Burgon's Expectation: Ancient and New Cartographic Visualization for Numismatic Data and Coin Finds

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ABSTRACT

Using Callegher's catalogue of ancient coin finds in the Trieste Province of NE Italy from the *Ritrovamenti monetali di età romana nel Friuli Venezia Giulia*, a spatial database of the findings (third century bce to sixth century ce) was created. The authors later developed a client side Web mapping application. All Free and Open Source Software tools were used to build both a spatial database (postgreSQL and PostGIS) and a Web mapping application (QGIS and Leaflet). The Web mapping application allows the user to find the territorial distribution of Celtic, Roman (Republican and Imperial), Byzantine, and Longobard coins. Each coin was georeferenced and linked to the denomination of the ancient coin, the authority that issued it, the coin mint, and the finding site. This project highlights not only the efficiency of the database methodology in managing numismatic data, but also the great potential of the geographic visualization process to reveal hidden relationships between the finding sites and the data connected with the ancient use of coins (e.g., ancient monetary areas, economic and commercial buffer zones, trade routes)

Keywords: coin finds, numismatic database, web mapping, client side, JavaScript, Thomas Burgon

RÉSUMÉ

À l'aide du catalogue de Callegher des découvertes de pièces de monnaie ancienne dans la province de Trieste, dans le nord-est de l'Italie, tiré de l'ouvrage *Ritrovamenti monetali di età romana nel Friuli Venezia Giulia*, une base de données spatiales à ces découvertes (troisième siècle av. J.-C. au sixième siècle apr. J.-C.) est créée. Les auteurs mettent au point par la suite une application cartographique Web côté client. Tous les outils logiciels libres et en source ouverte sont utilisés pour constituer une base de données spatiales (postgreSQL et PostGIS) et une application cartographique Web (QGIS et Leaflet). L'application cartographique Web permet à l'utilisateur de déterminer la distribution territoriale des pièces celtes, romaines (républicaines et impériales), byzantines et lombardes. Chaque pièce ancienne est géoréférencée et rattachée à sa valeur nominale, aux autorités qui l'ont émise, au lieu de la frappe et au site de la découverte. Ce projet met en lumière non seulement l'efficience méthodologique de la base de données dans la gestion de données numismatiques, mais également l'énorme potentiel du processus de visualisation géographique pour ce qui est de révéler les relations cachées entre les sites de découverte et les données liées à l'utilisation ancienne des pièces (notamment les zones monétaires anciennes, les zones tampons économiques et commerciales, et les routes commerciales).

Mots clés : base de données numismatiques, cartographie Web, côté client, découvertes de pièces, JavaScript, Thomas Burgon

Introduction

Relational databases have replaced numismatic paper catalogues and the World Wide Web has made it possible for researchers to access an impressive number of online coin catalogues and to perform queries of these relational databases. Working, for example, with the origin name of a registered coin, one is able to search the archival records rapidly and precisely within the database. This system of research, however, is not very suitable for tracing the distribution of coins[1] by type of finding, by epoch, authority, or denomination, either for vast territories (areal numismatics) or at specific archaeological excavation sites (stratigraphic numismatics).

With the acquisition of GIS methodology and WebGIS (Stefanini 2006; Wheatley and Gillings 2002; Hacıgüzeller 2012)[2], that is, tools helpful for supporting a spatial search of the digital archives, researchers are able to use areal and stratigraphic numismatics. In the attempt to establish a synergy between paper (Callegher 2010) and digital[3] numismatic databases with digital cartography, an interdisciplinary project, implemented by GISLab and NummusLab of the

Department of Humanities (University of Trieste/Italy), was set up. The results of the first project are presented here. They can be seen on a WebGIS by following this URL: http://disugis.units.it/ritrovamenti%20monetali%20epoca%20romana/index.html.

The territorial distribution of Celtic, Roman (republican and imperial), Byzantine, and Longobard coins in the province of Trieste can be found here; it is also possible to refine what emerges from the territorial dispersion by mint, denomination, and period. Each coin has been georeferenced precisely and linked to the following information (taken from the volume *Ritrovamenti monetali di età romana nel Friuli Venezia Giulia. Province di Gorizia e Trieste*, Callegher 2010):

- denomination of the ancient coin (for instance, "Sestertius," "Aureus," "Aes");
- authority that issued the coin (for instance, "Emperor Valentinianus II," "Theodosius I");
- mint that produced the coin (for instance, "Aquileia," "Costantinopolis," etc.);
- period in which the coin was minted (for instance, "Republican," "Imperial");
- area where the coin was found.

After a brief introduction to the historical connections between numismatic catalogues and maps, the current Web mapping reference frame is presented. Following this, the main features of the built relational database structure are presented, together with their connections to the WebGIS application. The functionalities of the Web mapping application are also shown, with particular attention paid to the available spatial queries. Some critical remarks conclude the article.

Ancient Cartography for Numismatics

Interaction and complementarity between territorial geography and numismatics can be traced back at least to the second half of the eighteenth century, when, having progressed beyond the phase of scholarly collecting, the search for rare specimens, and the creation of royal or imperial coin collections, studies were directed to establishing a link between coins and the places where they were struck and circulated (Giard 1995). Indeed, in that period, the "science des médailles" showed signs of persistent decline, becoming nothing more than a repetitive and sterile description of specimens, often lacking any critical–philological spirit, and merely tending toward the illustration of the coins in sumptuous volumes designed to celebrate the magnificence and authority of the collector or a collection (Foy-Vaillant 1700; Occo 1730; de France and others 1754, 1755).[4]

A change was brought about by the fact that many collectors belonged to the aristocracy or high-ranking civil service and were in close contact with travellers, or were travellers themselves. Visiting the ruins of the cities described by the classical geographers, they were able to expand their personal collections and to involve those who for various reasons were in a position to gather ancient coins. Joseph Pellerin (1684–1782) played a pioneering role in this effort (Kinns 1990).[5] In the course of his travels or by purchasing from collectors, travellers, and seafarers in the areas of the Turkish Empire or Aegean Sea, he put together perhaps the most notable collection of Greek coins of his time.[6] In arranging the enormous quantity of coins he possessed, he organized them by regions, cities, and authorities, disregarding any correspondence to modern geographical regions/names. This new "geographical" way of arranging the coins anticipated the major reorganization of the Greek and Roman coinage begun on a territorial basis and completed a few years later by the keeper of the Imperial Numismatic Cabinet of Vienna, Joseph Hilarius Eckhel (1737–98) (Nicolet-Pierre 1987; Demsbki, 2001), author of the monumental *Doctrina numorum veterum* (Eckhel 1792–98). Despite the new classification method being applied by a sedentary numismatist (the Viennese keeper was not a traveller), it quickly became established due to its intrinsic rationality, as Théodore Edme Mionnet (1770–1842) (Larousse 1963, 387) acknowledged a few years later in his introduction to *Description des médailles antiques* (Mionnet 1806–13).

> *J'ai suivi, pour la classification générale, la méthode établi par Pellerin, et perfectionnée par Eckhel, dans son bel Ouvrage intitulé:* Doctrina numorum veterum*; c'est à dire, que j'ai rangé sous un ordre géographique, toutes les Médailles des peuples, des Villes, des Colonies et des Rois, en commençant par les parties Occidentales de l'Europe, et en rapportant à chaque contrée ce qui lui appartient.*
> (Mionnet 1806–13, I, vi–vii)

Geography offered a necessary support for locating the places where the coins were struck or had circulated, leading Mionnnet, some years after his main work, to publish *Atlas de géographie numismatique* for the use of collectors and numismatists (Mionnet 1838). The new arrangement criteria, nevertheless, required leaving the libraries and numismatic cabinets to verify where the coins were unearthed, where they were sold or gathered by travellers and agents to then be distributed in the collections. A similar approach, complementary to the Eckhel method and destined to make on-site investigations a reality, was conceived by Domenico Sestini (1750–1832) (Monaldi 1835; Luppi 1890).[7] He concurred with the method of his Viennese colleague[8] (Sestini 1797), but chose to develop his numismatics research through travel and direct contact with the archaeological evidence (finds and monuments), starting from Sicily and the Aegean islands. He also ventured into the historical localities of the Anatolian coast, Syria, and Mesopotamia, continuing to the Balkans and then Hungary in the search for coins in the places where they had been struck or might have been struck. Combining travel with research on the coins allowed him to confirm this way of organizing, by sources and place of origin (Tondo 1990, 9–10; Rampazzo 2010–11, 47–74). However, Sestini was not alone, because another important travelling scholar, Esprit Marie Cousinéry (1747–1833), who also engaged in a lengthy correspondence with Eckhel (Nicolet-Pierre 1987; Williams 2012, 27–37), was working in those same years and in the same region. Leaving Trieste in 1769, he reached Ottoman Greece, where for more than 30 years, even during the turbulence produced by the French Revolution, he held various diplomatic posts, from registrar to consul. He travelled, investigated, wrote, and gathered notable archaeological, but more especially numismatic documentation, keeping in mind the criterion of territoriality, as evinced from the title of one of his most important contributions, *Voyage dans la Macedonie* (Cousinéry 1831). Nonetheless, despite such a significant change in arranging the collections and the search for coin documentation, it was generally no more than descriptive geography, even if innovative, thanks to the contributions of direct observations from traveller–writers.

Burgon's Expectation

A few years after the publications of Eckhel, Cousinery, Sestini, and Jean-Jacques Barthélemy (1716–95) (Gerin 1999), the potential for numismatic research, facilitated by "geographical classification," was perceived and formulated by Thomas Burgon (1787–1858), a merchant in Smyrna, a coin collector and a founding member of the Royal Numismatic Society (Carson 1986).[9] In his article of 1839 (Burgon 1839), tackling the uncertain origins of the ancient anepigraphic British coins, that is, if they were British or Gallic issues, he wrote

> our object being to endeavour to show the possibility of establishing, not only a tolerably correct geographical classification of ancient British coins by the discovery of the localities where they were current, but also, even the possibility of ultimately finding out at which towns they were most probably struck. (Burgon 1839, 37)

Furthermore, with practical realism, he assigned numismatists and those with an interest in an up-to-date classification the task of carefully recording and passing on the information regarding the places where the coins were found:

> The interest which naturally attaches itself to the correct classification of uncertain coins, ought to be heightened in us by national feeling for those found in our own country; and it must be confessed to be high time that we should begin to furnish our successors with gradually accumulating data concerning the finding of these coins, so that in time they may arrive at some satisfactory conclusions as to the places to which they belong. (Burgon 1839, 38)

He proposed that attention should be paid to coins found in digs, because only in this way would it be possible to clarify if the ancient coinage circulated mainly where it was produced or if its use in long-distance trade might have facilitated its also being lost far away from the area of origin. He also suggested a recording method, extraordinarily modern and still valid, which could ensure the usability of the information gathered over time:

> The notices or observations which are required, should be recorded in print, and should specify the spot where the coins were dug up, with descriptions of such as can be described, and with wood-cuts of the uninscribed, done with sufficient accuracy to enable us to recognize the types. The metal of which the coins are composed should be stated, and those of gold or silver should have the weights annexed in troy grains. It will be readily perceived that a series of observations, recorded as above recommended, will furnish progressively accumulating evidence for proving where and how often each recurring coin has been found; and will enable us to observe whether they are mostly found in the counties on the coast, or in those more inland. (Burgon 1839, 47)

Cartographic Visualization in the Nineteenth and Twentieth Centuries

Burgon's awareness of the purpose of mapping finds and of the recording methods certainly derived from the works of contemporary scholars, who had given ample attention to geography in numismatics, but also from his travels and stays in many ancient localities of the central and eastern Mediterranean (Burgon 1839, 39–40). The self-evidence of Burgon's article, long neglected, laid the basis for subsequent studies of currency circulation that only gained ground between the second half of the nineteenth and the beginning of the twentieth century[10]

In those same years, interest grew in a topographical rendition of the monetary evidence of a territory or historical period either through atlases (Charles 1853; Coster and de Everaerts 1888; de la Tour 1892) or with thematic maps. From then onward, a true numismatic cartography began to accompany the catalogues or corpora of mints/regions or the studies of the presence, in a diachronic sense, of coins in a well-defined area even if not coinciding with ancient administrative regions (Figures 1 and 2).[11]

It should be mentioned that cataloguing on a territorial basis and especially in connection with historical geography was widely subscribed to from the end of the nineteenth through the first decades of the twentieth century,[12] paralleling the study and publication of the collection of Greek and Roman–provincial coins of the British Museum (BMC Greek Coins 1873–1929), the production of catalogues such as the *Sylloge Nummorum Graecorum* (SNG),[13] and the analysis of the issues of a given *polis*, a region, or an archaeological site after a dig, to then be applied in the

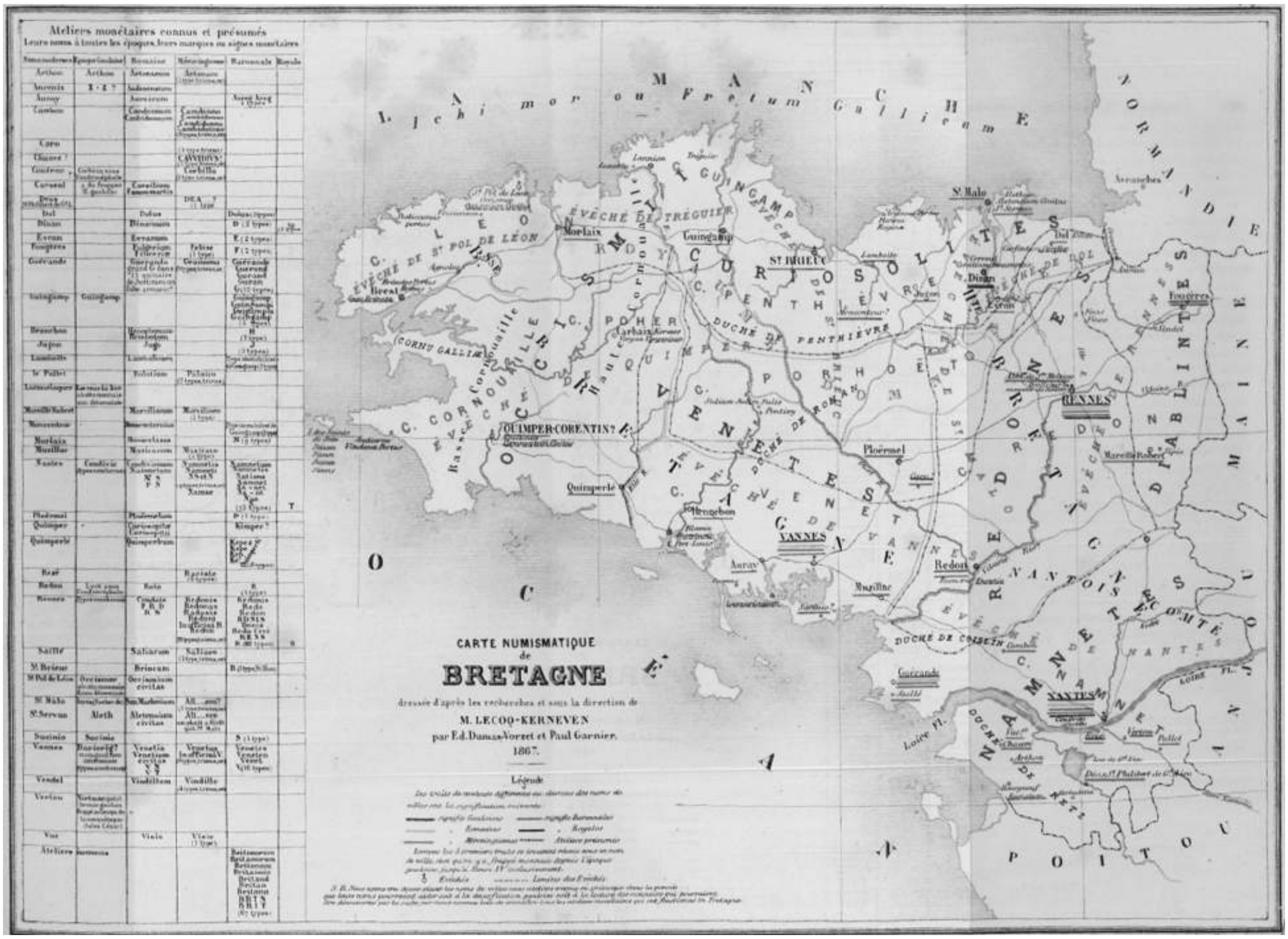

Figure 1. Numismatic map of Brittany, France.
Source: Lecoq-Kerneven (1867).

first systematic censuses of coin finds. In fact, the enormous amounts of numismatic information that accumulated in turn opened up new research topics, particularly regarding the supply and demand of money (production and circulation) on a regional scale or across territories, and made sufficient specimens available for study of the sequence of coins in a series or from a mint (Robert 1967, chap. XV; Le Rider 1999).

Gathering the numismatic records, often scattered in publications that were difficult to access, was time consuming, and at times caused insurmountable difficulties, which relegated Burgon's suggestions to the realm of wishful thinking. The answer came from the numismatists in Germany, where, the reform of Charlemagne having been set as the chronological limit, a detailed census began in 1953 of all the finds of ancient coins in that country. Once again the basic criterion was geographical–administrative, because the coins were grouped following the modern territorial divisions (Gebhart and others 1957). What was proposed by *Die Fundmünzen der Römischen Zeit* (FMRD 1960) later involved Slovenia, Hungary, Austria, Luxembourg, Holland, and from the 1980s also the Veneto Region (Saccocci 1996, 22; Gorini 1996; Asolati 1997; Gorini 2004)[14] where the innovative distinction was introduced between "areal numismatics" and "stratigraphic numismatics," with the aim of making the synchronic and diachronic study of the presence of money in a better established territory (Gorini 1974–75, 3; Gorini 1983; Gorini 1994, 265).[15] Nevertheless, the abundant numismatic information was only accessible by means of the indexes, and the sheer quantity made any mapping extremely laborious and not very legible (Gorini 1987, 264–65).[16] The spread of computers, and particularly of database technology, enabled researchers to get over the limits imposed by the mass of information (Callegher and Gorini 2004; Wigg-Wolf 2009) (Figure 3).[17]

The Web Mapping Reference Frame

Today, Web mapping is strictly based on mashup.[18] For instance, if you check on the Internet the "Mapping usage statistics" of the "Built with" Web site (http://trends.

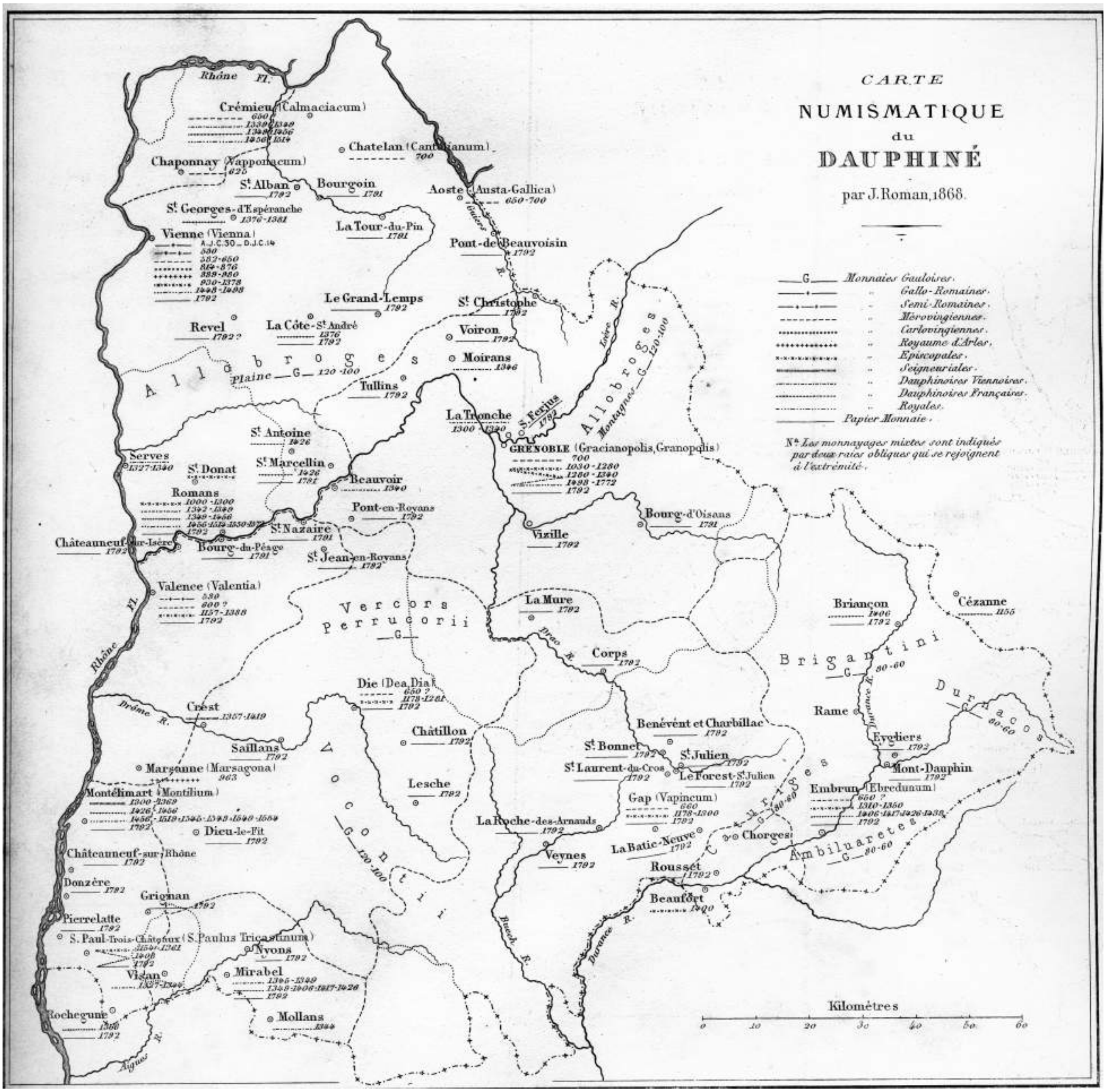

Figure 2. Numismatic map of Dauphiné, France.
Source: Roman (1868).

builtwith.com/mapping), you can see that the number of Web sites using mapping technologies is large (5,333,650 sites in the entire Web, counted on 7 January 2016); that all of the "Built with" considered sites use cloud computing[19] (mapping tools and/or base map); and finally, that Google mapping tools are the most used (Google Maps plus Google Maps API: 92% of users). Cloud computing, by means of the APIs,[20] made GIS and digital mapping very popular on the Internet. Moreover, the same technologies have fostered a "transformation of how geographic data, information and, more broadly, knowledge have been produced and disseminated," and this is also thanks to the advances in plethora of technologies loosely called Web 2.0 (Sui and others 2012).

Today we very often hear people talking about "spatial cloud computing," or rather, how this new way of intending "computing as a service" impacts on geospatial sciences (see, for instance, Yang and others 2011). Among all the technological developments that made this possible, we can mention image tiling and Ajax (Asynchronous JavaScript and XML). These are two important innovations connected to the transmission of maps on the Web.

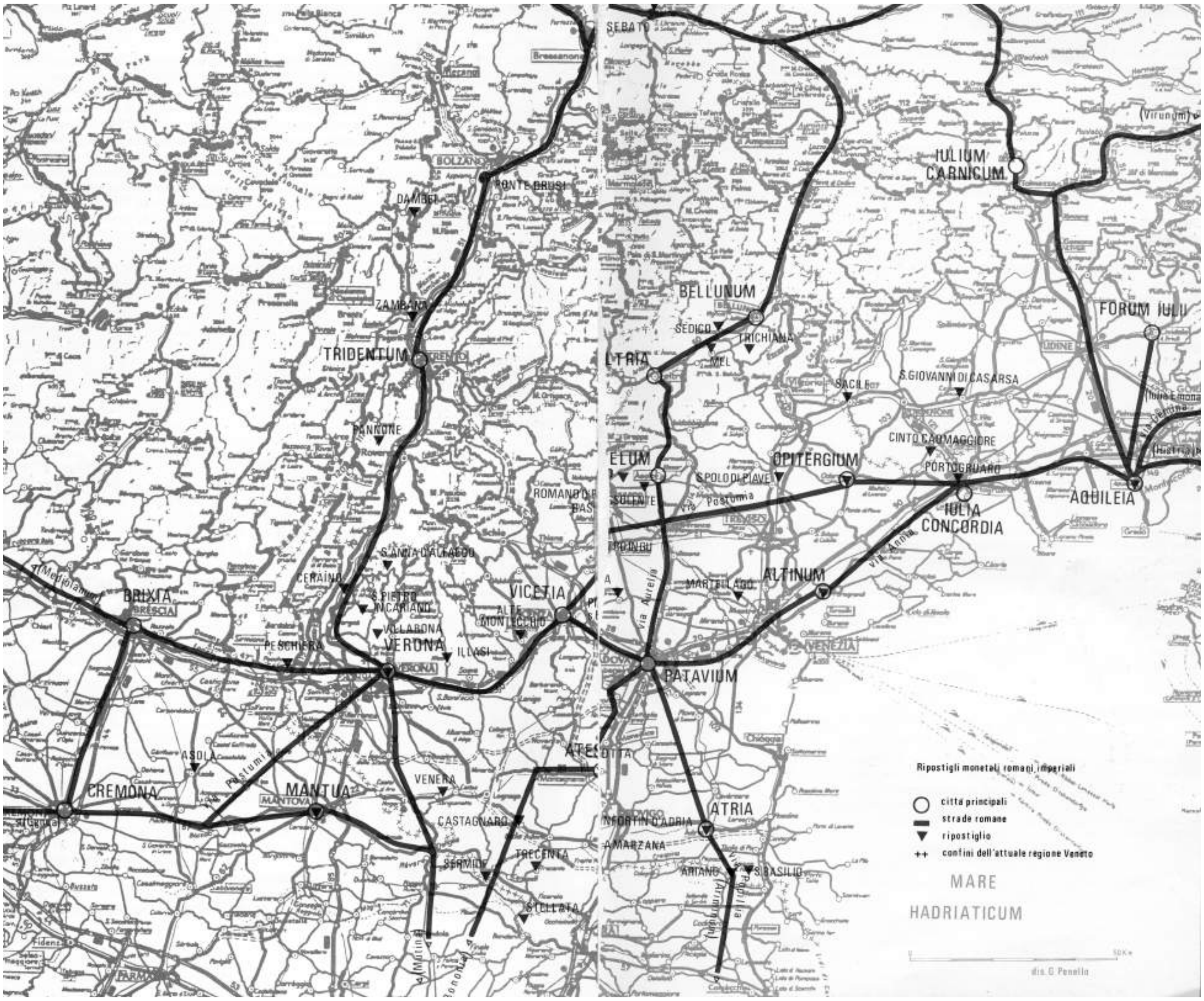

Figure 3. Map of the Roman roads and coin hoards found in *Venetia et Histria*, X *Regio*
Source: Gorini (1987). Used with permission.

They were both implemented by Google Maps in 2005. Image tiling has been used since the beginning of the World Wide Web to transfer images. Images are divided into smaller parts (the tiles) and are sent individually via the Internet. Google, however, on 1 January 2008 patented its "Techniques for Displaying and Caching Tiled Map Data on Constrained-Resource Service" (U.S. Patent 7315259 B2, Jan. 1, 2008. https://www.google.com/patents/US7315259). Ajax is a non-proprietary technology that maintains background communication between the browser and the server, to speed the server's answers (for instance, see Woychowsky 2007).

From a different point of view, the "GeoWeb" growth could be supported by the new role of GIS as social media, meaning that "GIS have become media for constructive dialogs and interactions about social issue" (Sui and Goodchild 2011). In this regard, we can mention the kml files posted online by mapping communities covering public interest topics, such as the BP oil spill in the Gulf of Mexico (check Public Lab: https://publiclab.org/) or the North Korea Uncovered project.[21]

To realize the Web mapping application, we decided to use all free and open source software (FOSS). For the Web mapping segment, we chose a relatively new application (it was released in 2011), named Leaflet. Currently Leaflet is perhaps the most popular open-source java script library for building interactive maps on the Web (http://leafletjs.com/). It is a client-side[22] Web mapping framework that can integrate raster and vector mapping data from distributed data sources on the Web. This is possible by using open standards (OGC)[23] and documented APIs. Furthermore, the clearly necessary conditions for combining geographic data are the matching of the projection systems, the map scale, and the quality (Neumann 2012).

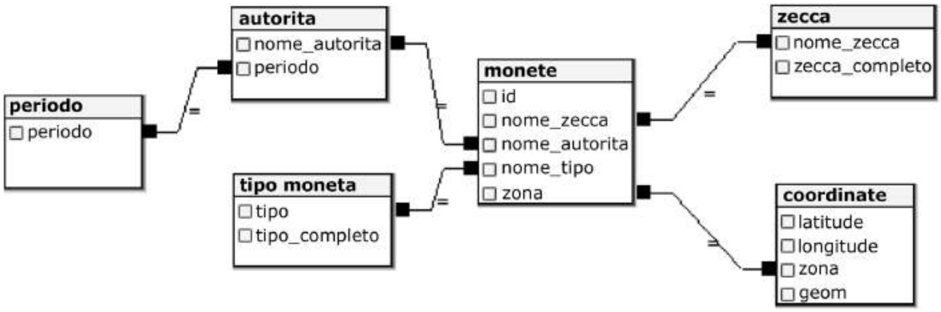

Figure 4. The relational structure of the Roman age coin findings database

All the numismatic information has been registered and organized in a relational database. In this regard, we chose PostgreSQL[24] (http://www.postgresql.org/), an open source object-relational database management system, with PostGIS[25] (http://postgis.net/) as the spatial database extender. In addition, we used PgAdmin [26] as a graphical user interface administration tool to simplify database creation and management. Finally, we used the open source desktop GIS software Quantum GIS (QGIS) to connect the numismatic database with the Leaflet Java script library (QGIS software can be found at http://www.qgis.org/en/site/).

The Database Structure

As mentioned before, we built a relational database about the Roman age coin findings in the Trieste Province (Friuli Venezia Giulia Region, North-East of Italy). The database is composed of six tables, related by five "one to many" relationships. The relationships among the tables are built by primary and foreign keys (PK – primary key; FK– foreign key).

The six tables are as follows:

1. "Zecca." This table contains information about the mints that minted the coins. Two fields are contained: "nome zecca" (mint name), which is the PK of the table; "zecca_completo" (mint complete name), which is the extended description of the mint.
2. "Tipo_moneta." This table contains information about the denomination (type) of the ancient coin. Two fields are contained: "tipo" (type), which is the PK of the table; "tipo_completo" (type complete description), which is the extended description of the coin type.
3. "Coordinate." This table contains the locations at which the coins were found. Four fields are contained: "zona" (site of finding), the PK of the table; "latitude"; "longitude"; "geom," the geometry of the geographic element – point – of the coin finding, plus the chosen spatial reference system identifier (SRID) – EPSG 4326.[27]
4. "Autorita." This table contains references to the authority that issued the coin. Two fields are contained: "nome_autorita" (name of the authority), which is the PK of the table; "periodo," which specifies the period in which the coin was minted. "Periodo" is the FK that is connected to the PK of the next table, named "periodo."
5. "Periodo." This table is made up of one only field, named "periodo" (period). "Periodo" is PK and, together with the previous "autorita.periodo" FK,[28] sets the domain of the possible values of the "autorita.periodo" field.
6. "Monete." This table contains information about the coins. It contains five fields: "id" (the code of the coin) is the PK of the table; the other four are all FK and are linked to the PKs of the previous tables. They are, respectively, "nome_zecca" (linked to the table "zecca"), "nome_tipo" (linked to the table "tipo_moneta"), "nome_autorita" (linked to the table "autorita"), and "zona" (linked to the table "coordinate"). Again, as in the previous item, every FK sets the domain of the possible values of each respective table.

After the building of the database structure (Figure 4), the following population of the table fields was realized using a semi-automatic import procedure available in the software dbase tools. To this aim, we prepared several csv files, which have been automatically imported. At the last check, the "monete" table counted 632 records (each record corresponds to a coin found in the Trieste Province).

The Web Mapping of the Numismatic Database

In addition to the querying of all the coins registered in the database, we decided to allow Web users to query the database by mint, denomination, and period. Each query triggers a dynamic Web page on the fly, combining the database information with the mashup layers (the raster base maps with the on-the-fly built interactive vector overlays). To build dynamic queries, the common solution on the Internet is PHP tools (the personal home

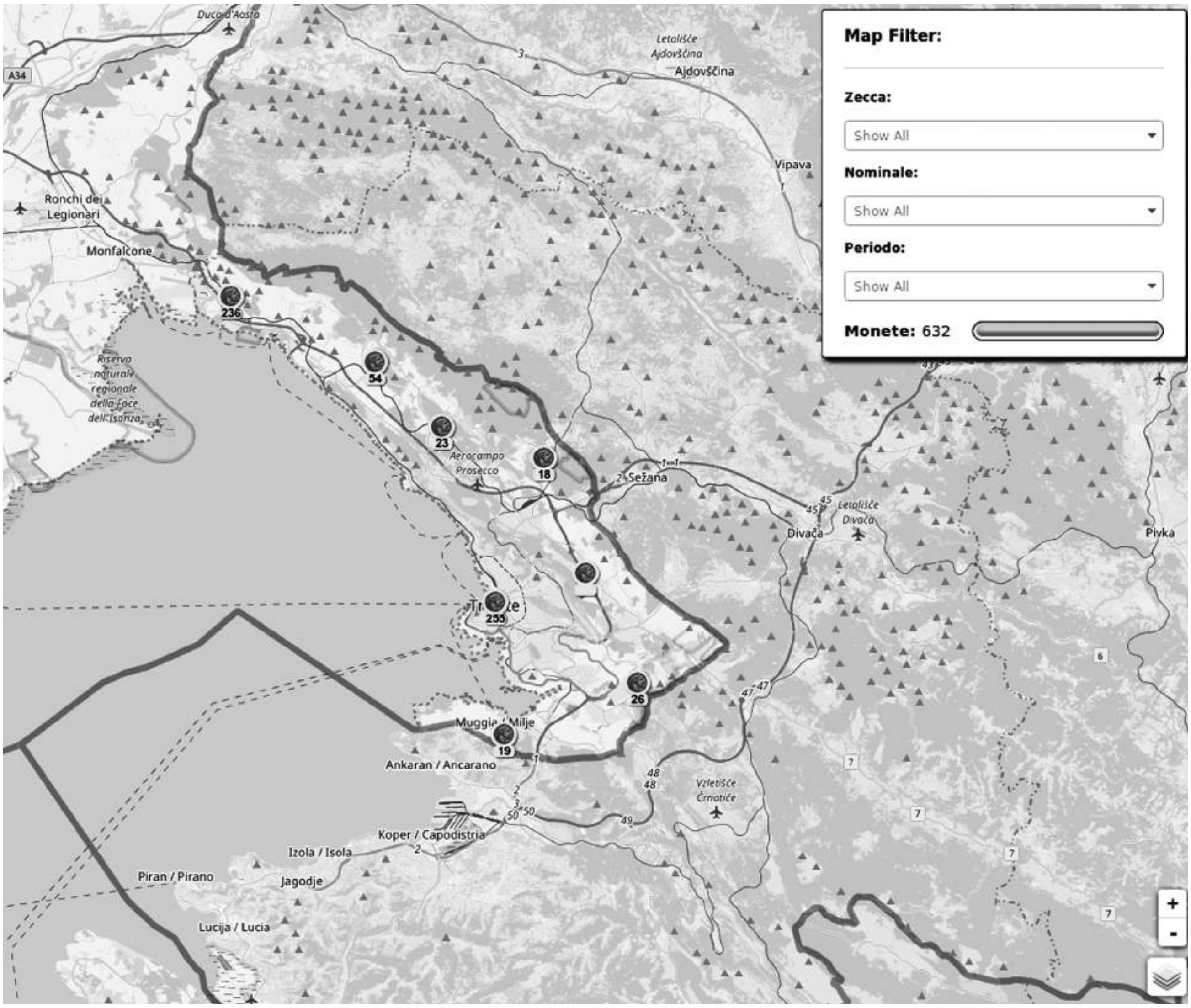

Figure 5. The homepage of the Web application
Source: ~~Pelagios via Create-Commons 3.0 (CC-BY) license;~~ © OpenStreetMap contributors.

page tool – http://php.net/), a server-side scripting language that works with all the main commercial and open source relational database management systems.[29] Bearing in mind the virtues and vices of client-side and server-side architectures, we decided not to use PHP, because we chose to realize a client-side Web mapping application[30].

These are the steps we followed:

1. Creation of a view, "monete_con_geometrie," containing all the information that will be displayed in the web plus the coordinates of the coin finding. The field are "id" (the code of the coin); "tipo_completo" (the complete description of the coin type); "nome_autorita" (the name of the authority that produced the coin); "zecca_completo" (the complete name of the coin mint); "periodo" (the period in which the coin was minted); "zona" (the site of the coin finding); and "geom" (the coordinate of the coin finding and its geometry).
2. Transformation of the "monete_con_geometrie" view in the GeoJSON format.[31]
3. Building of the Web mapping application with the Leaflet JavaScript library[32]. The built Web application can be found on the Internet at the URL http://disugis.units.it/ritrovamenti%20monetali%20epoca%20romana/index.html.

In Figure 5, it is possible to observe the default query of all the ancient coins. The icon shows the number of coins found at every site where more than one coin has been found. The default base map is OpenStreetMap.

Figure 6 shows again the default query of all the coins, overlaid on the "Impero Romano" – the PELAGIOS[33] project base map. Base maps can be chosen by moving

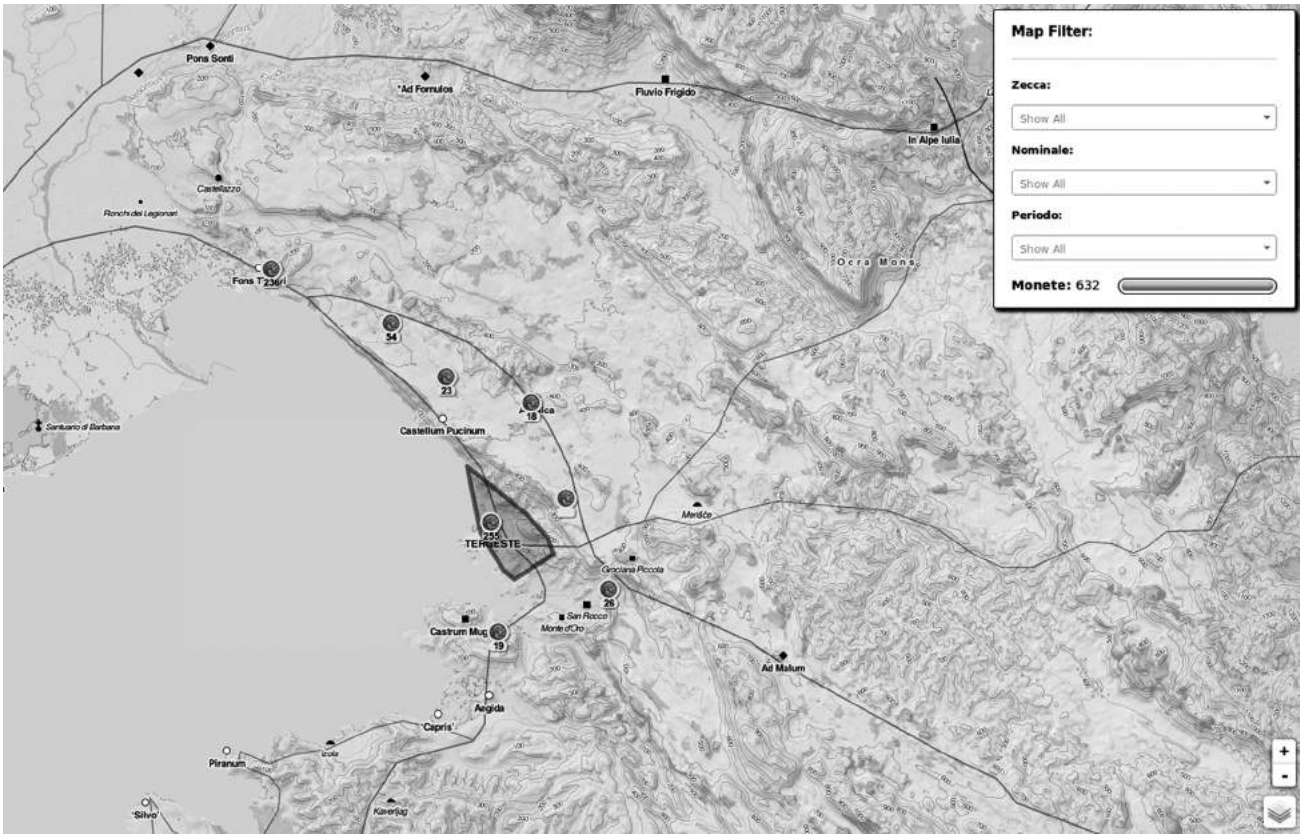

Figure 6. The default query of all the coins, overlaid on the "Impero Romano" – PELAGIOS project base map (see text for other details)
Source: Pelagios via Create-Commons 3.0 (CC-BY) license~~; © OpenStreetMap contributors~~.

the cursor to the lower right part of the map. Under the graphic controller of the zooming there is, in fact, an arrow that opens when the cursor is put over it. The cursor-opened window gives the possibility of choosing the base map: the default one is Bing satellite, but two other choices are possible, "Impero Romano" and "OSM Standard." The first is part of the PELAGIOS project; the second is the standard layer of the OpenStreetMap project.[34]

In the upper left part of the map is a check box identified by a + symbol. A window with some credits opens when that symbol is clicked. In the opened window is a short presentation of the project, and it is also possible to download the GeoJSON file of the coin findings (GeoJSON files can be opened with any desktop GIS). By moving the cursor over any icon with a number (this is the number of the coins found in the area), a blue polygon opens: it is the limit of the finding area. In the figure, you can see an opened polygon around the area of Trieste town (Tergeste on the map – 255 coins found). At the upper right of both maps (Figures 5 and 6) is the query window. The coins can be mapped by mint ("Zecca" on the window), denomination ("Nominale"), and period ("Periodo").

Figure 7 shows a query by mint ("Zecca" in the first row of the upper right window). The chosen mint is the Costantinopolis one. Please note that the fourth row of the window counts 13 coins found for this parameter. The base map chosen is OSM Standard. In the upper part of the map, one of the coins found in the area "San Giovanni. Mitreo" has been queried by the cursor (in the opened window more information is available). Please note the graphic solution adopted when there are more coins found in a single area (the circle of icons).

Conclusions

Starting from a paper catalogue of the ancient coin findings in the Province of Trieste (coins aged from third century bce to sixth century ce), we built a spatial database of the findings in the area, and then we realized a client-side Web mapping application based on it. We used FOSS established tools in building both the spatial database (postgreSQL and PostGIS tools) and the Web mapping application (QGIS and Leaflet). The Web mapping application can be found at http://disugis.units.it/ritrovamenti%20monetali%20epoca%20romana/index.html. The coins can be queried by the cursor on the chosen base map (Bing Map; the PELAGIOS digital map of the Roman Empire and OSM Standard are available) and also by mint, denomination, and period.

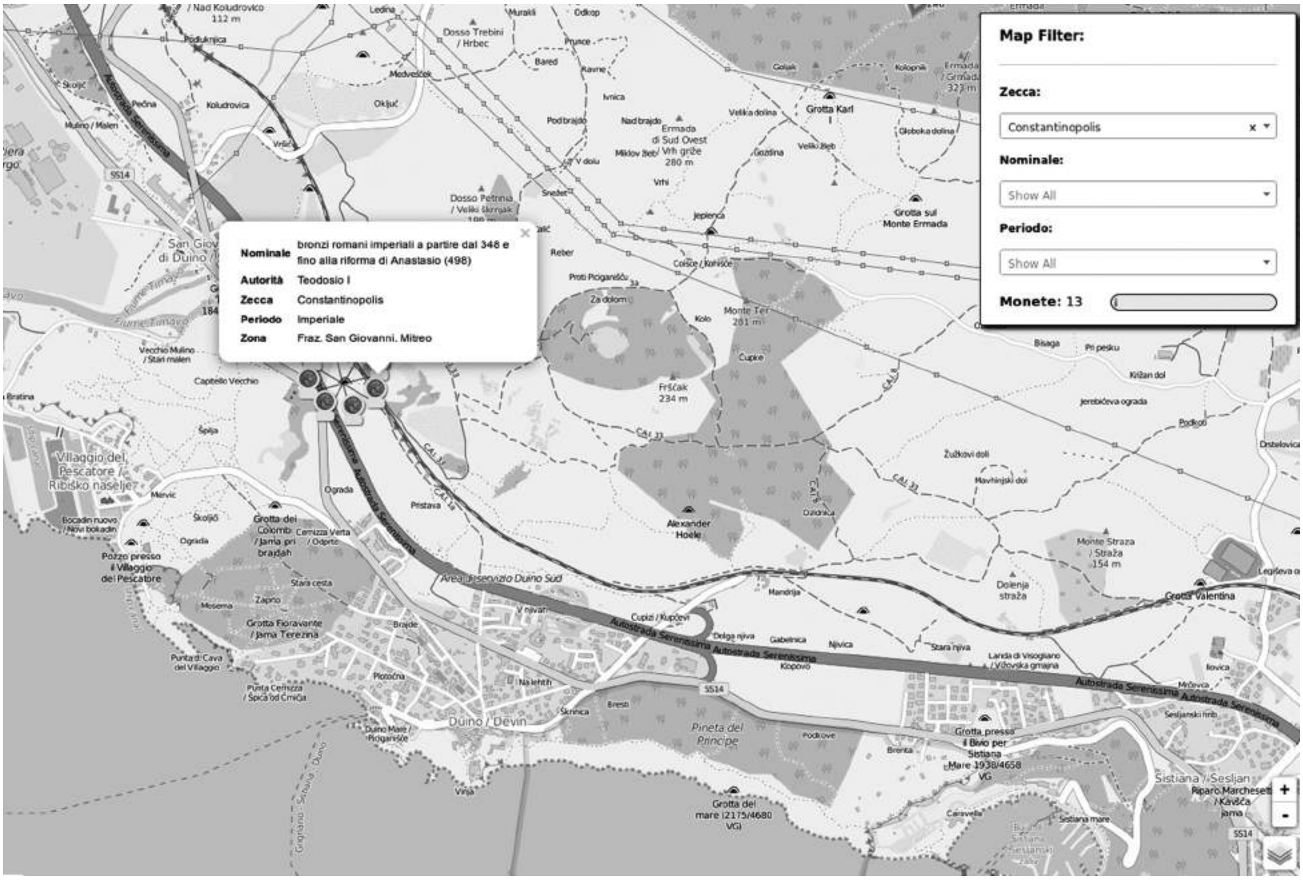

Figure 7. A query by mint: the “Costantinopolis” one
Note: The base map is OSM Standard (see text for other details).
Source: ~~Pelagios via Create-Commons 3.0 (CC-BY) license;~~ © OpenStreetMap contributors.

The whole work we have presented and the accomplished results that can be seen in the Web application show the potential of the geographic visualization process for highlighting and revealing hidden relationships between coin finding areas and mints, periods, and authorities. Some authors wrote that the visualization process “works essentially by helping people to see the unseen, premised on the simple notion that humans can reason and learn more effectively in a visual environment than when using textual or numerical description” (Dodge and others 2008).

We do not know whether our work can live up to Burgon’s expectation, but we would like it to. Surely Burgon could not even imagine the technological frame in which his idea declined and, above all, the efficiency of the relational database method in managing a coin catalogue. The flexibility of the queries to a well-done database structure (that is the integration of the data in the different entity/tables that compose the structure – see Date 1995), is surely a good reason to choose this methodology. In addition, geovisualization gives an added value to the accomplished results:

- Web users are stimulated to spatially consider the matter (the question is not only “what” but also “why” – see the three broad epistemological classes that explain the diversity in geographic visualization approaches: “Looking,” “Querying” and “Questioning” – Dodge and others 2008).
- The mapped message is easily understood and remembered.
- The Web and hardware technology (smart and portable devices) expand times and places for consulting the coin database. The cloud features of the application also allow Web users to use low-configuration devices connected to the Internet.

Finally, a few technical remarks on the software used. As we wrote, we used all FOSS instruments to build our application. The server on which the application runs is a Linux platform with Apache Web server software. We deviated from the well-known LAMP software bundle,[35] using PostgreSQL instead of MySQL to create the relational database and, with the used tools, to build the on-the-fly html pages (Leaflet Java Script library instead of PHP). These are the reasons:

- MySQL was acquired by Sun Microsystems in 2008. Sun Microsystem was purchased by Oracle Corporation in 2010. Oracle is the well-known world leader database software producer (see http://www.oracle.com/index.html). Although the software is still free, the open source community reports the difficulty of working with the MySQL developers at Oracle. Furthermore, some of the former users of MySQL do not like using proprietary software (for instance, since its seventh version, Red Hat Enterprise Linux uses the MariaDB database instead of MySQL; see https://access.redhat.com/).
- As we have already observed, we preferred to use a JavaScript library to build the Web mapping application instead of using PHP tools, because we wanted to create a client-side Web application. A client-side application should be more interactive than a server-side one; it should impose less overhead on the Web server and so be faster in responding to Web user queries. These advantages (with respect to PHP) depend on other variables such as the hardware configuration of the client, the kind of browser, and the efficiency of the Internet connection.

In the near future, research will focus on the Adriatic Sea coastal area. The presented methodology will be applied to the Ravenna mint coin finds of the Byzantine age (540–751 ce). The aim will be to connect the coastal coin finds to the Byzantine marine settlements and their commercial trade in wheat, olive oil, and pottery.

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Notes

1. In Italy, the geo-referencing of coin finds follows a fixed procedure defined by the NU Scheda (2004): http://www.iccd.beniculturali.it/index.php?IT/459/micromanuali/micromanuali_533a7d77d3bc7/2. Its application on a large scale is still a work in progress.
2. Cf. http://www.ucgis.org/;Conolly and Lake 2006; Faucher 2011; Meeks 2015. About the critical review of the methods applied in GIS archeology, the basic question is,"How did our GIS representations and practices come into being across time and place and how did / can they become part of the complex process of creating worlds in the past present?" (Hacıgüzeller 2012).
3. See, for example, the numismatic data for the site known as "mitreo" di Duino-Aurisina available at the Centro di Catalogazione Regionale di Villa Manin di Passariano (UD): http://www.ipac.regione.fvg.it.
4. See Dekesel and Dekesel-De Ruyck (2009–13) for its exhaustive review of the numismatics literature of the eighteenth century and the necessary comparisons.
5. He was one of the most influential members of the French Royal Navy. His "suppliers" included personnel of the French fleet stationed in the central eastern Mediterranean. The first edition of his catalogue *Recueil de médailles de peuples et de villes, qui n'ont point encore été publiées, ou qui sont peu connues*, Paris 1763, was followed by numerous supplements and addenda. The geographical approach represented a turning point in numismatics cataloguing that could be considered prodromal to the work of J.H. Eckhel (cf. infra).
6. His collaborators included the numismatist Gaspard Michel Leblond (1738–1809) (De Callataÿ 2013, 194–95).
7. The fact of his being a travelling scholar and numismatist is stated both in his biography and in his published works (Tondo 1990).
8. Note that the Author dedicated this work to Cousinéry.
9. The sphere of his collecting and the fate of his collections and library can also be inferred in part by consulting http://www.ashmolean.org/ash/amulets/burgonarchive/. See also the auction catalogue S. Leigh Sotheby & John Wilkinson, *Thomas Burgon Collection* [London, 22 December 1858].
10. It is sufficient to observe the appearance of geographical indications, often highly accurate and detailed, in the literature starting from the last decades of the nineteenth century (see for instance the principal numismatic journals). An example of the close relationship between geography, numismatics, and history is proposed by Blanchet (1900: 99–105). This author, having censused the finds of hoards « pour chacun des pays qui sont formés aujourd'hui d'une partie de l'ancienne Gaule», places them in relation to the routes of the barbarian incursions into the Roman Empire past the Rhine *limes* and *Barbaricum*.

11. The map (Figure 1) shows the mints active in the Armorican region, starting from the earliest issues; in the second map (Figure 2), the coins, subdivided from the « période gauloise » to the « période révolutionnaire 1792–1794 », are listed by site and accompanied by a «Carte numismatique du Dauphiné ».
12. The frontispiece of *The Numismatic Journal* 1 (1836–37) carried a portrait of J.H. Eckhel, marking the recognition of his importance and the innovation of the geographical method.
13. This project began in England in 1931 (Project S.N.G. 2004).
14. The census, begun also in Lombardy (Muffatti Musselli 1997), has not been continued; the initiative was also started in Friuli Venezia Giulia (Callegher 2010, 2014).
15. The series for the Veneto Region (RMRVe 1992) is innovative because it includes references to stratigraphic units and context and because it reports the weights of the gold and silver coins or denominations of interest to scholars.
16. The map (Figure 3) (Gorini 1987, 264–65) shows the sites where the imperial Roman coin hoards were found in the *X Regio Venetia et Histria*.
17. On the progressive spread of computers in numismatics (Wigg-Wolf 2009), see also the journal *Coins and Computers. Newsletter*. Today, the Internet provides access to a considerable number of numismatic archives/databases created by museums, universities, Agencies for the Protection of Cultural Properties, private collectors, and numismatists (http://www.coinarchives.com/) of various European countries and the United States. Among the first numismatic databases, certainly the first in Italy (Callegher and Gorini 2004; Doyen 2011), was that planned at the end of the 1980s and created as a collaboration between the Bottacin Museum of Padua (Andrea Saccocci), Padua University (Giovanni Gorini), and the Veneto Region.
18. The term mashup indicates, in computing, a "combination of multiple data formats or sources, such as maps, music, photographs, video, and animations, into one digital file" (cf. Encyclopedia Britannica, http://www.britannica.com/topic/mashup). With reference to the Web environment, mashups can be defined as "web applications that are developed by integrating data, application logic, and user interfaces sourced from the Web" (Florian and others 2010). Map mashup, last, "indicate[s] the melding of data and mapping tools to create new presentation of information" (Peterson 2014).
19. According to the NIST (National Institute of Standards and Technology), cloud computing refers to "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance 2011).
20. "API, in full Application Programming Interface, sets of standardized requests that allow different computer programs to communicate with each other" (cf. *Encyclopedia Britannica*, http://www.britannica.com/technology/API). "API are specialized libraries of computer code that are accessible on the Internet" (Peterson 2014).
21. North Korea Uncovered is a dataset of kml vector layers of North Korea. The dataset has been produced by volunteers who identified an impressive number of sensitive geographic elements such mass graves, military airports, power plants, and river dams on remote-sensed images. The file can be downloaded at http://www.nkeconwatch.com/north-korea-uncovered-google-earth/
22. In a Web mapping application with a client side architecture, "tasks can be completed locally at the user's computer" (Skarlatidou 2010).
23. "The OGC (Open Geospatial Consortium) is an international not for profit organization committed to making quality open standards for the global geospatial community" – http://www.opengeospatial.org/.
24. See for instance Douglas and Douglas (2003).
25. See for instance Obe and Hsu (2011).
26. See PgAdmin (PostgreSQL Tools) at http://www.pgadmin.org/docs/.
27. EPSG (European Petroleum Survey Group) is a relational database, with the geodetic parameters of all the world's CRS (coordinate reference systems). It was built in 1985 by a European scientific organization connected with the oil industry. Today it is maintained by an industry association named OGP (International Association of Oil and Gas Producers) and it can be queried on the Internet at https://www.epsg-registry.org/. The EPSG code 4326 corresponds to the so-called "Plate Carree" projection, DATUM WGS 84, units: degrees.
28. In the relational database methodology it is often used to specify a certain table field with the name of its table, in order to avoid confusing fields with the same name that belong to different tables. For instance, the field "periodo" in the table "autorita" is specified as "autorita.periodo."
29. According to W3Techs (http://w3techs.com/), PHP is used by 81.7% of the whole Web as a server-side programming language, followed by ASP.NET (16%) and Java (3%). Query submitted to W3Techs in January 2016.
30. To build a Web mapping application, it is possible to reference two basic architectures: server side and client side. In the first case, all the computational work is at the expense of the server, while in the client-side case, "tasks can be completed locally at the user's computer" (Skarlatidou 2010). Both solutions have virtues and vices. Server-side architecture can be limited by bandwidth problems and by large file transfers. Client-side suffers client computer low configurations and it is limited by the ability of different Web browsers to execute JavaScript geo-processing (see for instance the work of Hamilton 2014).
31. GeoJSON is a format for encoding a variety of geographic data structures; it supports Point, LineString, Polygon, MultiPoint, MultiLineString, and MultiPolygon geometry types (see http://geojson.org/).
32. This step was realized first by running the "qgis2web" plugin with the GeoJSON file in the QGIS environment; then the plugin built structure was completed with some additional features (for instance, different base maps and some different icons). The dynamic queries to the database (contained

in the "monete_con_geometrie" view) were realized with JavaScript ("if … else" statements referenced placed in the main html file).

33. PELAGIOS (Pelagios: Enable Linked Ancient Geodata in Open Systems): "its aim is to help introduce Linked Open Data goodness into online resources that refer to places in the historic past" (see http://pelagios-project.blogspot.it/p/about-pelagios.html). It is a collective of projects of over 40 research and higher educational institutions (such as the British Museum, the King's College of London, and Pleiades – Institute for the Study of the Ancient World – NYU). The use of the "Digital Map of the Roman Empire" is permitted under a Creative-Commons 3.0 (CC BY-SA) licence. The Web map can be seen at http://pelagios.org/maps/greco-roman/.
34. See http://www.openstreetmap.org and, for further information, Ramm and others (2011); Bennet (2010); Neis and Zielstra (2014).
35. LAMP means Linux-Apache-MySQL-PHP. It is a Web development framework for building applications with open source software. The framework includes an operating system (Linux), Web server software (Apache), a relational database (MySQL), and a tool for making dynamic queries to the database and producing on-the-fly Web pages (PHP).

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