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Before Highway Maps: Creating a Digital Research Infrastructure Based on Sixteenth-Century Iberian Places and Roads

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Cover Page Footnote
Earlier versions of this work were presented in 2010 at the annual meetings of the Association of American Geographers in Washington, D.C. (by Hibberd) and of the Association for Spanish and Portuguese Historical Studies in Ottawa, Canada (by Owens). The authors thank those who offered at that time suggestions for improving the manuscript.

Before Highway Maps: Creating a Digital Research Infrastructure Based on Sixteenth-Century Iberian Places and Roads

Robert Hibberd and J.B. Owens

In this article, we talk about roads.[1] Usually when people chat about roads, they deal with the one they are on: its condition or delays caused by accidents, construction, or natural events. We discuss all of the major Iberian roads of the mid-sixteenth-century polycentric urban pattern, and we have used them to provide a digital research infrastructure, a free, downloadable *gazetteer*, to which others can link their information in order to create complicated narratives that will yield improved understandings of the period. Following the techniques we present, researchers can aggregate their information to particular locations and establish the shifting connections among them over time.[2] Transportation networks reflect and facilitate patterns of human interactions and interconnectedness.[3] In fact, the history of the people of any place is shaped in profound ways by the manner in which that place is connected to other places and people.[4] Within this context of places related to each other, the famed cartographer and geographer Waldo Tobler postulated his influential first law of geography: "Everything is related to everything else, but near things are more related than distant things."[5] Of course, the idea of "near things" for a traveler is a matter of time as well as distance, and for the necessary understanding of relatedness, one must know something about the available routes, in our case the terrestrial ones.[6]

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[1] Earlier versions of this work were presented in 2010 at the annual meetings of the Association of American Geographers in Washington, D.C. (by Robert Hibberd) and of the Association for Spanish and Portuguese Historical Studies in Ottawa, Canada (by J. B. Owens). The authors thank those who offered at that time suggestions for improving the manuscript.

[2] ESRI's ArcGIS Network Analyst provides assistance for this type of work; see, http://www.esri.com/software/arcgis/extensions/networkanalyst, accessed 8 June 2015.

[3] G. D. R. Sanders and I. K. Whitbread, "Central Places and Major Roads in the Peloponnese," *The Annual of the British School at Athens* 85 (1990): 333-361.

[4] J. B. Owens, "Toward a Geographically-Integrated, Connected World History: Employing Geographic Information Systems (GIS)," *History Compass* 5, 6 (October 2007): 2014-2040; doi: 10.1111/j.1478-0542.2007.00476.x.

[5] Waldo Tobler, "A Computer Movie Simulating Urban Growth in the Detroit Region," *Economic Geography* 46, 2 (1970): 236.

[6] We are not the first to study such Iberian routes. For example, see Jean-Pierre Molénat, "Chemins et ponts du Nord de la Castille au temps des Rois Catholiques," *Mélanges de la Casa de Velázquez* 7 (1971) : 115-162 ; Molénat, "En Espagne à la fin du XIVe siècle, la naissance de Puente del Arzobispo : une relecture, " *Le Moyen Age* 2 (1980) : 233-249.

Therefore, we offer a methodological article, which should stimulate the imagination and ambition of some of our readers. We want to encourage you to innovate in the ways that you think and write about Iberian history. Because we rely on geospatial technologies, and particularly on geographic information systems (GIS), we realize that some readers may be intimidated by this unfamiliar technical environment, which is rapidly becoming commonplace in the digital humanities. To assist such readers, Owens has created a GIS training manual for novices, which is available free for download, along with the data for all exercises and the free, companion GIS software for the first ten chapters.[7]

Envision yourself as an early sixteenth-century traveler, who must journey a long distance within the Iberian Peninsula, the "Spain" of that era. Perhaps you wished to undertake a devotional pilgrimage from the Aragonese city of Zaragoza in the northeast to the shrine of the Virgin of Guadalupe in west-central Castile. Or perhaps you were a merchant from some town north of Toledo who wished to travel to Sevilla. Maybe you were a court receiver (*receptor*) of the superior royal court (*audiencia*) of Granada, and you were assigned to take depositions from witnesses in Talavera. How would you obtain the necessary directions to make such long journeys outside of your familiar local space?

The one thing that our traveler could not have done was to chart a course directly toward the desired destination. The topography of the peninsula prevented that, even in the nineteenth century. Here is the observation on this subject from a commission that in 1821 was charged with creating Spanish provinces with sufficiently well-connected municipalities for administration to function effectively.

> Habría poco qué hacer si el territorio ofreciese siempre secciones circunscritas por límites naturales y con población suficiente para formar una provincia; pero las más de las veces hay que luchar con los obstáculos que en esta parte opone un país tan irregular, de tantas montañas y de tan grandes desniveles como el nuestro. Frecuentemente se interponen sierras y cordilleras que durante una parte considerable del año producen grandes dificultades para la comunicación pronta y fácil, circunstancia que perjudica a la comodidad de los moradores de las provincias, al pronto despacho de sus negocios y a la circulación rápida y egecutiva [sic] de las órdenes de las autoridades. Y así como antes se dijo que la comodidad de los pueblos y la acción del Gobierno está en razón inversa de las distancias de la capital,

[7] J. B. Owens, Anderson Sandes, Barbara Stephenson, David Dixon and Catherine Zajanc, *A Geographic Information Systems (GIS) Training Manual for Historians and Historical Social Scientists* (Pocatello: Idaho State University, 2014), http://www.geographicallyintegratedhistory.com/ (accessed, 8 June 2015).

> ahora es menester añadir: y también de las dificultades de las comunicaciones.[8]

Once the trip was underway, the terrible quality of peninsular roads also constituted a barrier. Poor roads were a constant of Iberian life in the First Global Age, 1400-1800. Even by the mid nineteenth century, nothing significant had changed since the sixteenth century, as this observation by Pascal Madoz (1806-1870) demonstrates.

> El funesto círculo vicioso que generalmente predominaba, de que por falta de viajeros no había medios de comunicación, y que por falta de estos medios no había viajeros, mantenía á los españoles en tan deplorable estado, que el dirigirse á la corte de éste las principales capitales de las provincias se tenía por lo común del pueblo y hasta por otras clases, como uno de los acontecimientos más arriesgados; mirando con asombro sus conciudadanos á aquel que después de un viaje largo, lleno de penalidades y molestias y excesivamente costoso, regresaba a su hogar doméstico. Poco ó nada se había adelantado en la época que dejamos referido [1808 hasta 1815], en facilitar las comunicaciones interiores, al estado que tenían *cuando Cervantes y otros ingenios españoles ridículizaran con tanta gracia en muchos romances y divertidos escritos* [emphasis added], el atraso y abandono en que se sostenía en la nación este importante elemento de la cultura y riqueza de los pueblos. En las arraigadas preocupaciones en que nos hallábamos envueltos, colocar los capitales en negociación tan aventurada, era un acto poco menos que el heróico. Sin embargo, no faltaron ciudadanos celosos por el bien y prosperidad de su patria, que se decidieron á hacer todo género de sacrificios para proporcionar al país el incalculable beneficio de trasladarse de un punto de la monarquía á otro periódicamente, con celeridad y comodidad. Con este objeto se formó en 1816 la Sociedad de Diligencias, titulada de Cataluña, primera de este género, y de la cual es una continuación no interrumpida la de que tratamos.[9]

[8] From the "Informe de la Comisión de División del Territorio Español, leído en la sesión de las Cortes de 19 de junio de 1821," as quoted in Jesús Burgueño, *Geografía política de la España constitucional. La división provincial* (Madrid: Centro de Estudios Constitucionales, 1996), 350-351.

[9] Pascal Madoz, *Diccionario geográfico-estadístico-histórico de España y sus posesiones de Ultramar*, Tomo X (Madrid, 1850), 941, capítulo "Madrid."

To illustrate the condition of the roads at a scale that shows greater detail, we offer this mid-nineteenth-century description of Requena, a city of particular interest to the authors.

> Caminos. Los más principales son los que de esta ciudad dirigen á la capital de provincia [Cuenca], los cuales se ponen intransitables en el invierno á causa de las desbordaciones de los ríos *Moya*, *Cabriel* y *Guadazaon*, cuyos puentes y vados son inutilizados por las lluvias. De mayor interés para esta ciudad y aún para la mayor parte de la provincia es la carretera titulada de las Cabrillas, la cual pasa por el centro de la ciudad, cuyo estado es el más lisongero, sin embargo de no estar enteramente concluida: los demás caminos que conducen a los pueblos inmediatos se hallan en mal estado por lo escabroso del terreno [abbreviations extended].[10]

In commenting on the shift in June 1851 of the partido of Requena from the Province of Cuenca to that of Valencia, Jesús Burgueño insinuates that the change was due to political influence because the minister who signed the decree, Beltran de Lis, was from Valencia. However, the minister's Valencian origin may only have given him sufficient experience with the difficulty of traveling through Requena to the west so that he realized the value of the proposed boundary shift to enable the citizens of Requena to get to a provincial capital more easily. In this regard, it is worth noting that this change in provincial boundaries was part of the reorganization plan of 1822, substantially before Beltran de Lis was in a position to influence the decision.[11]

Travelers in the peninsula encountered other serious barriers in the First Global Age. They faced a very real danger of violent assault by criminals whom

[10] Madoz, *op.cit.*, Tomo XIII (Madrid, 1849), 423, capítulo "Requena."

[11] Burgueño, *op.cit.*, 186: the change of June 1851 was that most of the *partido conquense* of Requena was shifted to the Province of Valencia; the decree was signed by a minister from Valencia, Beltran de Lis (p. 186). Putting Requena in Valencia had been part of the plan of 1822 (*op.cit.*, 183). For the order in the form that it was received by Requena's council on 29 June 1851, see: http://www.requena.es/es/content/documento-del-mes-de-junio-de-2014-la-agregaci-n-de-la-comarca-de-requena-la-provincia-de-va (accessed 8 June 2015). Burgueño resorts to the same allegation of personal interest as the explanatory factor for the decision of a commission in September 1836 to move Sax and Villena from Murcia to the province of Alicante, without any real regard for the difficulties that residents of those municipalities may have faced in traveling to the city of Murcia in comparison to a journey to the city of Alicante, which was also an important port. "Para el éxito de esta reforma no debió ser un hecho casual que el subsecretario de la Gobernación, Joaquín M. López, fuese natural de Villena y diputado por Alicante. López y [Fermín] Caballero [Progressive liberal Cortes deputy for Cuenca; important geographer involved in Spain's political reorganization] compartían la titularidad del *Eco del Comercio* y tuvieron una carrera política paralela: años más tarde, el geógrafo escribiría la biografía de su correligionario" (*ibid.*, 177).

the Spanish government had only begun to control in the mid nineteenth century. The situation was so shocking that in the 1845 volume of his *Diccionario*, Madoz broke off his technical discussion of the territorial court in Albacete to remind his readers how dangerous travel was even in the very recent past.

> Por el conocimiento topográfico de un país, se sabe dónde están los puntos más peligrosos para los caminantes, bien por la aspereza del terreno, bien por sus sinuosidades y veredas, por la espesura de los bosques, por el aislamiento en que se encuentra, y que ofrece a los criminales mayor facilidad para perpetrar sus atentados; y el poder ejecutivo adopta las disposiciones convenientes a fin de proteger la seguridad personal de los ciudadanos, y abriendo caminos menos penosos, y conduciendo los de nueva empresa, por otros sitios que presentan menos dificultades, ya mandando se desmonte el terreno demasiado poblado, o construyendo edificios en parajes aislados, o proviniendo a sus agentes vigilan más de cerca aquellos puntos. No se olvidarán en muchos años los robos y asesinatos que diariamente se cometían en el paso del Brú, en el Coll de Balaguer, en Serrallonga y bosque de Comiols (Cataluña), en la sierra de Crevillente y ásperas serranías de Tous (Valencia), en el Confesionario y Monte-hermoso (Extremadura), en la cuesta del Espino, entre Córdoba y la Carlota, en la cuesta de Velillos, entre Alcalá la Real y Pinos de la Puente (Granada), en los inmensos e inhabilitados llanos de la Mancha (Ciudad Real), en los montes de Toledo, en la venta del Puñal, en el peligrosísimo paso del puerto del Frasno y la venta de la Romera en el camino de Madrid a Zaragoza, y en los Pedruscos, sierra de Alcubierre y venta de Ballerías, entre la última ciudad y Barbastro. Pero afortunadamente aquellos horrorosos hechos, aquellos atentados escandalosos, quedarán relegados a la historia de nuestras debilidades; con la mejora de los caminos, con el establecimiento de diligencias, y otras medidas de policía y buen gobierno, que hicieron desaparecer las madrigueras en que se ocultaban los bandidos.[12]

Perhaps Madoz selected examples from many Spanish regions in order to reveal the general pathology of transportation in the country. Five years later, in 1850, he returned to the subject in his volume on Madrid.

> No ofrecen hoy los caminos los inconvenientes que hace 40 años presentaban; en esta época del paso de ciertos puntos, por desgracia de muy frecuentes, ponía á cada momento en inminente peligro la vida y la

[12] Madoz, *op.cit.*, Tomo primero (Madrid, 1845), 241, capítulo "Albacete, Audiencia Territorial de la Península."

> propiedad de los viajeros. Nadie pasa aún en el día sin que se conturbe su espíritu, por el Pico del Diablo en la sierra Ministra, por la venta del Puñal, por los muchos puertos del Guadarrama y Somosierra, por los montes de Toledo, por los de Ávila y otros, al recordar la funesta historia de los atentados en ellos cometidos y ver las muchas cruces que todavía se conservan, como otros tantos signos de víctimas sacrificios dictadas por infinitas partidas de salteadores y asesinos que tenían en ellos sus guaridas. Afortunadamente los caminos han recibido incalculables mejoras; y aún que no exentos de todo de riesgos por el descuido con que se mira de su reparación, el establecimiento de la guardia civil [founded in 1544], institución digna de todo elogio, asegure el tránsito en los parajes más peligrosos.[13]

Therefore, simply to understand the movement of people and goods within the peninsula, or the nature of administration, historians will need to aggregate information from disparate sources to the places mentioned in those sources. Sometimes the task will be made difficult because the location of a named place[14] will not be known. Even if the location of the named place is known, it may not be clear how the place was connected to others. To assist this type of vital research, Robert Hibberd has constructed a gazetteer of historic places.[15]

One of the grounding elements of historical geography, or more generally what J. B. Owens refers to by the higher-level concept "geographically-integrated history," is first, the understanding that historical processes involve the integration of space with a particular time. Second, analyzing an integration of space and time can pose methodological challenges that modern information management and visualization techniques may be capable of resolving.[16] Such work requires

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[13] *Ibid.*, Tomo X (Madrid, 1850), 521, capítulo "Madrid."

[14] In this article, we follow the common pattern in geospatial research and use the contraction "placename," following the form of the contraction "online."

[15] For a full explanation of the gazetteer concept, see chapter 5 of Linda L. Hill, *Georeferencing: The Geographic Associations of Information* (Cambridge, MA: The MIT Press, 2006).

[16] On the concept of geographically-integrated history, see J. B. Owens, "Toward a geographically-integrated, connected world history: Employing geographic information systems (GIS)." *History Compass*, 5, 6 (October 2007): 2014-2040; doi: 10.1111/j.1478-0542.2007.00476.x; Owens, "Dynamic Complexity of Cooperation-Based Self-Organizing Commercial Networks in the First Global Age (DynCoopNet): What's in a name?" In "Self-organizing Networks and GIS Tools: Cases of Use for the Study of Trading Cooperation (1400-1800)," ed. A. Crespo Solana and D. Alonso García, *Journal of Knowledge Management, Economics and Information Technology*, Scientific Paper, Special Issue, Vol. II, Issue 3 (June, 2012), http://www.scientificpapers.org/special-issue-june-2012/, accessed 8 June 2015; Owens, "Narrating Little Stories about the Portuguese in the Making of World History," in *Oceans Connect: Reflections on Water Worlds across Time and Space*, ed. Rila Mukherjee (New Delhi: Primus Books, 2013), 101-120 (chapter 6).

that information technologies be used to employ historical information. In this paper, we discuss the incorporation of geographic information systems (GIS) into historical placename research based on the Iberian Peninsula. Real-world geographic coordinates, such as longitude and latitude, are assigned in GIS to each location on a map. Ian Gregory and Richard Healey point out that beyond the ability of GIS to map geographical features, it is a database that stores and allows queries on both *spatial data*, which is data based on a location, and *attribute data*, or descriptive data assigned to an object such as a person. This database is also useful as a platform for spatial, statistical, and cartographic analysis. They explain other advantages of GIS in historical studies, such as the capacity to combine by spatial location sources of historical information that vary widely in format and purpose.[17] Narrative stories, records of monastic institutions and devotional sites, and tabular population data are some examples of these varying data sources.[18] While GIS has played a prominent role in geographic research for decades, historians are only slowly embracing this technologically based tool in their scholarship. In their explanation of the role of GIS in historical research, Gregory and Ell warn that some risks exist in combining history and historical geography with GIS because GIS originated in scientific disciplines that have focused on quantitative approaches to scholarship. Historical geographers, they argue, have rightly avoided too great an emphasis on quantitative methodologies.[19] Historians and historical geographers can benefit from using GIS, however, if they focus on answering the question, "what are the geographical aspects of my research question?" Methods exist for using GIS appropriately in historical studies.[20] Authors such as Gregory, Healey, and Paul Ell provide guidance on these methods.[21]

To undertake such work, one must use a gazetteer. A gazetteer's basic elements are a placename and a geographic location for that placename. Figure 1 provides an example of a 1906 atlas and gazetteer.[22] Road maps and atlases

[17] Ian N. Gregory and Richard G. Healey, "Historical GIS: Structuring, Mapping and Analysing Geographies of the Past," *Progress in Human Geography* 31, 5 (2007): 638.
[18] On the vast possibilities for such "unified georeferencing," see Hill, *op. cit.*
[19] Idaho State University's Geographically-Integrated History Lab does a great deal of qualitative research. For example, see Owens, "Dynamic Complexity," *op. cit.*
[20] Gregory and Healey, 1-2. J. B. Owens, "Historical Studies, GIS for," in *Encyclopedia of Geographic Information Science*, ed. Karen Kemp (Thousand Oaks, California: Sage, 2008), 220-221.
[21] Also see, Ian N. Gregory and Paul S. Ell, *Historical GIS: Technologies, Methodologies, and Scholarship* (Cambridge, UK: Cambridge University Press, 2007); *Toward Spatial Humanities: Historical GIS and Spatial History*, ed. Ian N. Gregory and Alistair Geddes (Bloomington, IN: Indiana University Press, 2014).
[22] George F. Cram, *Cram's Quick Reference Atlas and Gazetteer of the World. Containing 105 Newly Engraved Maps and Over 40,000 Index Entries with the Latest Area and Census Statistics*, ed. Eugene Murray-Aaron (New York: George F. Cram, 1906), 10, Figure 1.

commonly use this format; one looks up in the gazetteer of the atlas a place he or she wants to visit, and the gazetteer provides a map page, column, and row, allowing the map user to locate quickly the placename and all of the spatial elements surrounding it, on that map page.

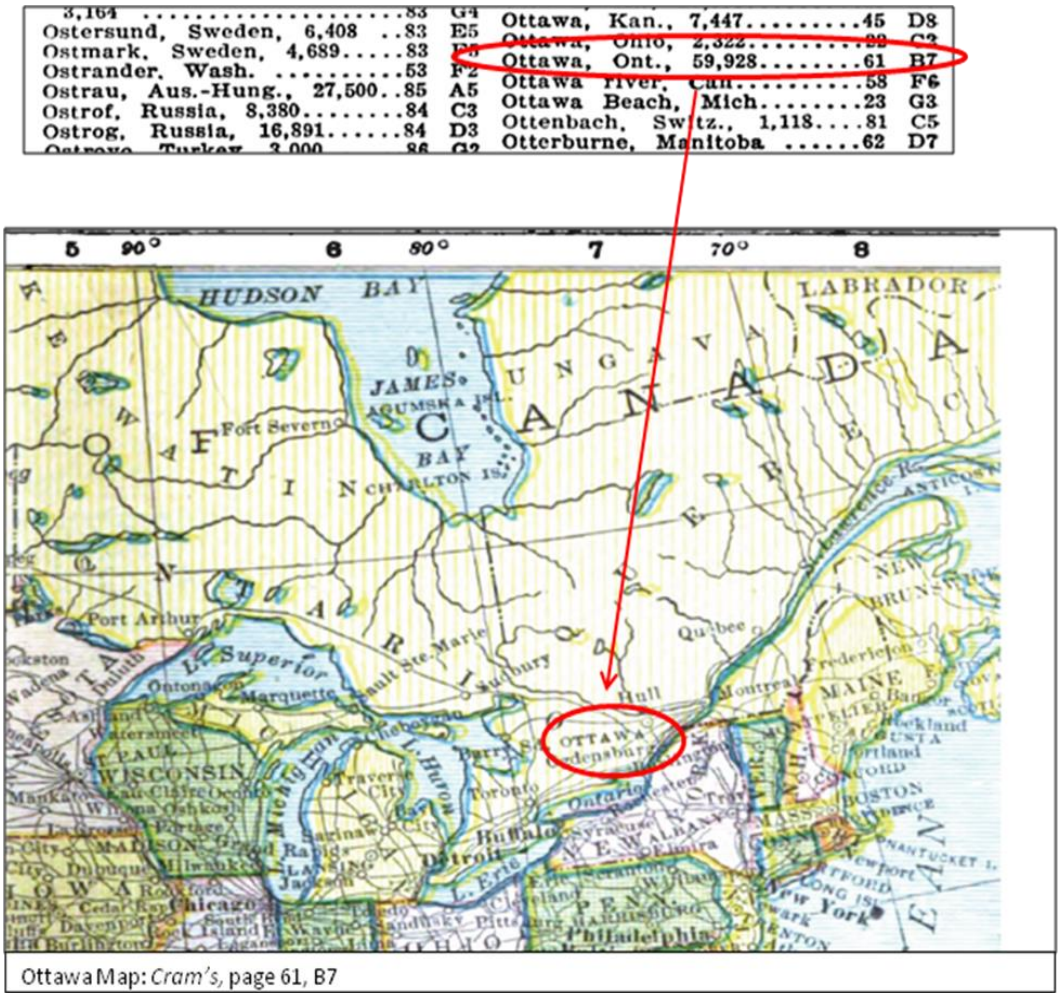

Figure 1. Gazetteer and corresponding map. From 1906 atlas.

Our gazetteer project applies the standards of gazetteer design from several prominent sources. The common core elements in most authorities' gazetteer standards are: *geographic coordinates* (or footprint), *placename*, *date* (time stamp), *feature type*, and *data source note*. Other common elements, which vary in coverage across our sources, are: *nearby place*, and *part of* (political hierarchy). The Alexandria Digital Library (or ADL), which is no longer funded, provides perhaps the most ambitious gazetteer content standard, and researchers

widely treat it as the model to be followed.[23] The China Historical GIS (CHGIS) project generally adopted the ADL best practices.[24] Merrick Lex Berman explains how the temporal element could clarify placename changes over long periods when there are lots of variants. He notes that the major challenge of placename gazetteers is to disambiguate the historic and modern name variants to their locations, so that only one name can be the output of a query about a placename. In essence, one must eliminate the problem of identifying one place with several different names. Placenames, Berman argues, can be distinguished from their variants easily through the use of time values, or time stamps, for each placename variant. Another difficulty presents itself when a placename exists during a number of time periods but the name does not always represent the same geographic location.[25] Essentially, one needs to resolve the problem of finding the same name attached to multiple places. Clearly, those creating gazetteers of high quality require the collaboration of historians experienced in dealing with the sources of the various time periods covered by the gazetteer.[26]

All activity was increasing dramatically in the sixteenth century. The economy was growing; it was a period of religious renewal; and political and cultural institutions expanded their activities. As a result, the peninsula's roads carried increased numbers of travelers. The peninsula is one of the most mountainous regions in Western Europe. Some roads were poorly marked, while others were crossed by well-worn paths, such as the sheep-walks (*cañadas*) employed by transhumant herders. In many areas, herders of the *estantes* (more localized sheep herds) created their own trails to get to and from pasture resources. Anyone who has hiked through unfamiliar mountains knows how easily one becomes disoriented, but now, you use maps, a pocket compass, and a GPS (global positioning system) device to make decisions when faced with a choice of trails. Villagers would not know about distant places, but they could indicate the directions to nearby villages and towns. But were these necessarily the best places through which to pass to get to a distant destination?

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[23] http://legacy.alexandria.ucsb.edu/gazetteer/ContentStandard/version3.2/GCS3.2-guide.htm, accessed 8 June 2015.

[24] http://www.fas.harvard.edu/~chgis/; Merrick Lex Berman, "Places in the Past: What's in a Name?" (presented at PACSL GeoHistory Network Conference, Philadelphia, PA, December 2005), http://www.fas.harvard.edu/~chgis/, accessed 8 June 2015.

[25] Merrick Lex Berman, "Georeferencing Historical Placenames and Tracking Changes over Time" (paper presented at the Georeferencing Workshop, Harvard University, Cambridge, Massachusetts, 21 March 2008), http://www.fas.harvard.edu/~chgis/, accessed 8 June 2015; Berman, "Temporal Referencing for Historical Gazetteers" (presented at AAG Annual Meeting, Washington, DC, April 2010), accessed 8 June 2015.

[26] Humphrey Southall, Ruth Mostern and Merrick Lex Berman, "On Historical Gazetteers," *International Journal of Humanities and Arts Computing* 5, 2 (2011): 127-145.

Clearly, the travelers had information needs, which presented an opportunity for an innovative businessman. To meet this perceived demand and with funding from publisher Juan de Espinosa, printer Pedro de Castro of the commercial center of Medina del Campo brought out Juan Pedro Villuga's *Reportorio de todos los caminos de España* in 1546.[27] Villuga created a guide to both commercial and pilgrimage routes. In the absence of a country known by the name, Villuga's *España* stood for the entire Iberian Peninsula, and therefore, we wish to stress, particularly for readers of this journal, that the guide serves as a source for information about the historic road infrastructure of modern Portugal and Spain. However, for some of our work with this resource, we made use of Castilian sources of types that we did not have for the domains of the Crowns of Aragón or Portugal.

As a product of Idaho State University's Geographically-Integrated History Laboratory, with Robert Hibberd as the lead researcher, we have created a digital historic gazetteer or placename list, and we have linked the historic names to the more modern ones.[28] We based this work on Villuga's *Reportorio*. Although sixteenth-century cosmographers and mathematicians had begun defining the coordinate and projection systems we associate with modern cartography, cartographers were not yet using these concepts and tools to deal with the task Villuga set for himself. Therefore, instead of providing those who purchased his book with some sort of highway map or map collection, he outlines for travelers 139 routes, defined by major beginning and ending places, by listing the possible stopping places along each route. Sometimes, these places were cities and towns, which have had a continuous history up to our time and which can, therefore, be located on modern maps and in modern gazetteers, even though urban growth will have displaced their geographic centroids from those of Villuga's time. However, Villuga often lists roadside inns, which can only be located by some technical detective work if the name has not stuck to a populated place. Villuga aides both the traveler and the detective work by providing an estimate of the distance between any two places, expressed in *leguas* or leagues. Because unlike the modern metric measurement, the kilometer, the league possessed no standard length, varying by both distance and time of travel, Hibberd contributes to research requiring knowledge about the duration of

[27] The Hispanic Society of America reprinted the book in facsimile at the De Vinne Press in 1902 as number 69 from the library of Arthur M. Huntington, and the Kraus Reprint Corporation of New York reprinted this edition in 1967 with the Society's permission.

[28] The U.S. National Science Foundation (NSF) funded this work through a grant awarded to Owens (Award Number SES-0740345; $394,000; 2007-2010) for the project entitled "Dynamic Complexity of Self-Organizing Cooperation-Based Commercial Networks in the First Global Age" (acronym: DynCoopNet). This project forms part of the European Science Foundation's EUROCORES (European Collaborative Research) Scheme program "The Evolution of Cooperation and Trading" (TECT).

journeys to move information and goods by exposing the regional variations in the way that this concept of distance was employed by Villuga and his sources of information (see below). Unfortunately, Villuga provides no information about his sources. Nor does he explain why he offers no description of some important roads used by merchants, carters, and other travelers of the period. When Villuga's roads are mapped on the basis of our gazetteer, the "information holes" appear quite clearly (see Figure 4), and sometimes these blank areas, such as that to the west of Zamora, supported a good bit of commercial interaction.[29]

Figure 2 shows a page from Villuga's guidebook. It presents the beginning of the route from Cuenca to Burgos. In the column on the left are the places through which a traveler would pass. These places are mostly municipalities. However, for those routes that spanned spaces with great distances between towns –on the Granada to Cuenca route, for example— Villuga lists a large number of "ventas", inns where travelers could stay and obtain supplies.

In the column on the right, Villuga provides the distances between the places, expressed in *leguas* or leagues. Throughout the First Global Age, no standardized version of the legua took hold in the Iberian Peninsula. The early nineteenth-century Spanish royal order on the subject clarifies why. As part of an ordinance about weights and measures of 26 January 1801, the Crown ordered that:

> Para que la legua corresponda próximamente á lo que en toda España se ha llamado y llama legua, *que es el camino que regularmente se anda en una hora* [emphasis added], será dicha legua de veinte mil pies, la que se usará en todos los casos en que se trate de ella, sea en caminos reales, en los Tribunales, y fuera de ellos.[30]

[29] The routes of this area are suggested by Amândio Jorge Morais Barros, "As redes comerciais portuenses em Castela durante o século XVI," in *Actas Coloquio Internacional "Patrimonio Cultural y Territorio en el Valle del Duero"* (Junta de Castilla y León, Consejería de Cultura y Turismo, 2010), 309-322.

[30] *Coleccion de pragmáticas, cedulas, provisiones, autos acordados, y otras providencias generales expedidas por el Consejo Real en el reynado del señor don Carlos IV* ... Tomo III (Madrid: Josef del Collado, 1805), 31.

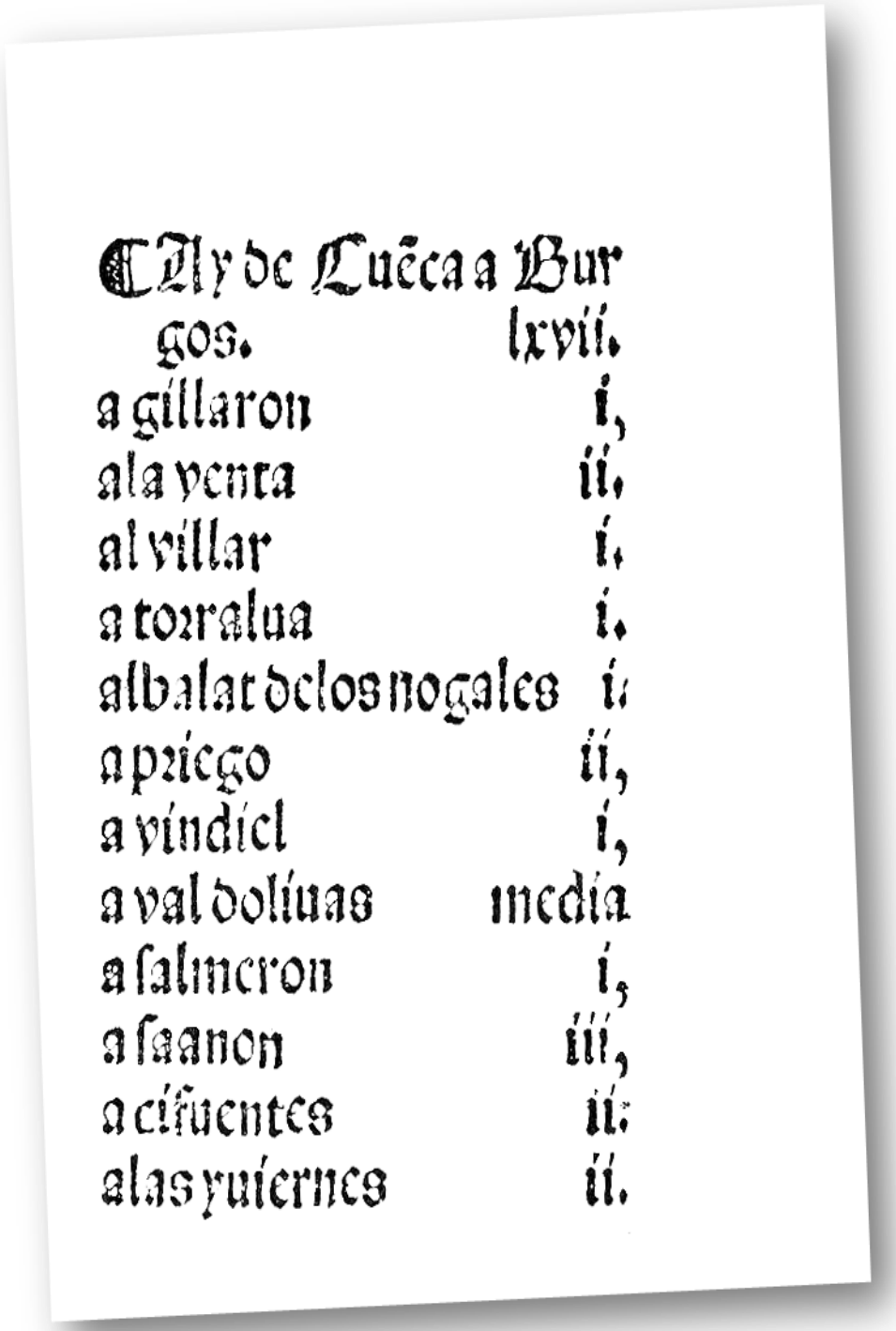

Figure 2. Facsimile of a page of Villuga's record: beginning of a route.

In other words, a local understanding of the *legua* would depend heavily on the ease or difficulty of travel over a particular stretch of road, causing its length to vary on the basis of topography. Even in 1801, the royal authorities had to concentrate on the royal roads (*caminos reales*) and the major law courts (*los Tribunales*). In the mid-nineteenth century, only nine *carreteras generals* existed, and work on some of them had not been completed.[31] Madoz acknowledges in a number of ways that the norm had not been followed away from these main highways. Even in some short chapters, Madoz's local collaborators mix *leguas* with *horas* (or *horas del camino*).[32] Madoz provides a useful table of the distances from Madrid to the provincial capitals and between the provincial capitals. He stresses that he is applying the 20,000 *pies* standard of the *caminos reales*, but rather than calculate the linear distance between these places, he bases his calculations on the roads that were generally employed by those making these journeys –in other words, usually the routes given by Villuga three centuries before. Except for places that were so near to each other that variations were not obvious, the figures in Madoz's table are frequently larger than those given by Villuga. Thus, in order to compare nineteenth-century local understandings of the *legua* with the figures given by Villuga, one would have to go through Madoz's sixteen volumes, chapter by chapter, to extract the distances given for each road segment. We did not undertake this tedious task, but we want to provide researchers with a note of caution when they try to calculate Iberian distances on the *leguas* given in contemporary documents.

The league provided sixteenth-century European travelers with a general, imprecise distance measurement, which varied in length across the Iberian Peninsula. Villuga uses the league as his measurement unit, with vague and variable lengths throughout his record. In some places, based on GIS analysis, the league equals approximately (never exactly) 4.2 kilometers; in others, it approximately equals 5.6, and several other lengths for the league emerge from this study. Our efforts to match all historic placenames from Villuga's record to their modern variants brought about the discovery of a number of missing historical placenames. Finding these missing places required more understanding of the league's usage in the Iberian Peninsula. Ranges of kilometers-per-league distance, derived from a cartographic classification analysis, fit the data better than one single measurement. In other words, a range of distances (e.g., 0 – 5.6 kilometers per league) fit Villuga's data better than one single measurement, such as 5.6 kilometers per league. An analysis using spatial autocorrelation determined where ranges of league distances fit best, and described the spatial patterns of the measurement length of the league. Spatial autocorrelation analysis tools in GIS can identify spatial patterns, such as those found within the distance data in

[31] Madoz, *op. cit.*, tomo X, 554-555.
[32] *Ibid.*, tomo III (1846), 329, "Balsa" [de Ves]; tomo VI (1847), 48, "Casa de Ves."

Villuga's guide. Spatial autocorrelation determines to what degree spatial features, locations on a map, demonstrate similarity in attributes as a function of their spatial proximity to each other. The results of a spatial autocorrelation analysis aides researchers in deciding which of the distance ranges pertains to a particular missing placename from Villuga's record. This information provides a helpful tool in locating the missing placenames, by supplying minimum and maximum distances for each placename from the other placenames in its route(s), thus narrowing down their possible locations on the map.

Peter Enggass raised the issue of the extreme variability of the measurement of the league in Spanish history. He stated that nearly half of the Iberian Peninsula's regions had unique measurements for the league prior to Spain's implementation of the metric system. Obviously, Villuga's guide does not provide information about this variability, probably because he did not have it. The lack of standardization of units of measurement created imprecision of measurement. Standardization became law and practice only after Spain adopted the metric system in the late nineteenth century.[33] Researchers can use Iberia's extreme topographical variability as a template for the variation of the measurement of the league. People in less-populated areas used a good deal of guesswork in the league's measurement (due to topographical extremes), and they used several measurements for the league.[34] We present the application of GIS and statistical analysis tools to produce a solution to the difficulties in measuring the league.

As an illustration of the variability, we present a comparison of leagues in two traveler's routes. Gaspar Barreiros was Portuguese, a "man of the church, erudite, and a writer of classical skill" who was born in Viseu and died in 1574. He became a priest and journeyed to Rome to honor the Pope on behalf of the cardinal don Enrique.[35] On his way to Rome in 1542, Barreiros described the journey from Badajoz to Milan, Italy. His record presents no description of his mode of travel. Barreiros's journey took him from the far western edge of Castile to the far north-eastern corner of Catalonia. His record, which includes each stopping place and the distance between them in leagues, provides a good comparison with the record of Juan Pedro Villuga. Analysis of a section of the journey common to both records permits a comparison of the league as recorded by these two travelers. The analysis considers each stopping place in both records, as well as the placenames each author recorded. This comparison provides greater

[33] Peter M. Enggass, "The Spanish League: A Geographical Conspiracy," *Journal of Geography* 70 (1971): 407.
[34] *Ibid*., 410.
[35] Gaspar Barreiros, "Viajes," in *Viajes de extranjeros por España y Portugal: desde los tiempos más remotos hasta comienzos del siglo XX*, ed. J. García Mercadal, Vols. 1-3 (Valladolid: Junta de Castilla y León, 1999), 117.

context for the league measurements and placename conventions of both records by determining the degree of similarity between the sources.

Figure 3 presents a comparison of a portion of Barreiros's journey, with corresponding parts of two of Villuga's routes. One place, Alcalá de Henares, falls at the *zero distance,* because it sits at the beginning point of the portion of Barreiros's journey that overlaps with Villuga's route for the area.

Gaspar Barreiro, 1542		Juan Villuga, 1546		Barreiros, Column 2		Villuga, Column 2	
PlaceName	League	PlaceName	League	PlaceName	League	PlaceName	League
Alcalá de Henares	*Zero Dist.*	alcala de henares	*Zero Dist.*	la venta de Peñalva	2		
Guadalajara	4	guadalajara	2	Fraga	2	fraga	3
Tórtola	2	Tortola	2.5	Alcaraz	2	alcaraz	2
Torre	3.5			Lérida	1	lerida	1
Hita	1.5	Hita	1	Belloc	1	beloch	1
Padilla	1	Padilla	1	Cidamón	0.5		
La Casa	0.5	la casa	1	Mollerusa	0.5	molarusa	1
Miralrío	0.5	Miralrio	1	Golmes	0.5		
Bujalaro	1	Burjlaro	1	Bellpuig	2	el puyg	2
		los molinos	2	La Grassa	1.5		
		Vaydes	1	Tárrega	0.5	tarraga	1
Sigüenza	4	Ciguença	2	Talhadel	0.5		
Hijosa	2			Cervera	1	cervera	1
Torralba	1					los mesoncillos	2
Fuencaliente	1	Fuencaliente	3	Ostaletes	1		
Nodales	1			Momeneo	1	mon maneu	1
Arcos	2			Porcarizes to Igualada	2	porcarises	1
Mirabueno	0.5					golada	2
Huerta	1					la puebla	1
		Arcos	2			piera	1
Monreal	1	Monreal	2			masquesa	2
Ariza	1	Ariza	1	Collbató	1		
Contamina	1			Esparreguera	1		

Figure 3. Journeys of Barreiros and Villuga compared.

Gaspar Barreiro, 1542		Juan Villuga, 1546		Barreiros, Column 2		Villuga, Column 2	
PlaceName	League	PlaceName	League	PlaceName	League	PlaceName	League
		medina celi	1	Nuestra Señora de Montserrat	2		
		Luna	1	Martorell	1	martorel	1
Alhama	0.5	Lama	1	San Andrés	0.5		
Bubierca	1.5	Vbierca	1	Molins de Rey	1	molin derreche	2
		Tequa	1			el espital	1
		Terrer	1	Barcelona	2	barcelona	1
Calatayud	4	Calatayud	1	Moncada	2	moncada	2
la venta de San Esteban	2			La Roca	2	larroca	2
Frasno	0.5	el fresno	5	Linás	1.5	linas	1.5
La Almunia	2.5	Almunia	3	San Celoní	2	sancelonij	2
casa de los Romeros	2.5			Astarlid (Hostalrich)	2	astarlid	2
La Muela		la Muela	5	Gerona	5	girona	5
Zaragoza	4	Çaragoça	3	Madinham	1		
Puebla (de Alfindén)	2	la puebla	2	Vascara	2	bascara	3
Alfajárin	1	a fajari	1	Figueras	2	figueras	2
Osera	1	Hosfera	3	el puente de los Molinos	2.5		
la venta de Santa Lucía	3	la venta de santa lucia	3	La Junquera	1.5	xunqueras	3
Bujaraloz	3	Burjalalos	3	Perthus	1	el pertus	1
Candasnos	3	Candasnos	3	Total Leagues:	112	Total Leagues:	111

Figure 3 (continued). Journeys of Barreiros and Villuga compared.

This table demonstrates many of the issues with using the league as a measurement of distance. First, these travelers recorded many distances between sets of two places that did not correspond to each other. For example, while Villuga lists *Guadalajara* at 2 leagues from *Alcalá de Henares*, Barreiros records it as 4 leagues. Second, the routes each traveler took do not correspond exactly to each other. Only Villuga records the placename *los mesoncillos*; for the route segment from Bubierca to Calatayud, Barreiros does not note *tequa* and *terrer*, which Villuga includes as part of the route. Third, the placenames in one record in several instances do not match their counterparts in the other record. Villuga's

placename *el puyg*, without its geographic location, does not clearly represent the same place as Barreiros's *Bellpuig.* The context of the route suggests that these places do correspond to each other, but taken outside of that context, the traveler can easily consider these two placenames as separate locations on the route. Finally, these sources have recorded some of these placenames in more than one language: *molarusa*, which may be the *Castellano* version of the placename that likely becomes *Mollerussa* in *Valenciano.*

Historians interested in using our work as the infrastructure of their own research must look carefully at the page from Villuga (figure 2). Often the placenames cause much more trouble than the distances. Because of the large number of places involved, we struggled more with the Spanish placenames than with the Portuguese. Because few placenames changed after Spain's territorial reorganization of 1834, we used the published decree as a guide.[36] In the resulting database, we give both the historic name in Villuga –who sometimes used variant names for the same place— and the nineteenth-century name. Most researchers will use some sort of relational database management system (e.g. Microsoft *ACCESS*), and this program demands that every aspect of the spelling of a place name be identical. If a word begins with a capital letter, the program will only establish a match with another word that begins with a capital letter and is otherwise spelled in the same way.[37]

On the basis of this work, we have created a placename gazetteer that provides the modern name, the historic name or names, and the longitude and latitude of the place. The research presented here focuses upon Spain's territorial reorganization in 1834 and the changes to placenames throughout the territory of the Crown of Castile during the First Global Age, 1400-1800. Using a GIS-based visualization and available data management strategies, we compared and linked modern placenames with their sixteenth-century ancestors while searching for regional and temporal patterns of placenames and the possible reasons behind individual placename changes. Figure 4 provides a map of the modern locations of Villuga's placenames and routes.

[36] Instituto Nacional de Administración Pública. *Subdivisión en Partidos Judiciales de la Nueva Subdivisión Territorial de la Península e Islas Adyacentes, 1834*. (Madrid: Instituto Nacional de Administración Pública, 2000).

[37] These rigid relational database systems will be replaced by a new database management system that is becoming available to ease the use of GIS for historical research. See Vitit Kantabutra, J. B. Owens, and Ana Crespo Solana, "Intentionally-Linked Entities: A Better Database System for Representing Dynamic Social Networks, Narrative Geographic Information, and General Abstractions of Reality," in *Spatio-temporal Narratives: HGIS and the Study of Trading Networks (1500 – 1800)*, ed. Ana Crespo Solana (Newcastle upon Tyne, UK: Cambridge Scholars Publishing, 2014), 56-78.

Figure 4. Map of modern locations of Villuga's placenames and routes.

For those who may wish to use the data to support their own research, this article offers a brief discussion of how the gazetteer was created from the information supplied by Villuga. This gazetteer may be downloaded without charge.[38] The development of the Villuga Gazetteer made use of the best practices among leaders in the gazetteer design field, such as Linda Hill's work on the

[38] Go to http://www.geographicallyintegratedhistory.com/ or http://www.isu.edu/history/HibberdGazetteer.shtml.

Alexandria Digital Library Gazetteer Content Standard.[39] The incorporation of such best practices helped us overcome design problems in the formation of our gazetteer of Villuga's record. Therefore, the remainder of this article will focus on linking Villuga's placenames, which were written in Castilian, no doubt due to the book's publication in a major Castilian commercial and printing center, to modern Spanish names. The Spanish territorial reorganization of 1834 largely standardized these names, at least for the cities, towns, and villages mentioned by Villuga. However, Spain's 1978 constitution allowed autonomous regions to be established, and some of these mandated that placenames now be expressed in regional languages, such as Valencian, in maps and their associated gazetteers, thus complicating our efforts to associate Villuga's placenames with their modern equivalents. Figure 5 gives a sample comparison of Villuga's historic placenames and their modern counterparts.

	HISTORIC_NAME		MODERN_NAME
	Alicante		Alicante
	monforte		Monforte del Cid
	aldea		Elda
	bilena		Villena
	yecla		Yecla
	la venta juangil		
	montalegre		Montealegre del Castillo
	guaça		La Higuera
	xetrula		Pétrola
	chínchilla		Chinchilla de Monte Aragón
	albacete		Albacete
	la gíneta		La Gineta
	la roda		La Roda
	la mínaya		Minaya

Figure 5. Comparison of historic and modern placenames.

The Villuga Gazetteer, a spatially referenced database based on the modern variants of placenames found in Villuga's 1546 traveler's handbook, provides a framework for a GIS that allows the user to query by each route listed in the historical record. Queries can include modern and historical names for each locality, which are contextualized into each of the routes described in 1546. The

[39] Linda L. Hill and Qi Zheng, "Indirect Geospatial Referencing through Place Names in the Digital Library: Alexandria Digital Library Experience with Developing and Implementing Gazetteers," in *Proceedings of the ASIS Annual Meeting*, v36 p57-69, 1999, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.39.5867&rep=rep1&type=pdf, accessed 8 June 2015.

beginning and ending termini of the historic Iberian routes are still mostly well-known and populated locations, such as Madrid, Barcelona, and Sevilla. These well-known termini provide a good starting point in the identification of the remaining placenames, particularly with the general distances in leagues given in Villuga's record. Modern road atlases provide most of the modern placenames. Google Earth provides a search tool for finding placenames not located in the modern road atlas. Figure 6 provides a graphic of the Villuga Gazetteer database. This ACCESS database contains a table for a gazetteer, a related table that lists all of the routes' starting and ending termini, and a lookup table (essentially a unique identifier for each location) which combines these data to allow the user to query the route or routes of each placename, and also to query which placenames were found in each route.

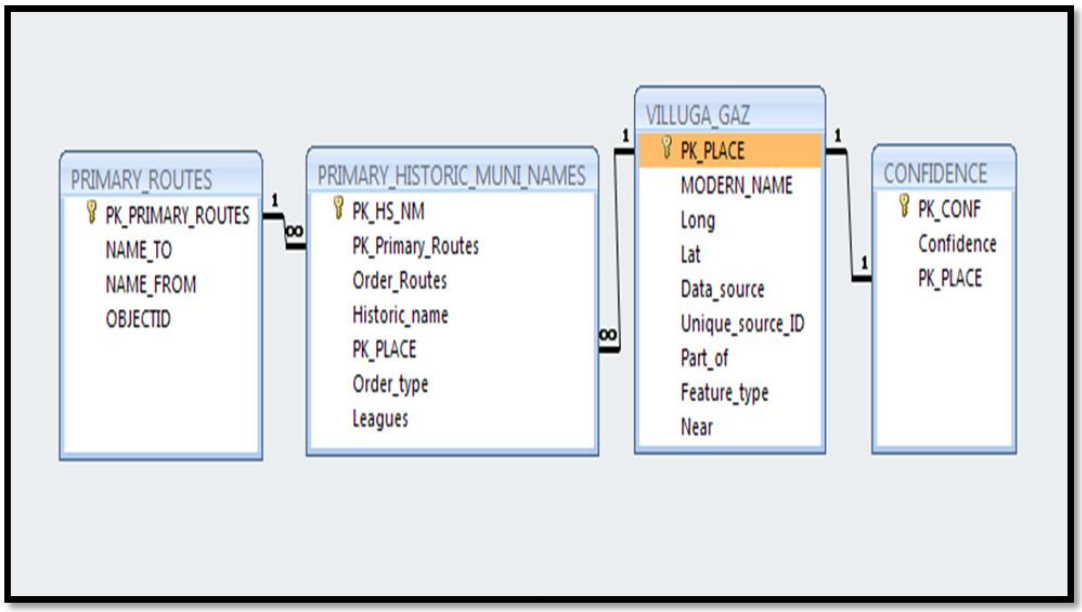

Figure 6. Villuga Gazetteer database structure.

The design of the Villuga Gazetteer includes these crucial elements: a 'primary key' field, to aid in its use in a relational database structure; a 'modern name' for each location; 'longitude' and 'latitude' fields, which provide modern coordinates (the database does not consider the changes in centroids over time); a 'data source' field, which identifies from which source the coordinates came; a field for a 'unique source ID' which is provided by the source of the coordinates; a 'part of' field to denote to which political boundary (administrative unit) the placename belongs in the present day; a 'feature type' field to provide identification to external users; and a 'near' field to provide information on a

nearby placename location. The confidence table lists confidence levels for each modern variant of Villuga's placenames in the gazetteer (see figure 7 for a cartographic visualization of the table's contents).

Figure 7. Map of confidence levels.

Confidence levels vary in range from 1 to 4; 1 is high confidence and 4 is little confidence. Each name in the Villuga database is assigned a confidence level based upon three criteria: 1) the level of accuracy, derived by hand, between the actual distance of a placename to the next placename, and the distance in leagues

provided by Villuga between these two placenames; 2) the degree to which the modern variant names match the historic variants in Villuga's record; 3) province assignment and nearby placenames are also considered in the confidence level. Confidence levels aid the user in determining the merit of the data available from this study. Confidence levels for most places fall between 1 and 2, for which we are grateful.

To create a greater density of sixteenth-century placenames with which to compare the 1834 reorganization names, we compiled additional placenames across several time frames in Cuenca and Toledo provinces from the *Relaciones topográficas* and other placename sources for these provinces.[40] We have already seen a sample comparison of historic and modern variants of Villuga's placenames (figure 5). Examples of places with several variants within Villuga's record, identified by their locations as representing the same place on the ground, demonstrate the lack of placename standardization in the sixteenth century.

Brian Tomaszewski provides a discussion of the process of placename matching in his Master's thesis on Aztec political geography. The Villuga Gazetteer is based on a trial-and-error method of matching placenames, which contrasts with Tomaszewski's automated approach to the process of populating a gazetteer.[41]

We matched Villuga's placenames by hand over hours of searching a modern road atlas and querying Google Earth for possible variant spellings not found in the official atlas. Then, queries of the online gazetteers by modern placenames determined which variants sufficiently matched the historic placenames. Because of problems he identified during his research, Hibberd found that in addition to time-stamping the data, as Berman recommends, nesting a placename within a province and relating it to a nearby placename were critical steps toward achieving a high-confidence validation of the geographic coordinates of a placename. This method removes ambiguities that occur, for example, when a given placename in one province is similar to that of another location in a different province. With such ambiguities reduced or eliminated, a gazetteer-user can search for places on large or small scales. To assure a unique name, the

[40] C. Viñas and R. Paz, *Relaciónes Histórico-Geografico-Estadísticas de los pueblos de España hechas por iniciativa de Felipe II: Reino de Toledo*, 3 vols. (Madrid: Instituto Balmes, de Sociología; Instituto Juan Sebastián Elcano, de Geografía; Consejo Superior de Investigaciones Científicas, 1963); Eusebio-Julián Zarco-Bacas y Cuevas, *Relaciones de Pueblos del Obispado de Cuenca* (Cuenca, Spain: Excma. Diputación Provincial de Cuenca, 1983). We were also able to check place names against the lists in *Censo de Castilla de 1591: Vecindarios*, ed. Annie Molinié-Bertrand (Madrid, Spain: Instituto Nacional de Estadística, 1984). See figure 9.

[41] Brian Tomaszewski, "The Reconstruction of Aztec Political Geography in the Toluca Valley of Mexico," MA Thesis (State University of New York, University Center at Buffalo, 2005), 33; Tomaszewski, "Reconstructing Aztec Political Geographies," *ArcUser* 9 (2006): 24.

Villuga Gazetteer documented each one in the context of province and a nearby placename.

Creating a greater density of placenames required further sources of names to compare to Villuga's record. The 1575 *relaciones topográficas* for the Toledo and Cuenca regions both revealed centuries-long temporal changes of selected names in Villuga's record. The 1834 reorganization decree also provided placenames from the early constitutional period to match to the modern variants of Villuga's placenames. The table of these name variants (figure 8) shows them by their source, one in each column. This table provides each source. Through database SQL [Structured Query Language] queries, a gazetteer-user can obtain a list of the placenames from one location across several time periods. Some placename values are empty, possibly due to changes in administrative boundaries over the time span between the placename sources. Some replicate earlier name variants, but many underwent changes over time, some more dramatic than others. Villuga's historic names are georeferenced by their relationship to the Villuga Gazetteer, which holds the modern variants of the historic names in their modern provincial context, with a unique identifier as the connecting key between each table.

VillugaCuencaNames	NamesCuencaRelaciones	HistNames1834	Modern_name
Alarcon	Alarcón Alarcon	Alarcón	
valadiego	null	Albaladalejo del Cuende	Albaladejo del Cuende
almodovar	Almodóvar	Almodovar del Pinar	Almodóvar del Pinar
alcaçar de huete	Alcázar del Rey	Alcazar del Rey	Alcázar del Rey
arcuaz; arquas	null	Arcas	Arcas
alguisuellas	null	Arguisuelas	Arguisuelas
barchi; barchin	Barchín del Hoyo	Barchin del Hoyo	Barchín del Hoyo
vilinchon; valenchon	Belinchón	Belinchon	Belinchón
buenache	Buenache	Buenache de Alarcon	Buenache de Alarcón
Campillo	null	Campillo de Altobuey	Campillo de Altobuey
cardenete	null	Cardenete	Cardenete
carraschosa d huete	null	Carrascosa del Campo	Carrascosa del Campo
el Castillo	Castillo de Garcimuñoz	Castillo de Garcimuñoz	Castillo de Garcimuñoz
Cervera	null	Cervera	Cervera del Llano
chillaron; chilaron; gillaron	null	Chillaron de Cuenca	Chillarón de Cuenca
Cuenca	Cuenca	Cuenca	Cuenca
alcañavale; cañavete	El Cañavate	El Cañavate	El Cañavate
el histo; el hito	null	El Hito	El Hito
el pedernoso	El Pedernoso	El Pedernoso	El Pedernoso
el provencio	El Provencio	El Provencio	El Provencio
Fuentes	null	Fuentes	Fuentes
agua valdon; guavaldon	Gabaldón	Gabaldon	Gabaldón

Figure 8. Density of place-names across time for the Bishopric of Cuenca.

Many placenames show little temporal variation, such as Alarcón. Albaladejo del Cuende and Almodóvar del Pinar have significant toponimical changes, but they are still recognizable as variants of their historic placenames

when both are georeferenced. Belinchón and Arcas both exhibit minor variations between the modern and 1546 variants, which are not a major stumbling block when evaluating placename matches by hand, but which are a problem for exact searches in databases and online gazetteer server clients. Although shifting administrative boundaries influence the temporally dynamic administrative hierarchy of a placename, making that placename hard to identify by changing its context, GIS provides a solution to this ambiguity by providing a necessary unique spatial identifier for the place, to which the multiple placename variants are assigned. This use of GIS provides a unique identifier for the placenames in the form of a spatial footprint.

In the 1834 reorganization, Spanish names changed significantly. Figure 8 shows several cases of such changes. For example, alcaçar de huete became Alcázar del Rey. The inhabitants used this name as early as the 1575 *Relaciones topográficas* survey of Cuenca. One reason nineteenth-century administrators may have decided upon the latter form of the name was to conform to a more recent change made by the people of the town. The reorganizers changed *Buenache de Alarcón* and *Almodovar del Pinar* by lengthening the names to produce something unique to all of Spain, thus standardizing the names. *Caraschossa d huete* became Carrascosa del Campo, probably to remove the former administrative relationship to Huete from its name.

GIS facilitated analysis of the placenames of Villuga's record and their variants across time and in various historical sources. More complicated studies will benefit from integrating the common elements of the gazetteer standards we have discussed, such as time stamps. GIS offers the power to combine multiple gazetteer sources through the context of space by comparing the geographic coordinates of similar placenames. The use of multiple historical sources for placenames allowed us to recognize the best, most common historic variant of a given placename. While the efforts of the nineteenth-century Spanish leaders to standardize their country's placenames had an important impact on those names, their contemporary variants exhibit the effects of Spain's cultural and political decentralization and linguistic variability.

Once historical research produces a placename gazetteer of sufficient quality to provide a basis for using geographic information systems (GIS) for the investigation of historical questions at varying scales, a researcher can employ the results in other types of projects.[42] For example, one can explore the complicated organization of human habitation with multiple urban centers and the degree to

[42] Building such a world-historical gazetteer is one of the announced purposes of the Collaborative for Historical Information and Analysis (CHIA, http://www.chia.pitt.edu/, accessed 8 June 2015). As we were completing this article, Merrick Lex Berman and Bill Hayes announced their Temporal Gazetteer API for work with the China Historical GIS. It offers sophisticated means for gazetteer search that will enhance CHIA; see http://chgis.hmdc.harvard.edu/tgaz/.

which this polycentric place system survived in the face of the rise of Madrid as a dominant urban center in the century after Philip II named it as the location of his Household and Court in 1561, perhaps enriching work already done by others interested in this issue.[43] Various researchers connected with the EUROCORES project DYNCOOPNET use the Villuga Gazetteer as part of geographically-integrated studies of cooperation in world history.[44] Their work suggests that all important human activity was shaped in significant ways during the First Global Age, 1400-1800, by spatial relationships and the available network of communication and transportation routes. In order to grasp better the nature of reality during this period, historians will need to explore more thoroughly the impact of geographic space and the ways that places were connected to each other,[45] and to make possible this type of research on the Iberian Peninsula, the Villuga Gazetteer now exists as an essential tool.

[43] See David Ringrose, *Madrid and the Spanish Economy, 1560-1850* (Berkeley and Los Angeles: University of California Press, 1983), and the modifications to Ringrose's picture introduced by authors of various chapters in *El impacto de la Corte en Castilla: Madrid y su territorio en la época moderna*, ed. J. M. López García (Madrid, Spain: EUROCIT, 1998).

[44] On this project, see J. B. Owens, "What Kind of System Is It? The DynCoopNet Project as a Tribute to Andre Gunder Frank (1929-2005)," in *Networks in the First Global Age 1400-1800*, ed. Rila Mukherjee (New Delhi: Primus Books, 2011), 3-9.

[45] In order to grasp all of the ways that space is an important variable for historic understanding, see Diana S. Sinton, "Spatial Thinking," in *21st Century Geography: A Reference Handbook*, ed. J. Stoltman (Thousand Oaks, CA: SAGE Publications, 2011), 733-744.

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