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The naïve map of the sixteenth century roads in Spain

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ABSTRACT
This paper presents a naïve map that attempts to reflect the vision that Philip II and his advisors probably had of the Spanish road network in the second half of the sixteenth century, a crucial aspect for the choice of the seat of the capital of the kingdom. The elaboration of the naïve map was carried out in two phases: in the first, the road network was reconstructed based on a thorough revision of the primary sources that have survived to the present day. As these sources showed evident problems of completeness, the network was completed using mathematical methods, which were statistically contrasted. The analysis carried out is an important novelty since it shows that most of the transport in the Iberian Peninsula was channeled through the center following a radial structure with six principal axes two centuries before what has been traditionally considered.

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Road network; Philip II; capital city; Spain; naive map

1. Introduction

The choice of Madrid as the capital of the Spanish Empire by Philip II in 1561 was an event of great historical significance and continues to be the subject of intense debate from both academic and social points of view (Alvar Ezquerra, 1989; Pablo-Martí et al., 2022; Ringrose, 1983). The choice of a nation's capital has, among many other factors, an obvious geographical component. The quality of communications with the rest of the territory or the ease of supply are issues of great relevance that must inevitably be considered.

Although the need for a detailed justification of the choice of the capital would have been far from the mentality of an authoritarian king like Philip II, it is relevant to determine whether his decision was appropriate from an economic and social point of view. This insight is essential, not only for a fair assessment of the historical figure but also to glimpse the opinion that his contemporaries might have had of his decisions.

The geographic decisions made by agents are not based on the reality of the territory but on the vision each of them has of it or, in other words, based on their personal mental maps (Gould & White, 1986). Today we do not pay too much attention to this question because modern cartographic advances have brought our vision of the world very close to reality. However, this was not the situation in the sixteenth century, so if we want to assess the decision to choose Madrid as the capital without falling into anachronism (Fischer, 1970), we must determine precisely the mental map that Philip II had of Spain, especially the location of the cities and the roads that connected them. This is, in this case, a particularly relevant question since, in the sixteenth century, the cartographic representation of the Iberian Peninsula was undergoing a profound process of improvement, in which Ptolemaic maps coexisted with other more modern ones with very different planimetries. The recreation of this mental map is the objective of the work presented here, which is structured according to the following scheme.

In the materials and methods section, first, the distorting effect that the deficiencies in the cartography of the time produced in Philip II's vision of the territory are evaluated. Secondly, the other sources of geographic information that also influenced the formation of the monarch's mental map and its limitations are pointed out. Finally, in third place, an approximate method is proposed to recreate the network of roads in Spain in the second half of the sixteenth century and the vision that the elites of the time had of it.

2. Materials and methods

To determine the extent to which the limitations of the time's cartography may have affected the decision on the choice of the capital, we must establish which maps were used..

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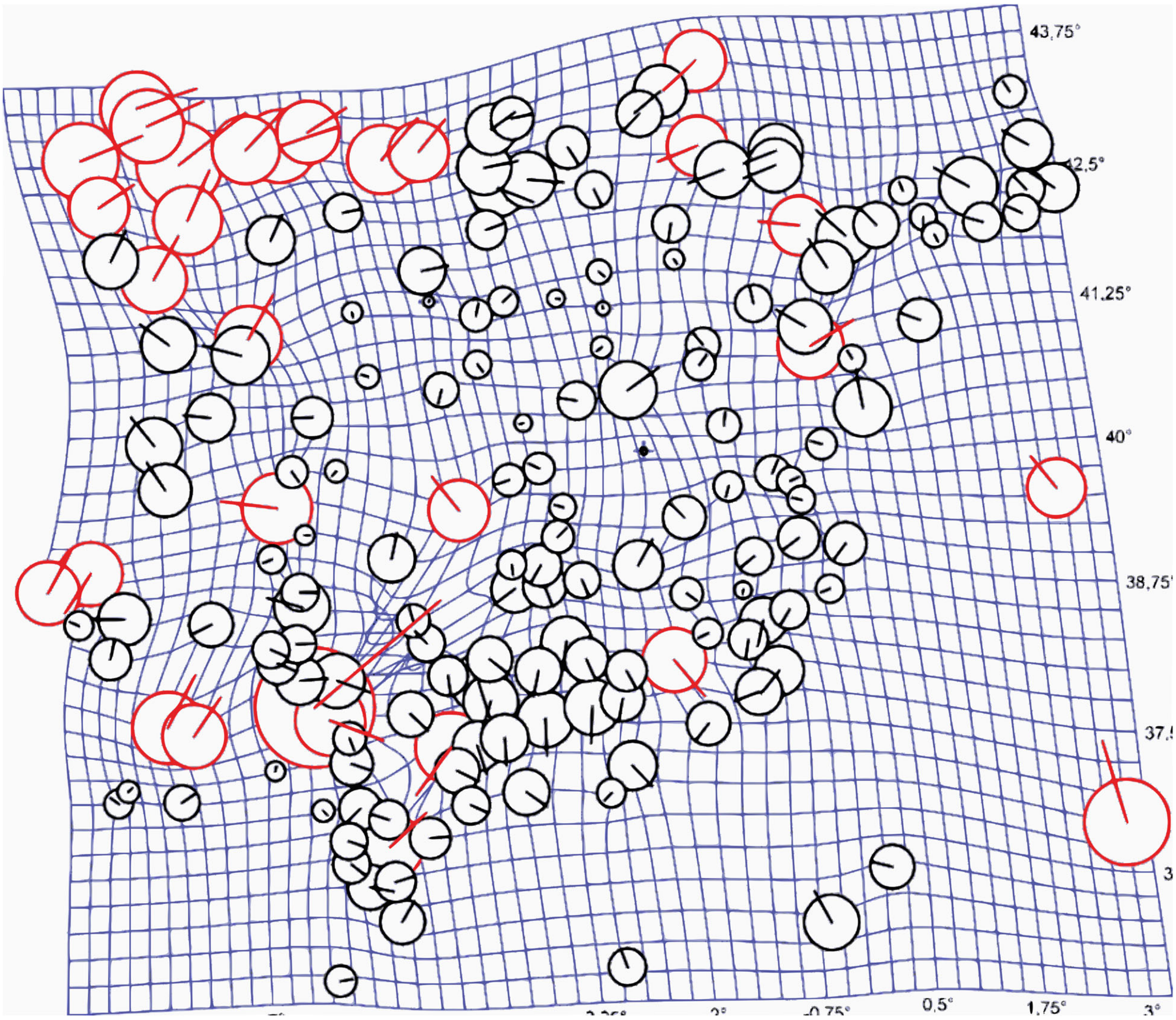

Figure 1. Accuracy of the map of Forlani Veronese (1560).

Philip II was a cultured king interested in the scientific advances of his time, especially those that most affected his political decisions, such as mathematics, geography, and naval engineering (Martínez Ruiz, 1999). Therefore, it seems reasonable to think that the mental map on which he based his choice of capital was constructed on the basis of the best geographical information available at the time.

Accepting this hypothesis and taking as a time frame the date in which the election materialized 1561, it seems clear that Philip II must have used as the primary reference for his decision one of the maps that emerged after the appearance of the map of Spain by Paletino Corsulensis (1551). This rare Venetian map, of which only one copy is available, was a significant improvement over the maps of Vavassori (1532) or Gastaldi (1544) and, above all, the Ptolemaic maps made by printers such as Servet or Münster. It, therefore, spread widely throughout Europe in the form of reduced copies and with slight variations made by other authors such as Cock (1553), Geminus (1555); Luchini (1559), or Forlani Veronese (1560).

This last map has been taken as a reference for this work because it is the one with an issue date closest to when the capital was chosen. However, any of the maps based on the Paletino Corsulensis (1551) would have given similar results.

MapAnalyst 1.3 software was used to quantify the size of the distortions (Jenny & Hurni, 2011). The analysis consisted of establishing control points that related the Forlani map information with a modern reference map. From this information, its planimetric and geodetic accuracy was computationally evaluated, and a view of the deformation of the underlying space on the map was generated using a distortion grid. A robust four-parameter Helmert transform (Andrews, 1974) was used.

The results are shown in Figure 1. The lines drawn from the center of the circles indicate the size and direction of the error derived from the difference between the positions of the control points on the Forlani map and their correct positions. The most critical errors are marked in red.

The results showed that, although the accuracy of the Forlani map is quite high, when compared to previous maps such as those of Gastaldi (1544) or the

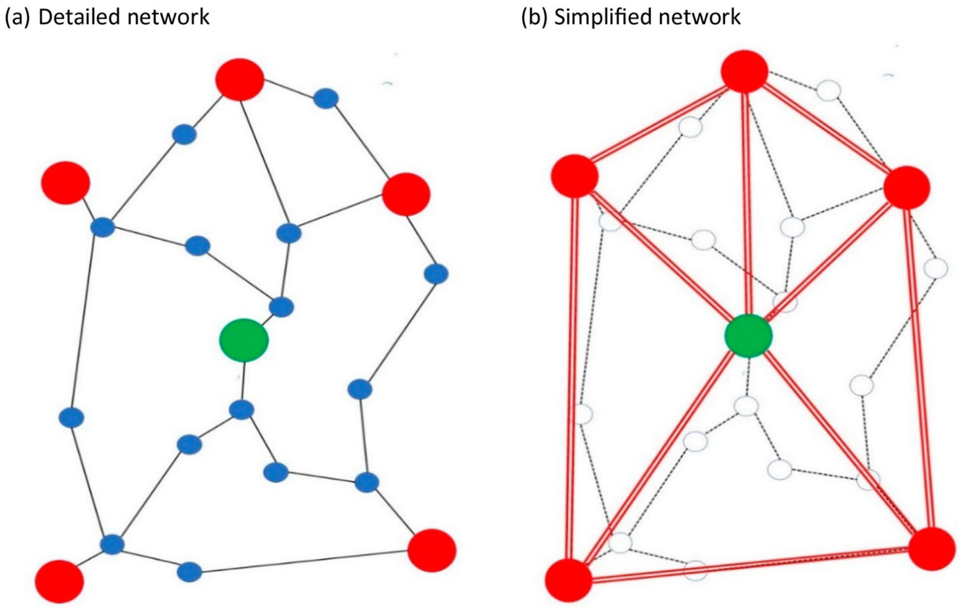

Figure 2. Effect of varying the number of nodes on centrality.

sketch of the Escorial atlas (Crespo Sanz, 2013), there are still significant errors. The best-represented area is the peninsular center, especially Old Castile and Aragon, while the most significant errors occur in the periphery, especially the northwest (Galicia and Asturias), Portugal, and Andalusia, especially in the western part, where there are serious spatial inconsistencies.

These errors necessarily influenced Philip II's selection process for the capital since the location advantages of the candidate cities were based on distances that were not real.

In addition to the position of the cities, it was essential to know the network of roads that connected them. The information in this respect was offered fundamentally by the itineraries. For the reconstruction of the network that Philip II could have considered, a detailed review of the historical sources of the time came down to us was carried out. In addition to the best-known itineraries of Villuga (1546) and Meneses (1568), those of D'Ocampo (1544), Estienne (1552), Gail (1563), Stella and L'Herba (1564), and Rowlands (1576) were included along with the cartographic itinerary of Hogenberg (1579).

However, the review of this historical information does not give us a complete picture of Philip II's knowledge of the territory, as it leaves out two important issues that he knew with certainty: that the road network was much denser than the itineraries reflect since there were roads connecting each city with its closest neighbors, and that although the lack of investment meant that the general quality of the roads was poor, they were not all the same.

2.1. Delauney triangulation

When there is not enough primary information to recreate a network, the only possible alternative is its artificial generation. The most common approach to the problem is the application of mathematical approximations. These procedures are usually local and consist of generating links using Delaunay triangulation that meet certain proximity conditions so that the resulting network coincides as closely as possible with the available evidence.

The main problem with these local approaches is that they do not include path dependency and inter-node coordination criteria in the development of infrastructures. More sophisticated approaches, such as those based on network analysis (Prignano et al., 2019) or agent-based simulation (Pablo-Martí & Sánchez, 2017), also present some drawbacks. On the one hand, they need strong assumptions for model building, and on the other hand, these approaches are computationally intensive.

Recently, there has been a remarkable development of bio-inspired approaches, starting from the pioneering work of Nakagaki et al. (2001) that revealed the computational capabilities of the slime mold – physarum polycephalum – to solve optimal trajectory determination problems. The results obtained with these techniques show structures comparable to real ones in terms of efficiency, fault tolerance, and transport costs. This methodology has been widely applied to the analysis of transportation networks from a historical perspective (Strano et al., 2012; Evangelidis et al., 2015). Evangelidis et al. (2015) also analyzed the Iberian road network through silt mold mapping. However, this methodology, although adequate to show conceptual frameworks, shows serious problems with its application in concrete cases. This lack of precision is due to the high sensitivity of the results to variations in the diffusion of chemoattractants that determine plasmodium development. To avoid these limitations,

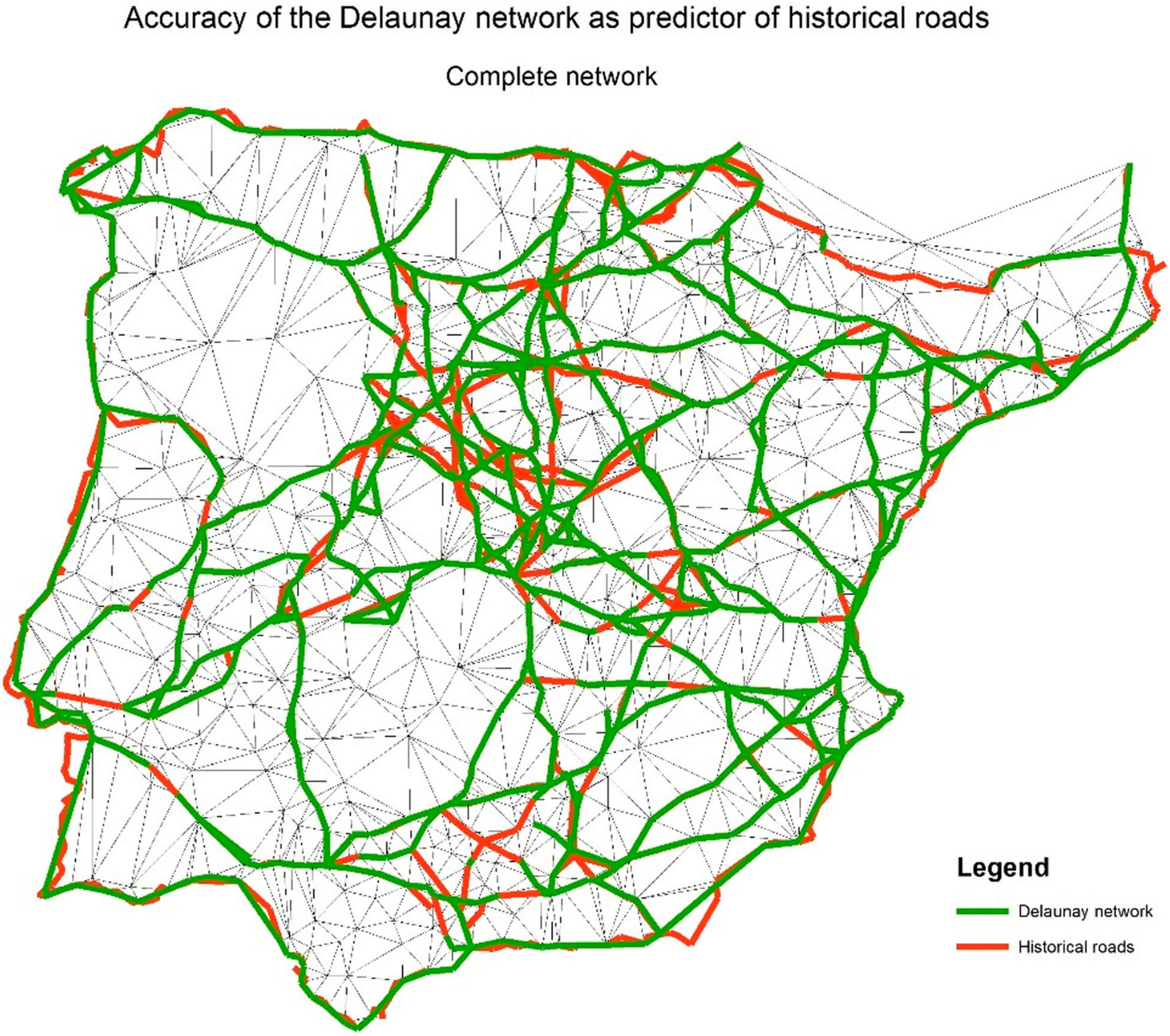

Figure 3. Accuracy of the Delaunay network as a predictor of historical roads.

biosimulations are being replaced by computer simulations using cellular automata (Adamatzky, 2016).

There is no generally optimal approach for the recreation of historical road networks since the evaluation of the fit will depend not only on the similarity in the conformation of the network but also on the level of detail used in its representation.

Figure 2 shows the effect of varying the number of nodes considered on the degree centrality and thus on the evaluation of the degree of fit of the artificial network generation model. The network on the left represents a map with a high degree of detail in which the nodes have a centrality of two or three (Figure 2(a)). After reducing the degree of detail of the map, the degree centrality of the remaining nodes increases, showing a formally very different, although functionally equivalent, characterization (Figure 2(b)).

The fact that the level of detail used in the historical sources affects the number of links considered increases the complexity of the analysis considerably by making it impossible to determine a completely objective network generation system validation criterion.

In a peninsular scale analysis with about 1000 nodes, as was usual in sixteenth century maps, the degree of detail is quite low and only important towns are represented, so it is reasonable to consider a model that generates a mean degree centrality per node with a relatively high value.

The Delaunay triangulation (1934), in addition to having adequate properties from the mathematical

Table 1. Predictability of the Delauny network.

	Type I error	Type II error
Less favorable interpretation: no more hits than observed.	0.6653	0.0344
Intermediate interpretation: the percentage of hits observed among roads appearing in historical sources applies to the rest of the Delaunay network.	0.3709	0.01944
More favorable case: some historical roads are missing, but all Delaunay's links correspond to authentic roads, although some do not appear in historical sources.	0.0000	0.0344

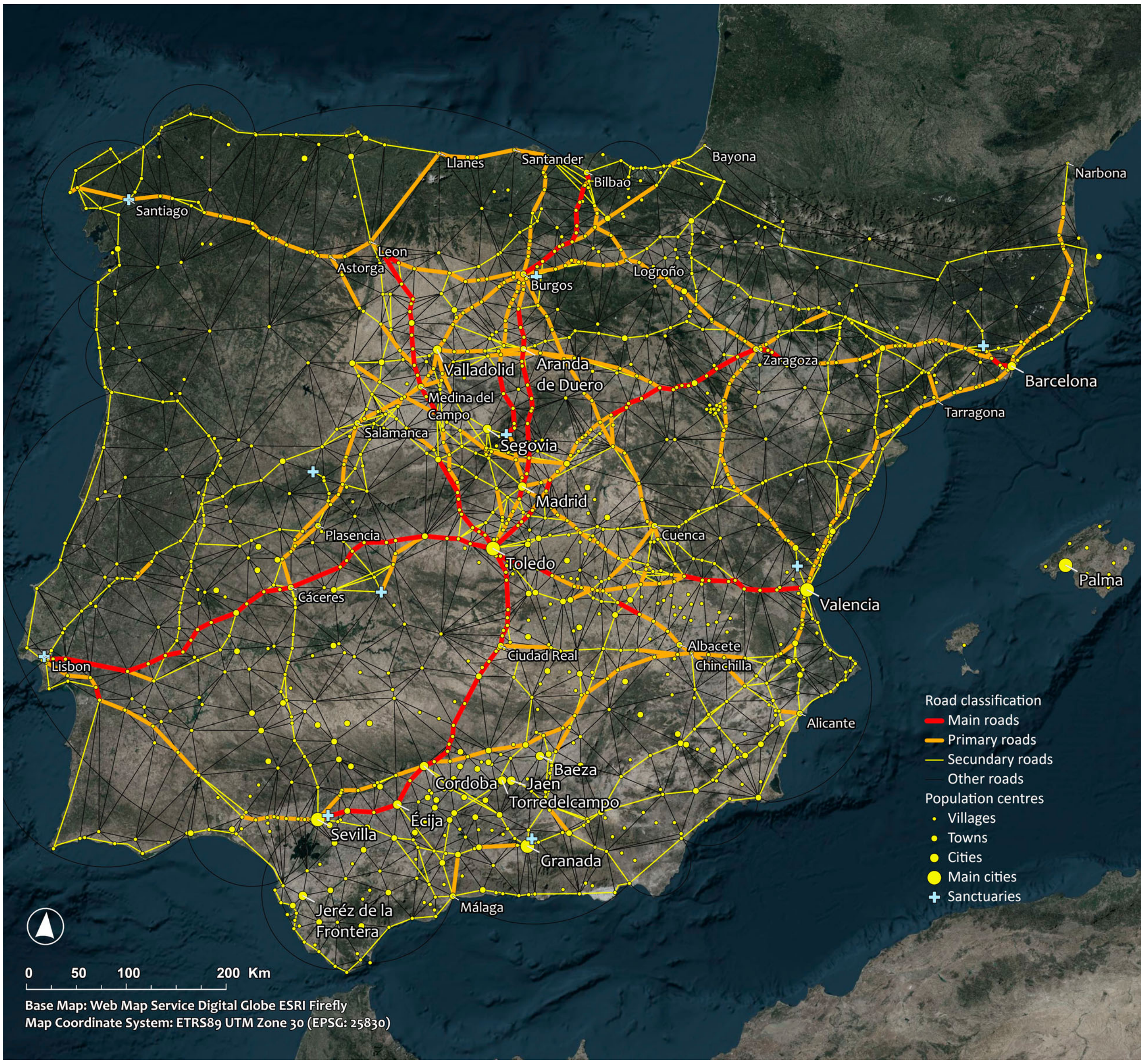

Figure 4. The Iberian road network in the second half of the sixteenth century.

and economic point of view (Pablo-Martí & Sánchez, 2017) meet this criterion, so it was considered that it could be an appropriate way to complete the road network in this type of maps. In larger scale maps in which isolated villages and buildings appear with insufficient traffic to justify more than one or two links per node it may be more convenient other network structures such as those generated by β-skeletons, especially Gabriel's graph (Gabriel & Sokal, 1969).

2.2. Test of the validity of the generated network

In order to verify that the Delaunay network was a good predictor of the sixteenth century road network, its results were compared with the information available in historical sources. To ensure adequate comparability of the roads, it was necessary to previously determine the nodes to be considered in the analysis and to homogenize the links. A total of 1,096 nodes were selected, representing approximately 65% of the peninsular population of the crowns of Castile, Aragon, Navarre, and Portugal. These nodes are formed by the sum of all the towns that appear on the Forlani map plus the main towns indicated in the itinerary sources used. Some towns or settlements (inns, hermitages) whose exact location is unknown have not been included.

The roads appearing in the historical sources were adapted to the selected nodes to avoid duplication. This simplification ensured that roads appearing in several sources with slight differences in their description did not result in apparently different roads.

With these assumptions, the number of possible road sections that could connect villages with each other was 600,060, while the number obtained from historical sources was only 1,100. The generated Delaunay network consisted of 3,137 links, i.e. it selected only 0.52% of the possible road sections. Despite this low figure, the selection proved to be very effective, as it matched 987 links from historical sources. The historic

Figure 5. The naive map of the road network of the Iberian Peninsula at the end of the sixteenth century.

road sections that were effectively predicted by the Delaunay network are shown in green, and the errors in red in Figure 3. Note that the high percentage of sections that were not accurately predicted does not imply that the generated network is structurally different since the generated links are very close and practically parallel to the observed ones.

A statistical test was performed to determine the predictive ability of the Delaunay network. Taking into account that only a part of the roads that existed, in reality, appear in the historical sources, there are three possible interpretations. In the most favorable one, it is considered that all the links generated correspond to roads that existed in reality, except in cases of proven errors. The less favorable one assumes no more 'hits' than those actually observed. The intermediate interpretation extrapolates the hit level obtained with the historical roads to the rest of the network. The results obtained for the three scenarios are shown in Table 1.

Additionally, the Delaunay network obtained was contrasted with an external database, the itineraries of travelers of the 16th and early 17th centuries (González-Tascón, 1997; Uriol, 1987a, 1987b). A very high level of accuracy, over 60%, was observed. The travelers' accounts are, therefore, a clear confirmation of the predictive capacity of Delaunay triangulation to determine unknown roads since it can determine a significant number of stretches that do not appear in any of the historical sources used.

Once the problem of the incompleteness of the road network was solved, the issue of its categorization was addressed. In the sixteenth century, the differences in quality between roads were not so much due to their width or the general quality of the road surface but rather to the comfort and safety of transit along with them.

The smoothness of the slopes, the existence of bridges and inns, or the rapid repair of potholes that appeared on the roads made travelers prefer some routes over others. The concentration of traffic on certain routes for these reasons generated an increase in their security and financial resources for their maintenance which, in turn, led to the establishment of new inns, prosperity in the towns and cities through which they passed and ultimately, an increase in the differences between roads.

Despite the importance of this issue, the information available to us is extremely scarce. Of the historical sources that have come down to us, only Villuga (1546) and Hogenberg (1579) make any mention of the differences in quality between roads.

In order to answer this question, the methodology proposed by Menéndez Pidal (1951) was used, which consisted of considering the most important roads that appeared most frequently in the historical sources.

3. Results: the actual and the naïve maps

Once the information on the road network was reconstructed, the Main Map was made. The map canvas includes two maps. The first, which was called 'The actual map', shows what we consider to be the road structure of the Iberian Peninsula in the second half of the sixteenth century. The second is 'The naive map', which represents the mental map that the cultural and political elite of the period probably had of the road network based on the diverse information they had at their disposal.

3.1. The actual map

The information collected on the road network was plotted on a map with ETRS 1989 UTM Zone 30N (EPSG 25830) Coordinate System. First, population centers were represented [open-strick][open-strick][open-strick]~~by grouping them into four groups~~[close-strick][close-strick][close-strick] according to their population. The population was defined based on the study conducted by Correas (1988). Correas listed all Spanish population centers that reached 5,000 inhabitants at any moment between XVII and XIX. Considering this list and based on Forlani's map, cities were classified according to the approximative number of inhabitants into main cities (over 10,000), cities (5000–10,000), towns (1000–5000), and villages (<1,000). In addition, the main places of pilgrimage (sanctuaries) were also located. Finally, the selection of villages and towns was carried out using the same criteria used to validate the Delaunay network.

Road sections were classified into four groups according to the number of times they were mentioned in the historical sources. Roads cited in six or more references were referred to as main roads, primary roads were those cited between three and five times, secondary roads were those cited in one or two references, and other roads were those that only appeared in the Delaunay network.

The final result of the transport network at the end of the sixteenth century is shown in the Main Map as well as in Figure 4. Surprisingly, the general scheme is very similar to the present one, in which six roads starting from the peninsula's center are the backbone of the whole network. The only important difference is that the center of the network was located in Toledo instead of Madrid. This radial configuration with Toledo as the epicenter, essentially aligns with the representation presented in the Hispania map of the first European road atlas, 'Itinerarium Orbis Christiani'. This atlas, edited by Hogenberg between 1579 and 1580, marks a milestone in the history of European cartography. The use of multiple languages – Latin, Italian, German, and French – in the titles, but without texts that would require costly translations, coupled with its compact size that made it more transportable and cheaper, indicates that it was aimed at a broad European audience. Consequently, the routes delineated in the atlas do not seem to cater to a specific category of users, leading to the conclusion that it provides a representative illustration of the road network in general (Pablo-Martí & López Requena, 2022).

3.2. The naive map

The naive map of the transport network at the end of the sixteenth century was elaborated with a methodology analogous to that used to construct the real network: all the available information on itineraries was incorporated, and the missing roads were generated using a Delaunay network between the towns that appear on the Forlani map. The roads were categorized according to the frequency with which they appeared in historical sources.

As shown in Figure 5, the results obtained for the naive map are similar to those obtained for the real network, although with some significant differences. Although the basic information is the same, the different planimetry of the network nodes means that the road layouts do not always coincide with those of the real map, and there are differences in the categorization.

In any case, the radial structure that characterized the royalist map is maintained, which suggests that according to the information available to Philip II, the center of the peninsula channeled most of the transport flows. Hence, the choice of locating the capital in that area was a natural choice.

4. Discussion and conclusions

This article provides a detailed examination of the cartographic aspects not thoroughly explored in Pablo-Martí et al. (2022) on the Philip II's decision in 1561 to establish Madrid as his permanent residence and the imperial court, a topic not thoroughly explored in the original study on the subject. The choice of Madrid has had profound implications on the development of Spain's infrastructure and economic activity, and this study seeks to understand the economic rationale behind this decision from a geographical perspective.

Although it is commonly accepted that anachronism in historical analysis is a serious problem that must be considered, the works that explicitly incorporate cartographic deficiencies in the assessment of decisions taken in the past are scarce. This paper reconstructs the vision that the cultural and political elite of the sixteenth century probably had of the road network of the Iberian Peninsula. The differences observed between the actual road network and the mental map they had of it were significant, which justifies the need to include this issue in the analysis of Philip II's choice of Madrid as the capital of Spain.

To accurately analyze these logistical issues, the transport network map of Spain at the time was reconstructed using primary sources and statistical methods. This focus on cartography is a key contribution of this article, providing a more complete understanding of the spatial dynamics at play during the period respect other previous works (Carreras Monfort & de Soto, 2010; Madrazo Madrazo, 1984; Menéndez Pidal, 1951; Uriol Salcedo, 1985).

In addition to the reconstructed map, a 'naïve map' was created, representing the limited geographical knowledge of the era. This map offers insight into the worldview of Philip II and his advisers at the time of Madrid's selection.

Utilizing the naïve map as a referential framework, the assessment of the capital's influence on the overall dynamics of peninsular road traffic revealed that Madrid emerged as the aptest city to assume the role of the capital. This was followed in suitability by Murcia, Barcelona, and Valladolid. This hierarchical ordering of suitability remained steadfast when the 'real map' was brought into consideration, with Madrid persisting as the optimal choice, succeeded by Valladolid, Córdoba, and Toledo.

In conclusion, this article affirms that the choice of Madrid as the capital by Philip II was not only reasonable from an economic point of view but also grounded in the geographical and cartographic realities of the time. The study also suggests that the intensive use of the transport network as a critical element in analyzing historical events opens a new and promising field of work in Cliometry. Furthermore, considering the inaccuracies of humanity's worldview before the eighteenth century could help reinterpret many historical events that are still not sufficiently explained.

Software

The assessment of the planimetric errors of the base map was performed with MapAnalyst 1.3, ArcGIS Pro 3.0 was used to create the map. The preparation of the population nuclei raster was carried out with GIMP 2.10.

Open Scholarship

This article has earned the Center for Open Science badge for Open Data. The data are openly accessible at DOI:10.17632/6pp5kc3x92.1 .

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Disclosure statement

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6.#Data availability statement

The data used are freely available on the Internet. References are available in the text. Shapefiles with the road network of the naïve map are available for download DOI: 10.17632/6pp5kc3×92.1.

References

Adamatzky, A. (2016). *Advances in physarum machines* (Vol. 21). Springer. https://doi.org/10.1007/978-3-319-26662-6

Alvar Ezquerra, A. (1989). *El nacimiento de una capital europea : Madrid entre 1561 y 1606*. Turner Libros, Ayuntamiento de Madrid.

Andrews, D. F. (1974). A robust method for multiple linear regression. *Technometrics*, *16*(4), 523–531. https://www.jstor.org/stable/1267603

Carreras Monfort, C., & de Soto, P. (2010). *Historia de la movilidad en la Península Ibérica. Redes de transporte en SIG*. Editorial UPC. https://ebookcentral.proquest.com/lib/bibalcala/detail.action?docID = 3203857#goto_toc

Cock, H. (1553). Nova descriptio hispaniae. Antwerp. https://commons.wikimedia.org/wiki/File:Nova_descriptio_Hispaniae_(Cock,_1553).jpg

Correas, P. (1988). Poblaciones españolas de más de 5000 habitantes entre los siglos XVII y XIX. *Revista de Demografía Histórica-Journal of Iberoamerican Population Studies*, *6*(1), 5–24.

Crespo Sanz, A. (2013). Herramientas y metodología para el análisis de mapas antiguos. *Tiempos Modernos: Revista Electrónica de Historia Moderna*, *26*(1), 1–29. Retrieved 21 August 2017. http://tiemposmodernos.org/tm3/index.php/tm/article/download/335/378

D'Ocampo, F. (1544). *Los quatro libros primeros de la Cronica general de España*. Juan Picardo. https://books.google.es/books?id = 1yRhAAAAcAAJ&dq = caminos&hl = es&source = gbs_similarbooks

Estienne, C. (1552). *Les voyages de plusieurs endroits de France & encores de la terre saincte, d'Espaigne, d'Italie & autres pays : Les fleuves du royaume de France*. Chez Charles Etienne. https://bibliotek.dk/eng/search/work?search_block_form = %28rec.id%3D810010-katalog%3A002471204%29&ref = worldcat#content
Evangelidis, V., Tsompanas, M. A., Sirakoulis, G. C. (2015). Slime mould imitates development of Roman roads in the Balkans. *Journal of Archaeological Science: Reports*, *2*, 264–281. https://doi.org/10.1016/j.jasrep.2015.02.005
Fischer, D. H. (1970). *Historians' Fallacies. Toward a logic of historical thought*. Harper Perennial.
Forlani Veronese, P. di. (1560). *[Mapa de España y Portugal]*. Bertelli, Ferdinando. http://bdh-rd.bne.es/viewer.vm?id = 0000032010
Gabriel, K. R., & Sokal, R. R. (1969). A new statistical approach to geographic variation analysis. *Systematic Zoology*, *3*(18), 259–270. https://academic.oup.com/sysbio/article-abstract/18/3/259/1624465
Gail, J. (1563). '*Raißbüchlin*'. *Ein neuwes nützliches Raißbüchlin der furnemesten Land vnnd Stett, durch mich, Jörg Gail, Burger zu Augspurg in truck verfertiget*. https://de.wikipedia.org/wiki/Raißbüchlin
Gastaldi, G. (1544). La Spagna. https://gallica.bnf.fr/ark:/12148/btv1b531002113
Geminus, T. (1555). Nova descriptio Hispaniae. Excusum … London. http://gallica.bnf.fr/ark:/12148/btv1b7200238 h
González-Tascon, I. (1997). Los caminos en la España de los Austrias. In *Viaje por la historia de nuestros caminos* (pp. 127–174).
Gould, P. R., & White, R. (1986). *Mental maps, The sciences*. Rouledge. https://doi.org/10.1002/j.2326-1951.1969.tb02563.x
Hogenberg, F. (1579). *Itinerarium Orbis Christiani*. https://bildsuche.digitale-sammlungen.de/index.html?c = viewer&bandnummer = bsb00016475&pimage = 3&v = 150&nav = &l = en
SourcesJenny, B., & Hurni, L. (2011). Studying cartographic heritage: Analysis and visualization of geometric distortions. *Computers and Graphics*, *35*(2), 402–411. https://doi.org/10.1016/j.cag.2011.01.005
Luchini, V. (1559). Hispaniae descriptio. Roma.
Madrazo Madrazo, S. (1984). *El sistema de comunicaciones en España, 1750-1850: La red viaria* (Vol. 1). Colegio de Ingenieros de Caminos, Canales y Puertos. Retrieved 25 July 2017. https://books.google.es/books?id = zAswAAAAMAAJ&q = El+sistema+de+comunicaciones+en+España,+1750-1850+Vol.+1+La+red+viaria&dq = El+sistema+de+comunicaciones+en+España,+1750-1850+Vol.+1+La+red+viaria&hl = es&sa = X&ved = 0ahUKEwiGpquE56TVAhXLB8AKHRZ4DJQQ6AEIJzAA
Martínez Ruiz, E. (1999). Felipe II, impulsor de la Ciencia y la Técnica. In *Felipe II, la ciencia y la técnica* (pp. 11–16).
Menéndez Pidal, G. (1951). *Los caminos en la historia de España*. Ediciones Cultura Hispánica.
Meneses, A. d. (1568). *Memorial ó Itinerario de los principales y mejores caminos de España. Con el camino de Madrid á Roma. Compuesto por Alonso de Meneses, Correo. Segunda (?* Alonso Calleja.
Nakagaki, T., Yamada, H., & Tóth, Á. (2001). Path finding by tube morphogenesis in an amoeboid organism. *Biophysical Chemistry*, *92*(1–2), 47–52. https://doi.org/10.1016/S0301-4622(01)00179-X
Pablo-Martí, F., et al. (2022). The choice of Madrid as the capital of Spain by Philip II in the light of the knowledge of his time: A transport network perspective. *PLoS ONE*, *17*(6), 1–39. https://doi.org/10.1371/journal.pone.0269419
Pablo-Martí, F., & López Requena, J. (2022). The Hispania Map of the Hogenberg Road Atlas (1579) and the current Spanish Transport Network. *Annals of the American Association of Geographers*, *112*(7), 2028–2044. https://doi.org/10.1080/24694452.2022.2042183
Pablo-Martí, F., & Sánchez, A. (2017). Improving transportation networks: Effects of population structure and decision making policies. *Scientific Reports*, *7*(1), 4498. https://doi.org/10.1038/s41598-017-04892-2
Paletino Corsulensis, V. (1551). [Mapa de España]. Venecia. http://www.kartografija.hr/old_hkd/hrvkart/paletine.htm
Prignano, L., et al. (2019). Modelling terrestrial route networks to understand inter-polity interactions (southern Etruria, 950-500 BC). *Journal of Archaeological Science*, *105*(November 2018), 46–58. https://doi.org/10.1016/j.jas.2019.02.007
Ringrose, D. R. (1983). *Madrid and the Spanish Economy, 1560-1850*. University of California Press.
Rowlands, R. (1576). *The post for diuers partes of the world to trauaile from one notable Citie unto an other, with a description of the antiquitie of diuers famous cities in Europe*. Thomas East. https://en.wikisource.org/wiki/The_Post_of_the_World
Stella, C. D., & L'Herba, G. da. (1564). *Itinerario delle poste per diverse parti del mondo*. https://books.google.es/books?id=Lc5cAAAAcAAJ&dq=poste+per+diverse+parti+del+mondo&hl=es&source=gbs_navlinks_shttps://books.google.es/books?id=Lc5cAAAAcAAJ&dq=poste+per+diverse+parti+del+mondo&hl=es&source=gbs_navlinks_s
Strano, E., Adamatzky, A., & Jones, J. (2012). Vie physarale: Roman roads with slime mould. *Bioevaluation of World Transport Networks*. https://doi.org/10.1142/9789814407045_0010
Uriol, J. I. (1987a). Viajes por España en la primera mitad del siglo XVI. *Revista de Obras Públicas*, *133*(3251), 331–338.
Uriol, J. I. (1987b). Viajes por España a principios del siglo XVII. *Revista de Obras Públicas*, 819–827.
Uriol Salcedo, J. I. (1985). Las calzadas romanas y los caminos del siglo XVI. *Revista de Obras Públicas*, 553–563.
Vavassori, G. A. (1532). Nova Descriptio Hispaniae.
Villuga, P. J. (1546). *El Reportorio de todos los caminos de España: hasta agora nunca visto en el ql allará qlquier viaje q quiera andar muy pvechoso pa todos los caminantes*. Pedro de Castro a costa de J. de Espinosa. http://www.traianvs.net/villuga/