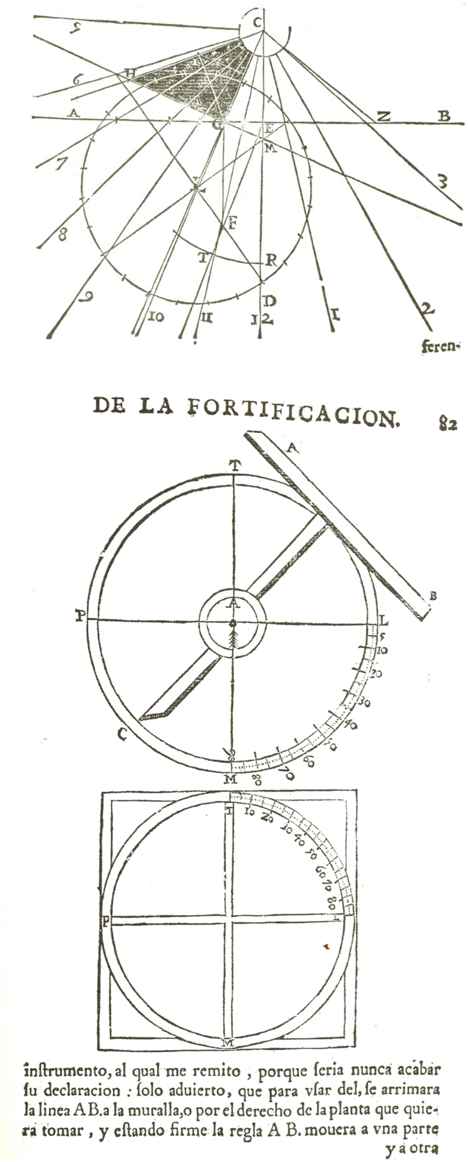


with glasses, levels, pantometer and compasses. Finally, in the work of the Zaragoza architect Antonio Plo y Camín, entitled *El Arquitecto práctico civil, militar y agrimensor*, published in Madrid in the 1767, the tools used in the 18th century are described, mainly the compass and the ruler for drawing, the graduated semicircle and square for drawing lines on the ground, and finally, the pantometer and level, of which, as more elaborate instruments, a detailed description of their manufacture and use is included.
The use of these tools and methods is clearly adopted in the procedures adopted in the eighteenth century for the description of the Spanish territory, as reveals an examination of the drawings made by military engineers for the description of the coast between Santa Pola and Alicante. In fact, the graphic analysis of the documents allows the recognition of the points chosen to structure the geodetic survey network, of the units of measurement and of the graphic codes necessary to represent the surveys, according to the required detail. The maps produced in the period 1721-1789 allow the collection and reconstruction of a considerable amount of historical and geomorphological data; their comparison with the current aerial photogrammetric surveys highlights an interesting quality of the techniques adopted which favors the application of a methodological path of analysis aimed of validating its repeatability in the scientific field.

The graphic analysis of the ‘*Isla Plana*’ drawings: towards a method proposal

The Isla Plana, located not far from the city of Santa Pola near Alicante, is included in the 70s of the eighteenth century as part of a reconnaissance activity aimed at the defense of the coasts and at the foundation of a new fortified settlement called ‘Nueva Tabarca’ [Pérez 2017].
The engineer Méndez de Ras (or Rao), in charge of the design of the new works, made a survey in 1766 [Capel et al. 1983] for the construction of a ‘*torre fuerte*’ and in the following years (1769-1779) executes several drawings that can be classified in four main themes: the geographical description of the territory, the urban project, the architectural project and the final state of the works carried out [Martínez-Medina, Pirinu, Banyuls I Pérez 2017].
However, a first representation, which goes beyond the simple geographical localization, is present in the ‘*Mapa*

Fig. 3. Instruments and methods for survey operations [de Rojas 1598, p. 189, 198].



de la costa de la provincia de Alicante, desde el Cabo de Santa Pola hasta la playa de San Juan' dated 1721 (which has two versions: an initial made with ink and pencil and another final made with ink and watercolor [14]); it is a territorial survey that we will take as the starting point of our study. For the wealth of references to the procedures adopted in its construction, the map is an interesting document that exceeds a mere description of the 'form' of the Isla Plana.
The study of these two maps is structured on several levels. An initial identification of the graphic rules (orientation, metric scale, graphic codes) is followed by an accurate survey of the axes that connect the representative points indicated in the 'preparatory' version. This step, essential for an in-depth knowledge, is carried out by retracing and vectorizing [15] the document line by line with the aim of facilitating the recognition of the instrumental survey network and of allowing the rediscovery of the graphic passages lost in the transcription of the map on the canvas.
The 'final' version repeats the first drawing with some differences in the positioning of place names, of the compass and in the directions that depart from it and with the addition of the metric scale in tuesas, useful reference for the comparison of the map with the current cartographic databases.
The graphic analysis is therefore conducted on the 'preparatory' drawing taking into account the information offered by both drawings (fig. 4). A first important reference on the map is the use of the compass centered in the bastion of San Carlo [16] and of an instrumental base (alignment xx parallel to the east-west axis) created starting from the walled line and the pier of Alicante (fig. 5a). The apex of the bastion facing the sea is the place in which to hinge the oriented axes system that reaches some characteristic points of the coast, such as towers and promontories (listed on the edge of the map [17]) and allows the survey of a stretch of coast of about 25 km between the mouth of the Montnegre river in the north and the fort of Santa Pola in the south.
A second system of axes (the only indicated in the final drawing) is positioned in the sea three kilometres away far from the port of Alicante (pos. A) and rotated according to an angle of 16 degrees if compared to the first system; from it, according to precise angles, start the lines that reach some points further 'targeted' by the first 'origin', connected to each other and to the coastal towers (fig. 5b).
Additional graphical constructions complete the construction of the map. These are axes orthogonal to the lines that connect the stations to each other or alignments created to thicken the survey grid; they allow the survey of some elements that characterize the territory and their location on the latest digital maps (fig. 6) among which, from the south to the north starting from the 'Castillo de Santa Pola': the '*torre de las Caletas*', the '*torre del Cabo Jub*' (also called *Atalaiola* or *Atalayola*, the actual lighthouse), the '*torre del Carabasy*' (disappeared in the first half of the nineteenth century), the 'Torre del Agua Amarga' and, after Alicante, the '*torre del Cabo de Levante*' (also called the 'Cabo de las Huertas', the actual lighthouse). An extension of the oriented system, necessary to reach Santa Pola, is structured close to the '*Isla Plana*' where the ship probably stationed in positions B, C and D (fig. 7) for instrumental surveys and measurements of the seabed. The study of this sector arouses particular interest because reveals the points located on the island, such as the '*Cabo Falcon*', '*la Nave de la Isla*' and '*la Guarda*' [18], which we also will find in subsequent representations.
Some alignments are clearly showed on the map, others can be 'reconstructed'; a line crosses the *Cabo Falcon* and the *Nave de la Isla*, point on the '*Isla Plana*', but if we extend this line we observe that it perfectly crosses the *torre del Carabasy*, a place from which it possible that a measurement was made from in the direction of the island.
The next document examined is the drawing called '*Planos de la Ysla Plana y Cabo de S.ta Pola*' [19] (fig. 8). This map, oriented, with a metric scale and legend and dated 1766, signed by the engineer Méndez de Ras, describes the geographical characteristics of the island, of the cape of Santa Pola and the strait between them. The map describe the depth of the seabed [20], the presence of obstacles to navigation [21], identifies the landings, the morphological characteristics [22] and the coastal towers system [23]. The object of the reconnaissance is the realization of a strengthening of the coastal defense [24] with the construction of a tower on the highest point of the island; a solution replaced a few years later entrusting the defense to the crossfire of a battery on the '*Cabo di S. Pola*' and another one on the 'Punta de Tierra', western offshoot of the Isla Plana describe in the plan designed by the same technician in the 1774.
The information acquired is shown through the integration of the plan view with the north profile; this document describes the hill identified with the letter 'A' and

Fig. 4. Top: digitalization and graphic synthesis of the two maps (analysis and representation by Andrea Pirinu and Andrés Martínez-Medina). Bottom: the two versions of the 1721's map (ACEGCGE).

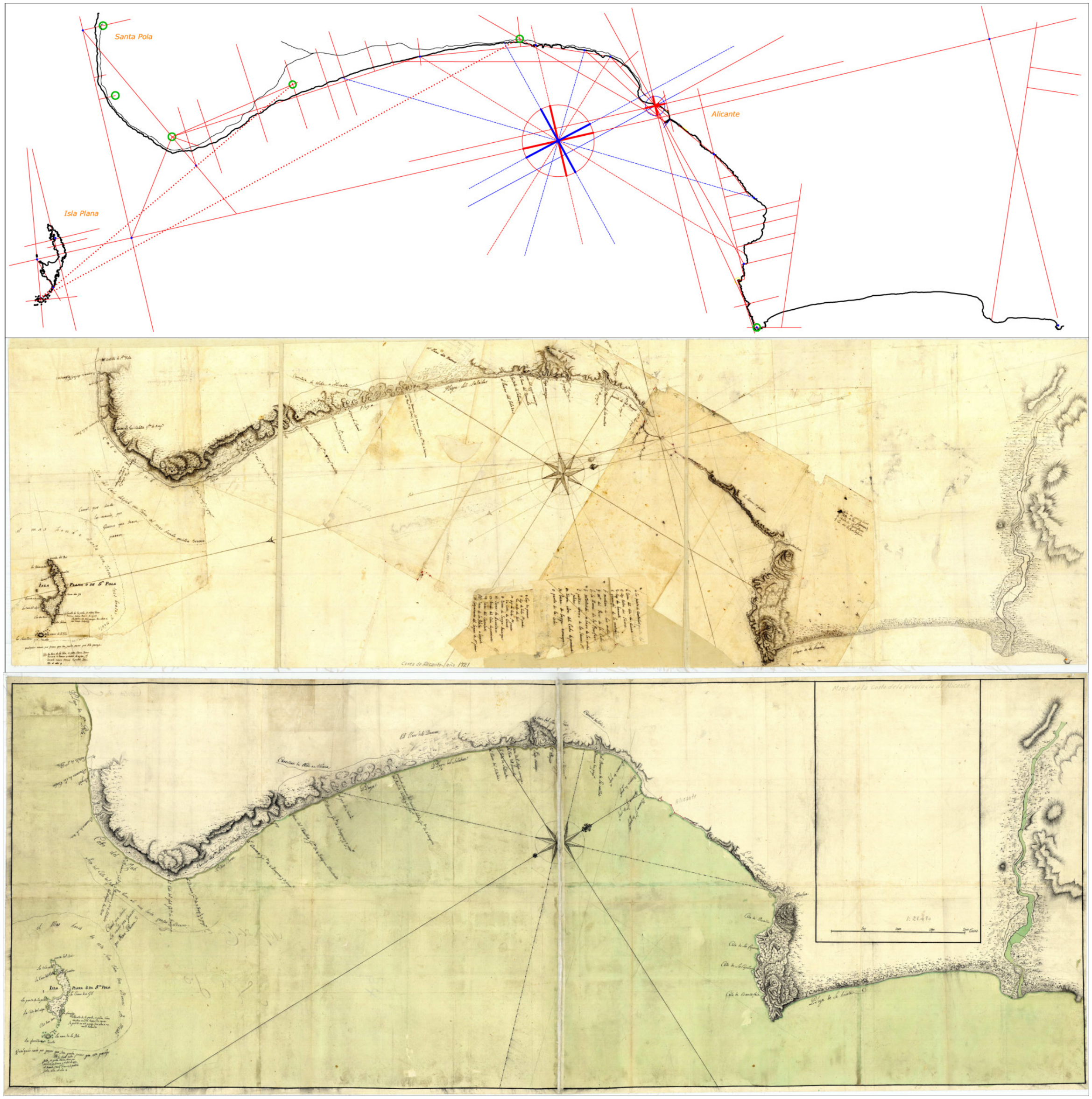


Fig. 5. Digital restitution of the 1721's map that highlights the construction of the survey grid that starts from the pier (Z) and the San Carlo bastion (Y) designed by Giovanni Battista Antonelli [Gonzales 2012] (graphic elaboration by Andrea Pirinu).

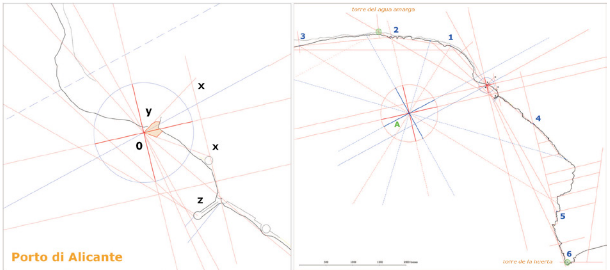


Fig. 6. Overlay mapping between the 1721's map and the DTM produced by the Institut Cartogràfic Valencià, Generalitat Valenciana: <https://visor.gva.es/visor/ (accessed 2020, May 20) (graphic elaboration by Andrea Pirinu).

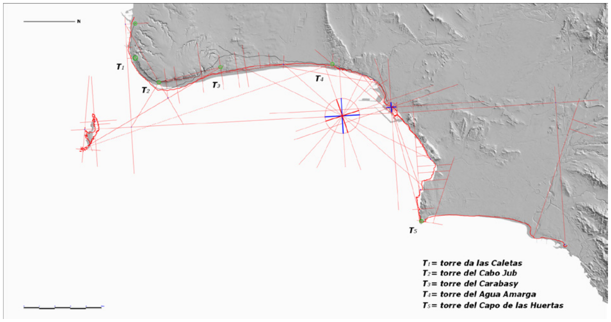
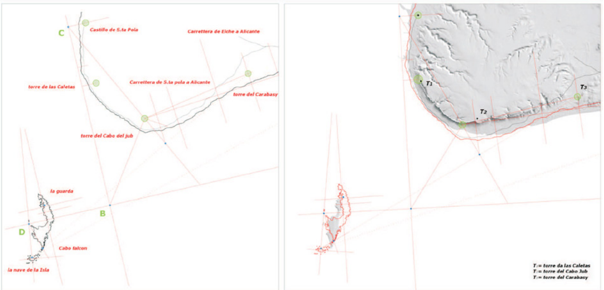


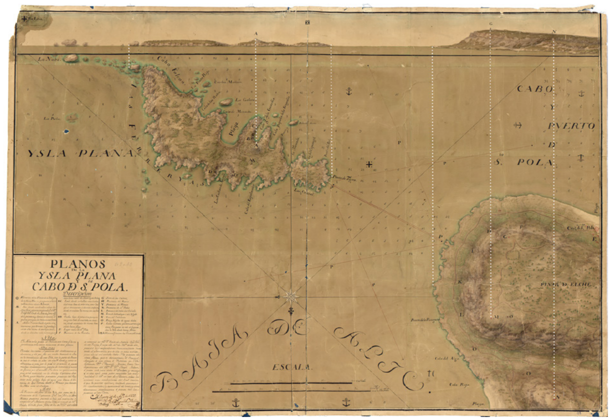
Fig. 7. Graphic elaboration and graphic overlay between the 1721's map and the 2009 DTM (graphic elaboration by Andrea Pirinu).



called 'la Guardia' (useful for '*los moros*' as a 'sentinel'), with the letter 'AA' the site in which to place the '*Torre Fuerte*' and some coves (BC and DD) including the '*Cala grande en la Isla Plana donde se refugian las Gal Galeotas de los Moros*' [25].
This drawing, supported by a metric scale in Castilian varas [26], French miles and tuesas [27], if compared with the latest digital maps (fig. 9), highlights a lack of correct restitution of the island dimensions and of the distance between the island and the cape of Santa Pola; the map also shown an 'artistic' drawing of the coastline used to complete the representation of a perimeter [28] of which the engineer have only a few points geographically located or perhaps aimed at emphasizing –with the description of numerous coves in which pirates find refuge– the need for a defense project. The drawing does not seem to take into account the excellent survey of 1721 and shows a use of graphic techniques linked to the sixteenth-seventeenth-century tradition, as the legend itself refers to with the term "Elevacion de los Planos de la Ysla y Cabo de Santa Pola en perspectiva â la Cavaliera, vistos desde Alicante". The territorial context appears compressed perhaps in an attempt to include in the map all the elements deemed useful [29], as in the case of the Castillo di Santa Pola, placed on the edge of the drawing.
The survey carried out in the 1766 precedes the design of the Nueva Tabarca settlement represented in the '*Plano de le Ysla Plana de San Pablo*' [30] (fig. 10) dated 1770, which focuses its attention on the island, leaving only a reference of the cape of Santa Pola in the margin of the map; it is the first drawing of the citadel inserted in its environmental context, the result of three years of work (1766-1769) necessary to elaborate the fortification project. The shape of the city walls is clearly identified together with the lantern and the additional works useful for the exploitation of the fields envisaged in the sector not built. In this new map no place names are present; the table is a rigorously technical project, oriented, provided with a metric scale and compatible with a recent aerial photogrammetric survey, because now it is necessary to record the true geography in order to design a small town and start the works. The method of graphic representation adopted is also different from previous documents: while the two maps of 1721 are drawn in a very technical and accurate way (with precision of shape and measurements) and the map of 1766 shows many islets and coves with their own place names and 'realistic' re-

presentation by means of watercolor, the latter drawing combines both characteristics (accurate representation of the shape, size of the island and realistic aspects such as the turquoise sea) adding the 'new' normalized codes for the building characterization, as the yellow for the new and red for the existing one, adopted in the following drawings of the citadel.
Another drawing examined is dated 1774 and also elaborated by Méndez (fig. 11). The size of the island and its distance from the coast are compatible with the actual digital maps. However, the description of the 'correct' form takes a step back from the 1770 map, probably because the only objective is to show the precise placement of the citadel design, well described in subsequent drawings produced between 1771 and 1779 [Martínez-Medina, Pirinu, Banyuls i Pérez et al. 2017], and the position of the military works located in *Punta de Tierra and Cabo di Santa Pola*, as suggested by the greater precision in the representation of the coastline that characterizes the project area.
The list of maps examined is completed with the last survey of the island performed at the end of the fortification works. This map (fig. 12) is realized by Antonio Ladrón de Guevara; the engineer in 1789 define an inventory of the defenses and of the buildings built in the citadel and proposed the construction of two towers. Now, the aspect on which we focus is the survey of the island's perimeter for which the technician does not perform a new measurement, but rather uses the 1770's data, however without reproducing them with the same precision, nor with the same graphic quality. This last drawing, poor in information and represented with a very simple graphic codes, reflects the fate of the island and its abandonment and will not contribute to its correct description that we observe at the end of the 18th century in the book *Atlante marítimo de Spagna* [Tofiño de San Miguel, Salvador Carmona, Mengs 1789].

Fig. 8. 'Planos de la Ysla Plana y Cabo de S.ta Pola', 1766, Fernando Méndez de Rao (ACEGCGE: Ar.G-T.3-C.3-347).



Conclusions: historical maps for the knowledge and 'memory' of the territory

The examination of the documents highlighted the correct application of the procedures in use in the eighteenth century for the survey and representation of the territory, but also the use of graphic techniques linked to the sixteenth-seventeenth century tradition. The analysis of the maps produced in the period 1721-1789 for the description of the stretch of Spanish coast between Alicante and Santa Pola made it possible to verify the use of a geodetic network set on points, clearly visible even from a great distance, which could play the role of sights or instrumental stations [Valenti, Romor 2019].
The recognition of the methods adopted for the construction of the maps and the identification of the points "for which a correct graphic recording is conceivable" [Valerio 1993, p. 295] made it possible to apply a methodological path repeatable in the scientific field to other contexts. A gradual process of defining the forms of the coastline was observed: a first step with the design of a network of strong points on a territorial scale (1721), a second with the collection of geographical information of the island (1766) and a third with the survey aimed to design the fortified citadel (1770); each of these 'steps' was characterized by a graphic result functional to the survey scale: first step, a linear and monochromatic drawing, second step a colored perspective view and finally a detailed plan view that shows the graphic codes established for a military use. The other drawings (1774 and 1789) did not participate in the construction of a new knowledge of the territory.
A comparison between historical maps and aerial photogrammetric surveys has also made possible to analyze the forms of the territory and its own characters and to preserve the memory of landscapes and architectu-

res now definitively lost, such as agricultural crops, small hydraulic infrastructures and some costal towers. The quality and the precision of the work of the engineers has been verified and a landscape, rapidly transformed over the last three centuries, has been 'rediscovered'. In conclusion, the old maps, built with care and scientific precision, are, in a certain way, the memory of places and, for this reason, the illustrated method becomes a useful tool for their knowledge, protection and conservation.

Notes

[1] "These are maps whose purpose is the recognition of the coast and the possibility of navigating according to a predetermined route in the Mediterranean sea: in these graphic documents the shape and the course of the coasts are described, the place names are indicated through writings placed orthogonally to the coastline, rotating the map for their reading, while a dense network of lines was used for tracing the routes and for determining the ship's position. In short, we are faced with a real work tool": Valerio 2012, p. 219.

[2] "In 1529, on the occasion of the war and the siege of Florence by Pope Clement VII, the pontiff ordered, for strategic purposes, the survey of the city (and the elements that compose it) and of the surrounding area. The tool used to implant a grid, structured on physical elements such as towers, bell towers, peaks and stations, is a compass, which allows a precisely control of the distances between the key points": Guidoni, Marino 1983, p. 196.

[3] *Teorica y Practica de fortificacion*, a compendium of the teachings of Cristóbal de Rojas at the Academia de Matemáticas de Madrid founded by Juan de Herrera (1530-1597).

[4] In terms of survey methodologies, a fundamental step occurred in Europe thanks to the contribution of W. Snellius who, between 1615 and 1622, carried out the first triangulation in order to determine the length of a meridian arc between Alkmaar and Bergen in Holland, at the mouth of the Schelda river.

[5] "Un ingenioso instrumento consistente en una regla en T de latón con brújula, que permitía medir ángulos y establecer la orientación de los paramentos": Muñoz 2016, p. 18.

[6] "*Las maquetas continuaron existiendo, pero más por interés didáctico o para expresión del poder real, que como instrumento de elaboración y transmisión del proyecto*": Muñoz 2016, p. 35.

Fig. 9. Comparison between the map of 1766 and the map of 1721 both digitized and integrated with the DTM (graphic elaboration by Andrea Pirinu).

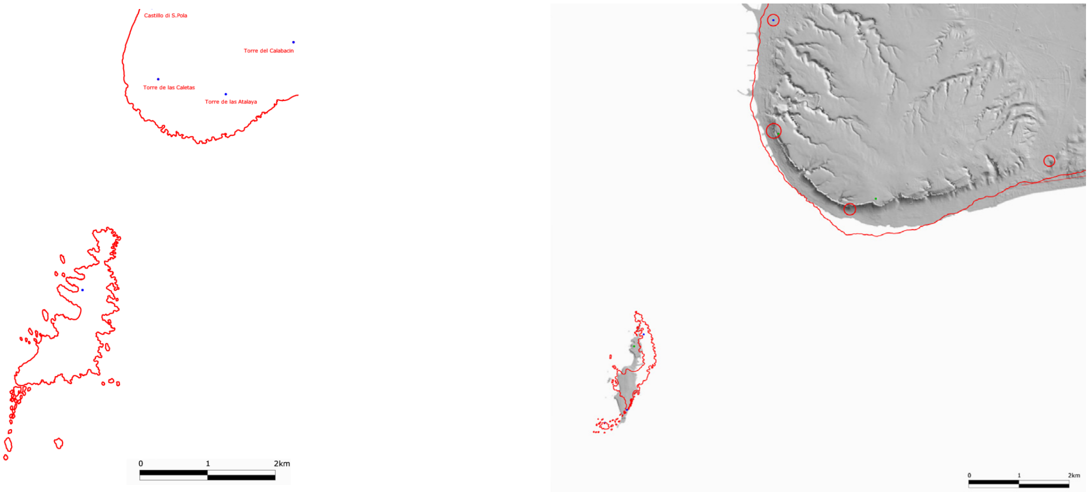


Fig. 10. Comparison between a recent aerophotogrammetric survey of the island and the 1770's map called 'Plano de la Ysla Plana de San Pablo', 1770, attributed to Fernando Méndez (AHM: SH, A-03-02, Madrid).

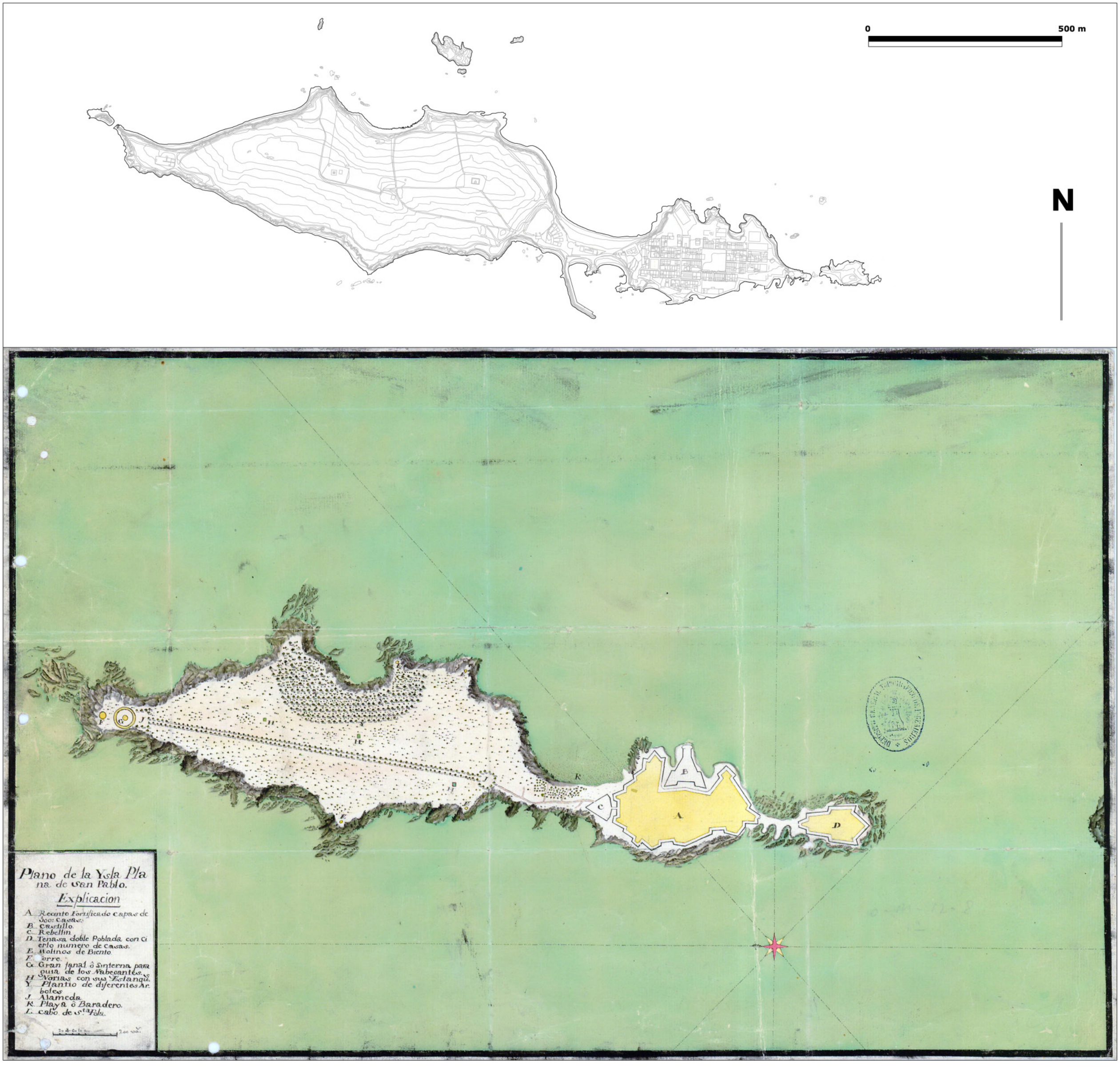
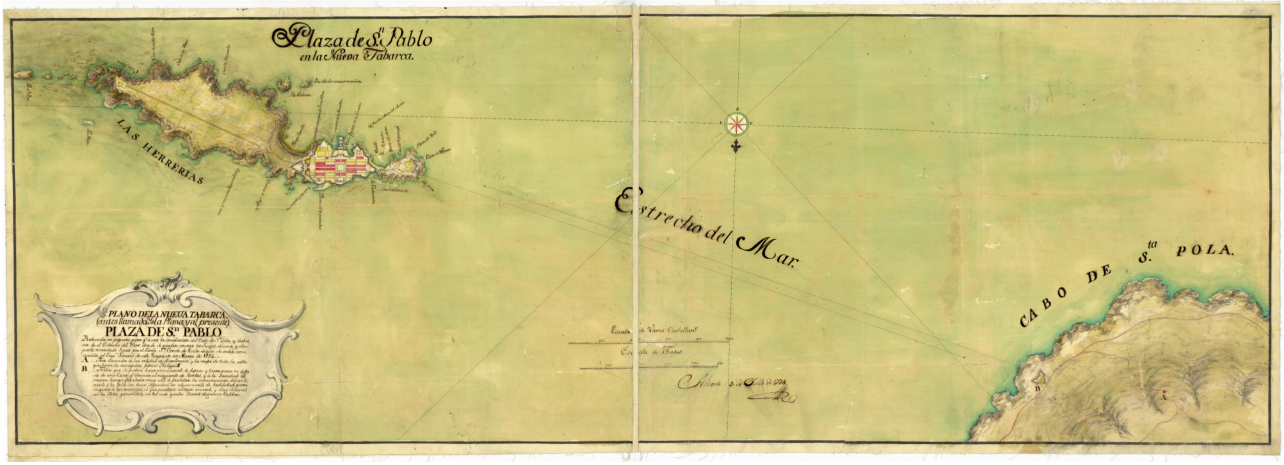
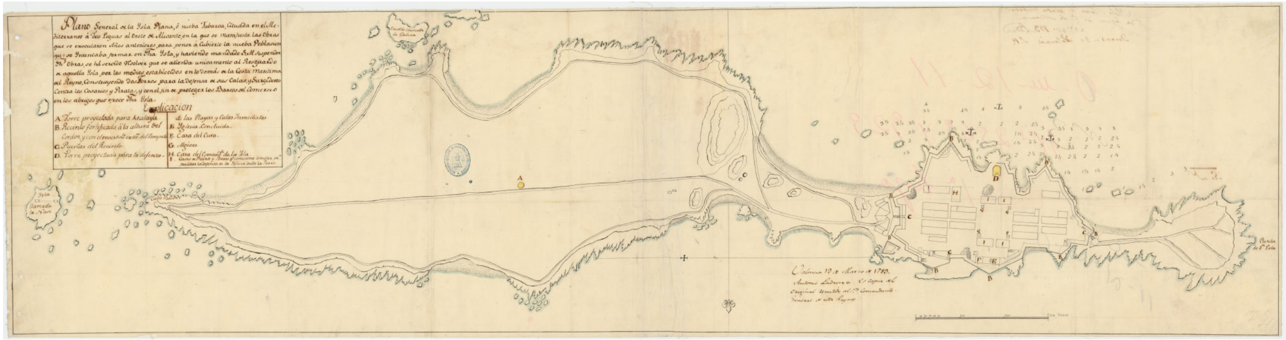


Fig. 11. 'Plano de la Nueva Tabarca (…) para qe. se vea la inmediación del Cabo de Sa. Pola (…), donde se pueden cruzar los Fuegos (…)', 1774, F. Méndez (ACEGCGE: Ar. G-T.3-C.4-350).

Fig. 12. 'Plano General de la Ysla Plana, ó Nueba Tabarca (…)', 1789, Antonio Ladrón (AHM: SH, A-03-04, Madrid).





[7] Among these: *L'Art de dessiner proprement les Plans, Profils, Elevations Geometrales & Perspectives, soit d'Architecture Militaire ou Civile* published by Henri Gautier in 1697 in Paris.

[8] Among these, in the Spanish area, the Tratado de Castrametación o Arte de Campar (1801) di Vicente Ferraz, a text that specifies the colors to be used for military architecture and follows the treaties of Alférez Medrano, who was director of the Royal and Military Academy of Brussels and wrote several texts for the training of military engineers, as: *El Ingeniero, primera parte* e *El Ingeniero, segunda parte que trata de la geometría práctica, trigonometría y uso de las reglas de proporció*n, Bruselas 1687 and *El Architecto Perfecto en el Arte Militar. Dividido en cinco libros*, Bruselas 1700.

[9] "Se enseñará el modo de delinear con limpieza, y de aplicar los colores, según práctica, para la demostración de sus partes, su distribución y decoración, con los adornos pertenecientes a todos los Edificios Militares, haciendo a este fin sus respectivos Planos, Perfiles y Elevaciones": Muñoz 2016, p. 36.

[10] King of Spain during the period 1700-1746.

[11] Only at the end of the century this problem will be faced with conviction and instrumental possibilities, through the use of portable barometers to measure heights and the use of new graphic symbols for cartographic representation: Docci, Maestri 1993.

[12] In his *Istruzioni pratiche per l'ingegnero* published in the 1748, G. Antonio Alberti, proposed some innovations for measuring angles, making the Praetorian tablet an instrument capable of measuring distances in a indirectly way, reducing the need for a second station point: Dotto 2010, pp. 117, 118.

[13] At the same time, the research on a better use of the instruments goes on, thanks to Tobias Meyer, to whom we owe the idea of the method of repetition of the angles, which consists in measuring an angle in different sectors of the graduated circle, in order to reduce errors due to manufacturing defects of the appliance, a method perfected by the French J.C. Borda (1733-99), with the construction of the repeating circle (1775), for azimuth measurements: Docci, Maestri 1983.

[14] In the *Archivo Cartográfico de Estudios Geográficos del Centro Geográfico del Ejército* (ACEGCGE) are cataloged the preparatory drawing called 'Mapa de la costa de la provincia de Alicante, desde el Cabo de Santa Pola hasta playa de San Juan': Ar.G-T.3-C.3-314 and the final version called: "Mapa de la Costa de la provincia de Alicante: Ar.G-T.3-C.3-315.

[15] The digitization of the maps is necessary to carry out subsequent comparisons.

[16] Demolished in the second half of the nineteenth century.

[17] Among these, indicated with the n.16, the 'Campanario del lugar di S.Juan', traceable to the tower of the 'Monasterio de la Santa Faz' and located in the north of the urban center of Alicante.

[18] Further alignments, such as the one that crosses 'la Guarda' (so called in the 1721 and renamed 'La Guardia' in the 1766), are parallel to the compass axes.

[19] *Archivo Cartográfico de Estudios Geográficos del Centro Geográfico del Ejército* (ACEGCGE): Ar. G-T.3-C.4-347. In addition to this work, there are further drawings also dated August 15, 1766: one of the Cala Grande and an another relating to the project of a 'Torre Fuerte'.

[20] Through a grid measured in arms (braza in Spanish) equal to 1.6718 m.

[21] Among these it is reported an "Escollo" (an obstacle to navigation) called "la Losa".

[22] To describe the shape of the Cape of Santa Pola all the ravines (Barrancos in Spanish) that characterize the sea side are represented.

[23] Among which the Calabacin tower, consisting of two connected buildings.

[24] In addition to the use of the island as a hospital, as the report accompanying the map specifies.

[25] Well described in a view attached to the map.

[26] The *varas* are part of the ancient anthropomorphic system adopted in Spain until the metric system introducted by law in 19 July 1849. The *Gaceta de Madrid* on December 28, 1852 publishes the equivalences between the ancient measures in use in the individual regions and the new system. The size of the *varas* differs within the Crown of Aragon itself until that date and the Valencian *varas* in particular consists of 91 cm, the Aragonese one of 77.7 cm and the Castilian one is 83 cm.

[27] One *tuesa* is equivalent to 1.949 meters: Carrillo 2005.

[28] As observed during the re-drawing of the map.

[29] Numerous examples are known in the history of the representation of architecture such as the table of 24.9x34.3 cm engraved by Matthäus Greuter in the 1623 which reproduces the square of St. Peter in Rome and reports: "this urban space was made into a square for the smallness of the copper that can be done with a length of 30 Arcs at least for each part".

[30] "Plano de la Ysla Plana de San Pablo", 1770, assigned to F. Méndez, Archivo Histórico Militar (Madrid): SH, A-03-02.

Authors

Andrés Martínez-Medina, Department og Graphic Expression, Composition and Design, University of Alicante, andresm.medina@ua.es.
Andrea Pirinu, Department of Civil and Environmental Engineering and Architecture, University of Cagliari, apirinu@unica.it.

Reference List

Battisti, E. Saccaro Battisti, G. (1984). *Le macchine cifrate di Giovanni Fontana*. Milano: Arcadia.

Carrillo de Albornoz y Galbeño, J. (2005). La fortificación abaluartada. Siglos XVI al XVIII. In *Poliorcética, fortificación y patrimonio*, pp. 33-82. Valencia: Universidad Politécnica de Valencia.

Capel, H. et al. (1983). *Los Ingenieros militares en España: siglo XVIII. Repertorio biográfico e inventario de su labor científica y espacial*: <http://diposit.ub.edu/dspace/ handle/2445/67042?locale=ca> (consultato il 22 ottobre 2018).

Docci, M., Maestri, D. (1993). *Storia del rilevamento architettonico e urbano*. Roma-Bari: Laterza.

Dotto, E. (2010). Lo strumentario tecnico per il rilevamento: le acquisizioni del primo Ottocento. In F. Buscemi (a cura di). *Cogitata tradere posteris. Figurazione dell'architettura antica nell'Ottocento*. Atti del convegno. Acireale: Binanno Editore.

Gómez López, C., López Díaz, J. (2016). I progetti dell'ingegnere Bruno Caballero a L'Avana, tra tradizione e un nuovo sistema di esercizio della professione. In *Archistor*, n. 6, pp. 36-63.

Gonzáles Avilés, Á. B. (2012). El origen del Muelle de Alicante: el proyecto de Antonelli. In *Revista de Obras Públicas*, n. 3.532, pp. 49-58.

Guidoni E., Marino A. (1983). *Storia dell'urbanistica. Il Cinquecento*. Roma-Bari: Laterza.

Martínez-Medina A., Pirinu A., Banyuls i Pérez, A. (2017). La fortificación de la isla de Nueva Tabarca, 1769-1779: De la estrategia militar a la táctica del proyecto urbano. In Echarri, V. (a cura di). *International Conference on Modern Age fortifications of the western Mediterranean coast. Atti del III convegno Fortmed*. Alicante, 24-25-26 Ottobre 2017, vol. 5, pp. 101-108. Alicante: Universidad de Alicante: <http://rua.ua.es/dspace/handle/10045/70417> (consultato il 20 maggio 2020).

Muñoz Cosme, A. (2016). Instrumentos, métodos de elaboración y sistemas de representación del proyecto de fortificación entre los siglos XVI y XVIII. In Cámara Muñoz, A. (ed.), *El dibujante ingeniero al servicio de la monarquía hispánica: siglos XVI-XVIII*, pp. 17-43. Madrid: Fundación Juanelo Turriano.

Pérez Burgos, J.M. (2017). *Nueva Tabarca. Patrimonio integral en el horizonte marítimo*. Madrid: Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente.

Rojas, C. De (1985). *Tres Tratados sobre Fortificación y Milicia*. Madrid: Ministerio de Obras Públicas y Urbanismo [Prima ed. Teorica y Practica de fortificación, conforme las medidas y defensas deftos tiempos, repartida en tres partes. Madrid 1598].

Tofiño de San Miguel, V., Salvador Carmona, M., Mengs, R. (1789). *Atlas Marítimo de España*. Madrid: (s.n.). <http://bdh.bne.es/bnesearch/detalle/bdh0000000294> (consultato il 10 maggio 2020).

Valenti, G.M., Romor J., (2019). Leon Battista Alberti e il rilievo delle mura di Roma. In *Diségno*, n. 4, pp. 103-114.

Valerio, V. (1993). Astronomia e cartografia nella Napoli aragonese. In *Rivista Geografica Italiana*, n. 100, pp. 291-303.

Valerio, V. (2012). La Geografia di Tolomeo e la nascita della moderna rappresentazione dello spazio. In V. Maraglino, (a cura di). *Scienza antica in età moderna. Teoria e immagini*, pp. 215-232. Bari: Cacucci Editore.