From Medieval Data to Geo-resources on the Web
An Innovative Way of Mapping History

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1 RESEARCH PROBLEM

This research project is being carried on in the Geodesy and Geomatics area of a Ph.D program in Environmental and Infrastructure Engineering. It raises from a Research Project of National Interest funded by the Italian Ministry of University and has the aim to equip Historians with a tool that can facilitate their work in terms of consulting historical archives. This project has been dealt with by using a cognitive approach, in order to identify the key issues and the appropriate tools to help the Historians in satisfying their research needs.

In the first phase of the project data collected from historical sources have been organized into table archives; these data have been associated with spatial information (point coordinates), corresponding to the place names found in historical sources: knowing the spatial reference it is possible to import data into a Geographic Information System (GIS), to display their location on the area of interest and to overlay them with existing base maps. The data used for the project date back to the late Middle Ages (mid-Fifteenth Century) and represent fiscal information, related to various kinds of taxes paid to different Kings or Princes in the Kingdom of Naples.

The second phase has been related to the creation of a relational database to be populated with the data: as compared with a basic single-table structure, for example implemented with a standard spreadsheet, a relational database has the great advantage to make data query and retrieval much more efficient, eliminating also unnecessary redundancies. The relational database design is achieved through the definition of the Entity-Relationship Diagram (ERD): in it, data are divided into different "entities", corresponding to different data tables or "relations", which can be put into "relationship" among each other, using simple identification codes.

In the third phase of the project, that has been the main focus of the Ph.D. program activities, the problem to be resolved is how to publish these data in the Web, in order to make them available for the consultation and query by Historians. Two kinds of approaches have been explored. The first one is typical of the WebGIS architecture, in which all the data and the GIS tools needed to analyse them are stored in a server and published on the Web, so that the only client-side software requested is a Web Browser. The second one is again based on a client-server architecture, but in this case only the data, collected into and managed by a Database Management System (DBMS), are stored in a server; the GIS tools are provided by a Desktop GIS installed locally on a PC.

In the next chapters these two architectures will be described in more detail, comparing them in order to underline advantages and disadvantages of each approach.

It is important to state that this research work presents several challenges, especially from the point of view of understanding the requirements of the System's users. In fact, Medievalist Historians appear to be usually not well acquainted with GIS technologies; so defining e.g., a proper conceptual model fit for XV Century data or implementing tailored queries represents a major task from the Geomatics point of view. Several such issues have been discussed in (Carrion et al., 2015, in press).

2 OUTLINE OF OBJECTIVES

One of the aims of the project is to create a GIS that can be useful for Historians to draw maps from historical data in order to study the territorial dynamics emerging from the historical sources, achieving a cartographical representation of the spatial distribution of historical information. Besides, the possibility to share data among History research groups is another goal and a feature that must be added to the system, through the publication of the Medieval geo resources in the Web.

Currently three historical sources have been collected into the DBMS:

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- the *Liber Focorum Regni Neapolis*, produced by the financial offices of Alfonso V of Aragon in the 1440s, after his conquest of the Neapolitan kingdom;
- the *Quaterni declaracionum*, produced between 1446 and 1463 by the leading Treasury officials (the *magistri rationarum*) of the last Prince of Taranto, Giovanni Antonio Orsini del Balzo, the greatest feudal vassal of the kingdom (Pizzuto, 2009);
- the *Quaternus decimarum*, drawn up in 1478 by Paolo Vassallo, bishop of Aversa, that registers the payments of the *Decima*, a tax related to ecclesiastical benefits (Mangia, 2013).

The relational database architecture is useful for representing this type of data, because it allows to subdivide the information into smaller parts, making easier to analyse and query them.

Regarding the GIS technologies to be exploited, it has been decided to use only open source software: this goal raises from the need to develop and maintain the system for a long period with limited economical resources.

Another important objective pertains the ease of use of the GIS, because the end users are not GIS experts, so the system must be complete but also simple and intuitive to use.

3 STATE OF THE ART

GIS design for historical information analysis is a rather new achievement, see e.g. (Schlichting, 2008). At the international level, many works have to be mentioned, see e.g. (Gregory, 2002), (Gregory et al., 2002), (Berman, 2005) and (Gregory and Healey, 2007), being the main references for this kind of research. In Italy some examples of GIS methodologies applied to the analysis of ancient maps can be found: (Balletti et al., 2000), (Balletti, 2000), (Baiocchi and Lelo, 2002) and (Balletti, 2006). However the latter works rather address the urban-historical analysis and the methods for adapting ancient maps to present-day maps through geometrical transformations.

Many examples of historical data organized into national atlases can be found, see e.g (Pawson, 1997) and (Black, 2003); in some cases data are structured into relational databases, to be managed into a GIS environment, see e.g. (Ardissone and Rinaudo, 2005); in most cases they are related to census data and rarely they date before the XVI century: (Boonstra et al., 1995), (De Moor and Wiedemann, 2001), (Fitch and Ruggles, 2003).

It is possible to find some examples of historical data organized into a GIS and published on the Internet, such as the China Historical GIS (http://www.fas.harvard.edu/~chgis/) or the northern Italy cadastral map WebGIS (Brovelli et al., 2012). Another interesting example published on the Web is constituted by the "E 179 database", (http://www.nationalarchives.gov.uk/e179/) which contains records relating to lay and clerical taxation and which is included into the United Kingdom National Archives. However, in this case the geographic component is not made explicit into a map.

Finally, the research developed and presented in this paper starts from previous works by (Carrion and Migliaccio, 2009) and (Barzaghi and Carrion, 2011).

4 METHODOLOGY

This project required a close cooperation between Geomatics experts and Historians, in particular for the data collection, data organization and design of the ERD. Historical know how is fundamental during the phase of extraction of data from historical archives and translation of the information into digital format (typically into a spreadsheet). Also the conceptual model of the database must be planned and designed in cooperation with Historians, in order to understand their needs and the meaning of the collected information (in particular the preparation of a data dictionary is necessary).

The participation of Historians in the discussion about the issues related to the publication of data is again very fundamental, because they are the end users of the GIS, so it is important to understand what tools can be useful for them. Obviously, technical aspects of the GIS publication concern only Geomatics experts, and this is the main topic discussed in this paper.

4.1 Historical WebGIS

The first type of GIS architecture approach adopted to publish the Medieval data has been an Historical WebGIS. The WebGIS (mainly developed in the context of another Ph.D. thesis, see (Zambrano, 2013)) has been the starting point of the research work presented in this paper. As already said, it is based only on open source software; its architecture is shown in Figure 1.

The server side is stored in an Ubuntu Linux

virtual machine and is composed by three modules: a DBMS, a GIS Server and a Web Server.

The DBMS used is PostgreSQL, an open source software that can be integrated with a PostGIS extension, which manages the geographical information stored in the database and allows to interact with QGIS Mapserver, a WMS server that takes advantage of the QGIS libraries and uses the .qgs projects created with QGIS Desktop. The GIS server is invoked by the Apache Web Server, whose task is to publish web pages.

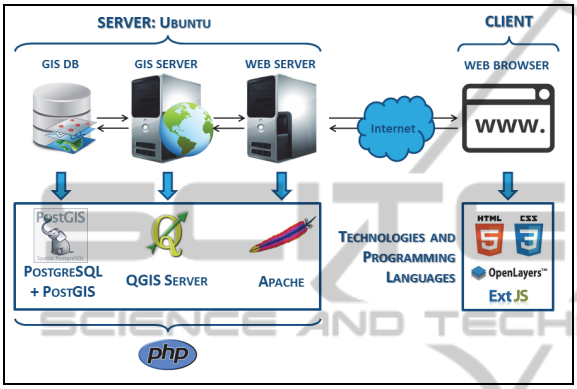

Figure 1: Architecture of the Historical WebGIS.

The client side is entrusted to a Web Browser, which interprets the web pages written in HTML5 language. The three components of this language are HTML, CSS and Javascript: they manage contents, customization and behavior of web pages. The Javascript toolkit GeoExt was used: it is composed by the ExtJS library, which allows to improve the graphical user interface and to integrate them with grids, buttons and toolbars, and the OpenLayers library, which allows to include web-mapping functionalities.

The Historical WebGIS, named *Geografie Medievali* (Medieval Geographies) and published into a Website, is composed by two parts: the "WebGIS" mode and the "Show table" mode (see Figure 2 and 3).

However, it must be underlined that the WebGIS only represents the georeferenced entities of the database and is based on the architecture just described, while the "Show Table" page displays all the entities, georeferenced and not, and some views that combine the information of two or more entities in one table, exploiting the relationships between them; this page is realized again with ExtJS libraries and allows to query tables and views with a query builder tool.

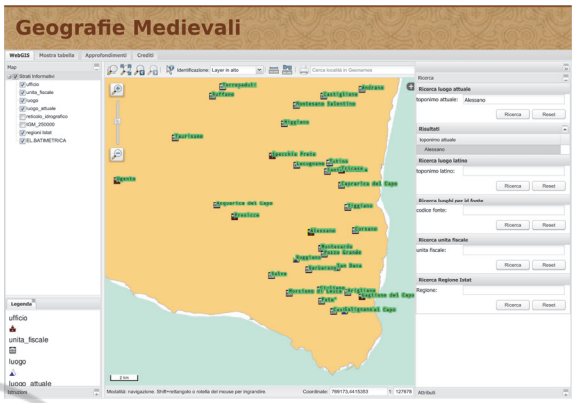

Figure 2: The "Geografie Medievali" Website: "WebGIS" mode.

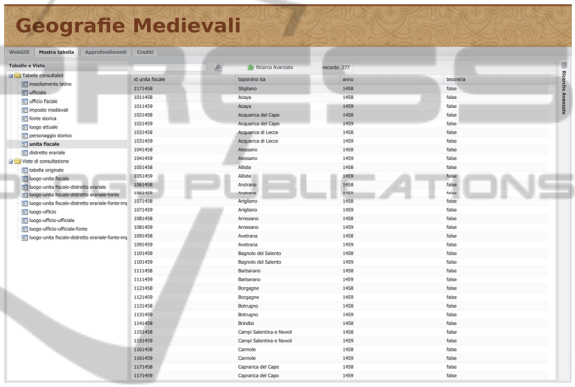

Figure 3: The "Geografie Medievali" Website: "Show table" mode.

The typical advantage of this kind of architecture is that the installation of GIS software is not required on the client-side, because all the GIS functionalities are implemented into the server. On the other hand the GIS tools provided by a GIS server are less advanced than those provided by a Desktop GIS. Moreover in the present architecture the "WebGIS" and the "Show table" pages are not connected to each other, because they are based on different versions of the ExtJS libraries. These are the reasons that led to explore other types of approach.

4.2 Historical Geo-resources Sharing through the Web

This new solution presents an architecture (shown in Figure 4) that is much simpler than a WebGIS architecture: in this case only the GIS database is stored into the Server; the Client is composed only of a GIS software, QGIS Desktop, that natively supports the connection with a PostgreSQL database through the Internet.

This configuration solves the problem related to the Medieval WebGIS, regarding the connection between attribute tables and cartographic representation, which is now implemented. Furthermore a GIS Desktop software offers many tools that are not available in a WebGIS architecture; finally QGIS Desktop is an open source software that does not require licensing costs and in recent years is catching up with commercial software like ArcGIS from the point of view of completeness and performances.

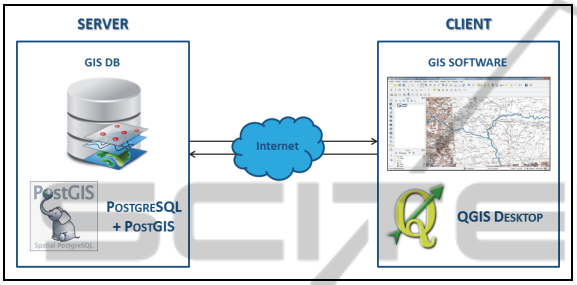

Figure 4: Client-Server architecture for Medieval Geo-resources sharing through the Web.

The main problem that remains in this approach is that the relationships implemented into the database are not recognized by QGIS, so when the connection with the DBMS is realized, the entities imported into QGIS, shown as layers or attribute tables, are not associated through relationships.

One possible solution is the one implemented the WebGIS: the creation of views into the database, that contain the information stored in two or more entities. The main disadvantage of this solution is related to the increasing in number of the attributes contained in a single table, which makes the consultation of data much more difficult and less intuitive (if all the relationships in the database would be implemented, the outcoming view should become equal to the huge Excel table resulting from the first phase of the project).

Another solution is being investigated at this moment, since it could prove to be more advantageous: namely, to exploit the possibility of creating some scripts that can work into the QGIS environment and that allow the software to take into account the relationships among entities established in the database.

The entities imported into QGIS from the Historical Database and one cartographic representation of the data are shown in Figure 5. They are overlaid onto a basemap of the Italian Military Geographic Institute (IGM) made available as WMS service on the Italian National Geoportal.

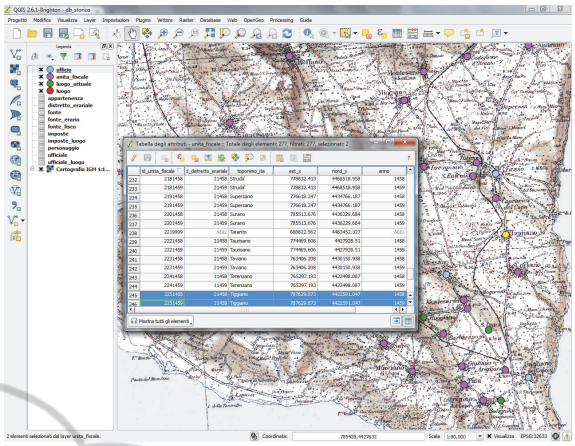

Figure 5: The Historical Database imported into QGIS.

5 EXPECTED OUTCOME

The approach presented in this paper has the final objective to import an Historical Medieval database into a GIS environment and to implement it in all its potentiality and completeness (all the entities related between each other, as represented in the ERD design). The goal is to supply Historians with an instrument that makes it possible to realize complex queries on the Historical data and to show the outcome of spatial queries on maps.

The System will be accessible mainly by experts in the field of Medieval research, who will be provided with suitable tools to easily integrate and edit data in the database according to their requirements. The results, in the form of an Historical Atlas containing selected data and maps, will be open to a larger community through the Web.

This type of technology is certainly useful for improving the ability to deeply analyse Historical sources and to extract information from them to support research methods in the field of Medieval History. Furthermore, even though the GIS will not be on the Web as a WebGIS, geodata will be stored on a server and published on a Website, so the data sharing features of the system will be in any case maintained with improved performances.

The proposal of this research to exploit the GIS environment in Historians work can be considered innovative, particularly for the structuring of a relational database containing information dating back to the Medieval period, and for the use of GIS and Web technologies for History data sharing through the Internet.

6 STAGE OF THE RESEARCH

Currently the research is focused on finding the best solution to realize a complete and useful Historical GIS, from the point of view of the database capacities. At the moment the final part of the study is in a preliminary phase, to understand how to realize scripts to import the database relationships into QGIS.

In any case the possibility to explore any other way to solve the problem is not yet precluded, also considering that GIS technologies are continuously improving, making new solutions available at a very fast rate.

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