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Availability of geodata and use of open-source geotechnologies for cultural heritage. The case of Toledo (Spain)

Disponibilità di geodati e utilizzo di geotecnologie open-source per il patrimonio culturale. Il caso di Toledo (Spagna)

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Abstract. Geotechnologies play an increasingly extensive and diverse role in our society. Their implementation in educational settings is growing at all levels, especially in higher education, and in a wide variety of disciplines. The analysis and management of cultural heritage are two of the areas where they are most used. The multiple, heterogeneous, and unspecific supply of geoinformation opens up considerable possibilities for learning and new opportunities for analysis by future specialists in cultural heritage, despite the difficulties in the management of, and approach to, the data. In a scenario in which open-source educational resources are increasingly important, this work presents an exploratory analysis of open sources of georeferenced information that facilitate access to geodata for teaching and learning on cultural heritage. As an example of the differences and shortcomings of the availability of georeferenced sources in Spain, this work presents a case study on the city of Toledo, recognised as a world heritage site.

Keywords: geotechnologies, geodata, spatial data infrastructure, cultural heritage, Toledo.

Riassunto. Le geotecnologie occupano uno spazio sempre più ampio e significativo nella nostra società. La loro implementazione nei contesti educativi sta aumentando a tutti i livelli, soprattutto nell'istruzione superiore, e in un sempre più ampio numero di discipline. Lo studio e la gestione del patrimonio culturale sono due degli ambiti in cui il loro utilizzo si sta maggiormente diffondendo. L'eterogenea e variegata offerta della geoinformazione permette grandi possibilità di apprendimento e rende possibili nuove opportunità di analisi per i futuri specialisti dei beni culturali, nonostante le difficoltà del loro sviluppo e delle loro applicazioni. In un contesto in cui le risorse educative open access stanno diventando strumenti essenziali, è necessario porre grande attenzione alle fonti di informazione geo-referenziate e open-source che facilitano l'accesso ai geodati, affinché questi possano essere usati per l'educazione al patrimonio culturale. A titolo di esempio delle differenze e delle carenze che si osservano ancora nella disponibilità di fonti georeferenziate nel contesto spagnolo, questo lavoro presenta un caso di studio applicato alla città di Toledo, dichiarata Patrimonio dell'Umanità.

Parole chiave: geotecnologie, geodati, infrastrutture dei dati spaziali, eredità culturale, Toledo.

1. Introduction

Since the last decades of the 20th Century, the digital revolution has triggered a fast-moving process of change that is profoundly altering individual and collective behaviours. Information and communication technology (ICT) has impacted the labour market, education, and many other areas, affecting the way we relate to one another in society. These novelties have enabled millions of people to use computers on a regular basis, becoming active agents in creating, disseminating, and searching for information (Capel 2010).

1.1. *The integration of ICT into education*

The use of ICT in the teaching-learning processes is another of the visible manifestations of the technological revolution. For years, the European Union has been promoting actions to bolster digital competences (knowledge, attitudes, and skills), with the aim of completing what is known as the digital transformation of the world. In this sense, digital competence is one of the eight key competences for lifelong learning. Additionally, the Digital Education Action Plan (DEAP), implemented because of the Gothenburg Social Summit (17 November 2017), has the same goal. This plan places even greater emphasis on the urgent need to transform systems of learning. It states that “while 90 % of future jobs require some level of digital literacy, 44% of Europeans lack basic digital skills” (European Commission 2021). The need for a better adaptation to life and work obligates us not only to enhance basic digital literacy, but also to facilitate the acquisition of new, more complex digital skills, which are grounded in autonomous learning and increasingly more open and flexible settings. The health crisis of the last two years, with the worldwide lockdowns and restrictions imposed in response to the Covid-19 pandemic, has highlighted just how important it is to improve the population’s digital literacy.

Integrating the enormous opportunities these transformations open up in education is no easy task (Dede 2008). The Qingdao Declaration (UNESCO 2015) recognised that, to achieve inclusive and equitable quality education and lifelong learning by 2030, it is essential to harness ICT to strengthen education systems. In the European arena, despite the significant advances made and the opportunities unleashed, goals and objectives need to be broadened still further (Koutsopoulos, Papoutsis 2016). The immediate availability of information and the ease with which it can be handled have still not been sufficiently leveraged in active teaching-learning

methodologies (Álvarez, De Lázaro 2017) and in today’s new, more open environments. Indeed, it is necessary to continue integrating the existing technological advances and the easy access to tools and data in the different levels of education, adapting to the changes in the diverse sources (Rienom et al. 2014; Ortwein et al. 2017).

In the case of higher education, which is the focus of the present study, it is key to harness the possibilities of the so-called Open Educational Resources (OER), which are free and openly licensed teaching, learning and research materials in any medium (digital or otherwise). As they reside in the public domain or have been released under an open license, they can be accessed, used, and modified free of charge (BCcampus 2021). Furthermore, the use of virtual learning environments, which allow students’ working time to be more efficiently deployed, appears to be increasingly valuable. Demand for these resources is growing in higher education settings (Bozkurt et al. 2017).

1.2. *Geotechnologies and digital competences in cultural heritage studies*

The so-called information technologies have revolutionised methods and forms of work in myriad disciplines, including those that deal with cultural heritage and fall within the scope of the humanities, such as history, history of art, archaeology, or geography. The last of these, in its dual role in the social sciences and humanities, is one of the areas of knowledge that has been most impacted by this step change in technology that began at the end of the last century and continues to grow irreversibly in the present one. In this case, as well as the incorporation of all the novelties of the digital revolution and the development of hardware, software and procedures, there is a further crucial element for the study of geography: the democratisation of access to geolocation.

The term geotechnologies (or geographic information technologies) has been coined to refer to a set of digital applications and tools that enable the generating, processing, and representation of geographic information, that is, data that are referenced in space by means of coordinates. The term encompasses geographic information systems (GIS), remote sensing, digital mapping, GPS, and photogrammetry, among others (Chuvieco et al. 2005, 37). Geotechnologies, viewed either as a paradigm shift in the discipline or simply as a set of tools for the analysis and representation of space, play an increasingly important role. They have become indispensable tools for research and problem solving in diverse areas

ranging from the environment and spatial planning to cultural heritage. Consequently, geotechnologies are considered “one of the three most important emerging and evolving fields, along with biotechnology and nanotechnology” (Gewin 2004, 376).

The digital revolution has not only permitted the spread of ICT skills among the student population, but also means that those who wish to work with geotechnologies, as well as having mastered the basic digital skills, need to go a step further, as they are required to manage concepts of a mapping and statistical nature. This training is necessary despite the instruments available being ever more user-friendly, which facilitates applicability at user level and in increasingly broader fields. It has been shown that students of humanities and cultural heritage continue to have specific difficulties as they often have very limited knowledge of the key concepts needed for working with space. Bolstering spatial thinking has thus become a necessity at all educational levels. Spatial thinking is highly useful in everyday life (for driving, choosing the best route to go home, etc.). However, using spatial thinking to accomplish daily tasks is not the same as what has been defined as spatial literacy (which allows students to describe and analyse the spatial patterns of people, places, and environments on Earth). There is a lack of focus on spatial thinking in cultural heritage studies, as is true in the social sciences and the humanities in general, as has been underlined by several authors (Hespanha 2009).

This technological transformation has also had other collateral effects, such as increasing interdisciplinarity, which is intended to remedy the traditional dichotomies between technological and scientific degree courses and those related to the humanities. Further consequences are the possibility of access to free software, which ensures equal opportunities for all, and the bolstering of collaborative and shared work (thanks to the capacity for interaction provided by Web 2.00). Finally, the access to high-quality open-source data is a crucial element in the study of cultural heritage, and, hence, our focus on this aspect.

1.3. Cultural heritage in urban settings

Defining cultural heritage is complex given the multiple facets and categories it involves. The content of the concept has grown over time. What was once a restrictive notion (based solely on the historic or artistic value of isolated objects) has been replaced by a much more inclusive approach, in which not only works from the past may be considered heritage, but also those of the

present, and not only tangible but also intangible assets. Even natural elements or landscapes, as an expression of the combined work of humanity and nature, form part of the wealth of cultural heritage. According to the UNESCO, “Cultural heritage is, in its broadest sense, both a product and a process, which provides societies with a wealth of resources that are inherited from the past, created in the present and bestowed for the benefit of future generations. Most importantly, it includes not only tangible, but also natural and intangible heritage” (UNESCO 2014, 132).

Since the middle of the 20th century, cultural heritage has emerged as a key element of European society. Community policies related to cultural heritage revolve around the recognition of its meaning in the construction of the identity of individual peoples, the promotion of its conservation and the interest in its development as an economic asset, as it is able to create jobs, becoming a resource and attracting investment and tourist flows. Additionally, it acts as an engine to revitalise cities. Urban cultural heritage is extensive and, beyond the archaeological assets and architectural ensembles built in the past or in the contemporary period, it further includes large-scale cultural projects that have significant, enduring impacts on the cities they are home to (Biedermann, Januchta-Szostak 2021).

World heritage cities are the perfect example of the trinomial heritage-culture-city. The World Heritage List covers an inventory of the cultural and natural heritage that meet the criteria to be recognised as of outstanding universal value. Fifteen Spanish cities are included in the list. Toledo, located in a meander of the River Tagus (Figure 1), is home to an exceptional historical ensemble that has served for its inclusion in the category.

The proximity of the city to the country's capital, Madrid, means it forms part of its multinuclear area, with which it is functionally integrated. It is also part of the cultural tourism circuit that runs from Madrid, which provides it with innumerable day trippers arriving from the metropolis. Due to its administrative status (regional and provincial capital), it is home to various authorities, which are partly to be found in the historic centre. Its importance as a tourist centre is justified by its splendid collection of historic heritage buildings and the comprehensive range of cultural activities on offer.

2. Approach and methodology

There is a broad consensus on the novel and wide-ranging possibilities of open resources for education, in general, and, in particular, for the teaching of geographic

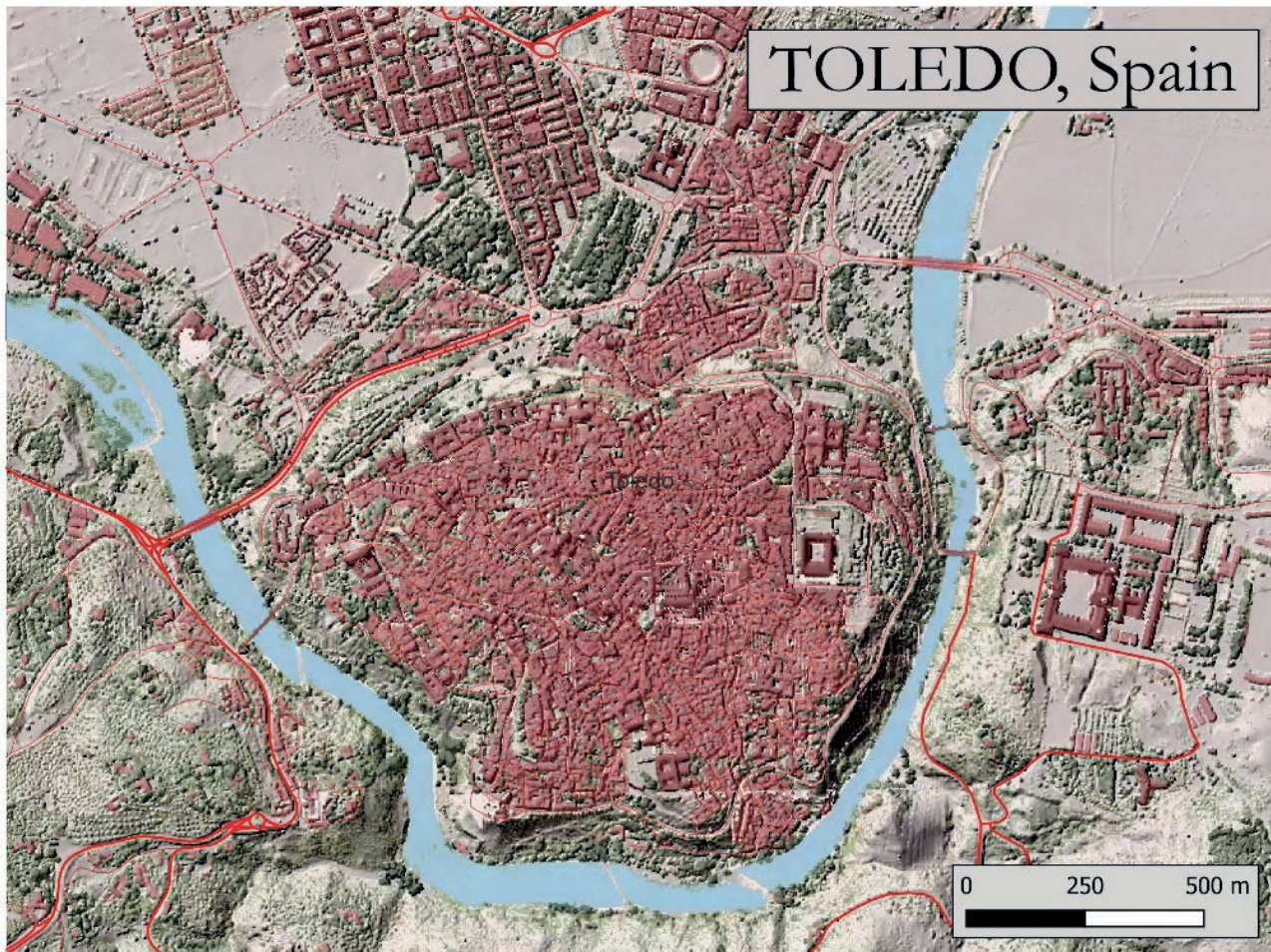


Figure 1. Location of the historic centre of Toledo. Source: authors' elaboration.

information technologies. The present study analyses geotechnologies that provide open-access georeferenced data for cultural heritage. The research first provides a detailed and systematic revision of the availability of cultural heritage geodata in Spain, and then focuses on a specific, defined setting, namely, the city of Toledo. This specificity is the result of the extensive nature of the possibilities of the multifaceted construct of cultural heritage. The starting premise is that the broad spectrum of works made possible by open access to specialised software should be complemented by the availability of geodata.

In recent years, a few changes have occurred that have led to the democratisation and growth in the use of GIS, changes that have affected several of their components, especially the hardware and software. Despite the gradual expansion in the free access to georeferenced data, there is still notable room for improvement. The emergence of volunteered geography and crowd-

sourced spatial data has marked a shift that requires consideration. The hypothesis of the present study is that the availability of sources varies greatly, depending on the topic, and, in the case of cultural heritage, there is an ongoing need for more precise data that allow us to harness all the novel options offered by geographic technologies. This study thus presents an analysis of the open sources available, classifying them according to the types established (differentiating between institutional, private, and collaborative sources) and ranging from national to local level.

2.1. Changes in Geographic Information Systems

In the last fifty years, the emergence of geotechnologies has changed the way territory is studied. Of these technologies, the so-called geographic information sys-

tems (GIS) are arguably the most prominent. They facilitate the organisation, storage, analysis, and representation of spatial data. GIS permit reality to be perceived and interpreted in a global, holistic manner and to work in a multivariable, multicausal and multiscale way. They can be analysed based on the components or elements of which they are made up: hardware, software, people, and data.

2.1.1. Hardware and software: ubiquity and accessibility as current features

There has been an increase in the diversification and use of computers and other devices with similar functions in all public and private spheres. They have become an integral element in our everyday lives and a widespread feature of learning at all educational levels, including, of course, universities. The reduction in costs and the increase in capabilities have led to their generalised use, fostered also by the practically ubiquitous ease of access to the Internet (Borruso 2013).

The possibilities of software have likewise grown. Many recent programs and applications are produced in multi-platform format, such that they can be used equally in computers, tablets, or smartphones. Moreover, as well as paid software, multiple high-quality free programs have appeared and been widely adopted by a variety of users. The development of open-source code languages has opened the door to their continuous growth and their increasing use. This can be evidenced in many disciplines taught at university level and is particularly clear in the case of geotechnologies. GIS have evolved from being available only under costly licences, within the reach of only a few university departments that maximised their use in teaching and research, to being used by students on their own computers, thus democratising access. Of the commercial software programs, ESRI and Intergraph continue to have a significant market share, offering different desktop and online products. Meanwhile, of the open-source code programs, the most prevalent are gvSIG¹ and QGIS², which are among the most widely used in university teaching in Europe.

The Global Positioning System (GPS), based on Global Navigation Satellite System (GNSS) technology, and developed by the United States for the purpose of determining the position of an object in any part of the world, plays a crucial role in geotechnologies. Broadly speaking, geolocation is a process based on positioning an object on the world's surface using a system of

geographic or plane coordinates. Further projects have been developed, such as the European Galileo, the Chinese BeiDou (Compass), and the Russian GLONASS, etc. (Tushar et al. 2014). The spread of its use has been most notable in mobile phones, which deploy it in myriad applications that are useful in everyday life, and which allow data to be collected to generate maps. The number of webpages or applications created by combining data or functionality from different sources (Mashup) has grown exponentially since Google launched its API (Application Programming Interface) in 2005 and its custom mapping service Google My Maps in 2007.

2.1.2. Personnel and training: reflections on the human factor

The human factor continues to be key in most aspects of life. The digital revolution and the advances in artificial intelligence cannot replace or supplant human behaviours and decisions. Two of the strands of reflection regarding technology today are the need to avoid its interfering with the guiding role of human attention and the debate on its subordination to the aims of users (and not the contrary) (Williams 2018). Encouraging independent thinking is one of the key points of the educational process, and it is thus essential that we make technology a support for human will and not a threat to concentration. A properly aware process of technological education should contribute to this goal. Training in digital competence, and, more specifically, in managing computers, has increased in formal education. A wide variety of devices, ranging from personal computers to tablets and smartphones, are now everyday tools for students in both their academic and private lives. In short, there has been a drastic change in the patterns of access to information and thought among all members of the educational community, and especially in universities.

However, the learning and management of geotechnologies have not increased to the same extent as other digital skills. Geography is present from early childhood in our spatial thinking. This useful knowledge, indispensable in everyday life, is extensively developed in geographic analysis and mapping. The use of geotechnologies requires two types of knowledge: computing and mapping. While the former has been implemented in the classroom, the latter continues to be taught as if the technological revolution had not occurred.

The ease of access to spatial data, the growing simplicity of programs and the more economical physical and logical components has helped notably increase the number of disciplines, and hence the number of stu-

¹ <http://www.gvsig.com/es>

² <https://www.qgis.org/>

dents, that include these tools in their work. There is, however, great disparity in the basic training and prior knowledge of the individuals that use geotechnologies. The spatial component is required for highly varied branches of science, ranging from the humanities and social sciences to all types of engineering and even the health sciences. The perception of space, prior learning and needs of people that engage in managing spatial data and cartographic documents differ and their aims and goals are diverse. Alongside the rising number of users of these tools, there has also been an increase in new spatial data, which sometimes results in the existence of considerable amounts of unreliable information, what Capel (2009) calls *cartorrea*.

In traditional teaching methodologies, the teacher was the owner of knowledge and information, which was made available through bibliographies. Only a few decades ago, the use of geotechnologies was associated with a costly licence that restricted their use to the classroom. Not only has the role of the teacher now changed but the tools and data have largely been released, leading to a more diversified arena for the teaching-learning process, now typified by the ubiquity of such tools as a further example of liquid modernity.

Moreover, training in geotechnologies has escalated in both amount and type. The technological revolution has allowed for the unilateral, bilateral, and multilateral use of forms of communication and learning with synchronous and asynchronous relationships that extend and intensify traditional in-person teaching. The variety of studies is substantial, ranging from paid education at both public and private higher education institutions, delivered in long-term courses, to other payment-free courses, organised by university institutions or companies in the field, and conceived as learning pills³. Online educational formats have an increasingly prominent role. Among these are the Massive Online Open Courses (MOOC), the number of which has multiplied in recent years⁴.

An enormous quantity of material and specific tutorials on tools and algorithms opens up an immense world of possibilities for lifelong learning. This diverse and heterogeneous supply has been systematised, usually on a selfless basis, by bloggers and persons that upload series of links whose continued existence tends to vary⁵.

2.1.3. Geodata, a differential element

The previous sections have evidenced the diversification and general implementation, across different levels of the education system, of hardware, software and training related to geotechnologies. The availability of high-quality georeferenced data, at multiple scales and of different origins, also appears to have expanded. The analysis of cultural heritage using geotechnologies requires these data. Their existence, free access, and reliability all greatly affect the work that may be performed as well as its outcomes. Nonetheless, there are a wide variety of material and topics, in which there is a considerable disparity in the availability of spatially located data. Hence, drawing general conclusions seems an impossible task. This leads us to conduct a critical study focused on a specific field, namely the study of urban heritage, and restricted here to a specific case, the World Heritage city of Toledo. The study considers a classification into three large groups of geodata sources, according to their ownership: institutional, private, and collaborative sources.

3. Results

For centuries, access to cartographic information and data has been restricted to a limited number of people. Due to their practical utility in controlling territory, they have always been considered a strategic resource and the reserve of the dominant elites. The digital revolution that has been ongoing since the last quarter of the 20th century has substantially changed the nature of such information. Following a first phase, in which access to spatial data was complex, costly, and difficult, the restrictions of availability and cost have today been resolved, although fresh concerns have emerged, such as reliability and quality.

The opportunities for obtaining cartographic information on the Internet are immense and extraordinarily varied in type, date, resolution, scale, and format. Geodata have diversified, given that anyone can now generate georeferenced information. The traditional repositories associated with public institutions and a few private enterprises now coexist with multiple, sporadic collaborations that have given rise to what is known as neogeography (Guimet 2015, Bosque 2015). In many cases, this is general geographic information that can be harnessed for the analysis of heritage. However, both the variety of geolocated data and the disparate types of cultural heritage give rise to highly diverse situations that complicate systematisation.

³ <http://didacticageografiaytic.uaedf.ua.es/preview>

⁴ An example of a MOOC whose purpose is to boost the use of geographic information technologies in university teaching is available at: <https://canal.uned.es/video/5f6469905578f2636f23449e>

⁵ <http://www.gisandbeers.com/listado-de-cursos-mooc-gis-gratuitos/>

3.1. Open source for the study of cultural heritage

A first classification was drawn up according to the origin of the data, either from institutional sources or from private companies or citizen organisations. A multiscale perspective was adopted, including European, regional, and local level. The intention of the case study is to serve as an example of the disparity of scenarios that currently coexist as regards the availability of heritage-related geodata.

3.1.1. Geodata from institutional sources: a growing yet disparate supply

The existence of institutions with different levels of coverage (from general to local) enables a classification of open geodata sources to be made. There is a somewhat inverse relationship between the range of the administrations responsible for producing geoinformation and the level of disaggregation of such information. It would be desirable for the administrations with spatial coverage to provide highly detailed data, which is not generally the case. Such availability would then avoid the disparities in detailed data of a local nature.

a) Information for major territorial areas: European and Spanish levels

The primary source of reference in Europe is the Statistical Office of the European Union⁶. It produces statistical and cartographic material that can be used to establish comparisons across the countries that form part of the organisation. The Geographic Information System of the Commission (GISCO) provides three levels of information, European, National, and regional, based on its nomenclature of territorial units, which range from major socioeconomic regions (NUTS 1) to the smallest units (NUTS 3) (Eurostat 2022a). It also includes urban information (Urban Audit) (Eurostat 2022b). However, it lacks a direct application for the management of heritage elements, which restricts the possibilities of this source for the case that concerns us.

On another scale, the Spanish Spatial Data Infrastructure (SSDI⁷) has a similar mission, that is “to integrate the data, metadata and geographic services produced in Spain into the web, conforming with the regulations, standards, and recommendations that permit their interoperability.” (Ministerio de Transporte, Movilidad y Agenda Urbana 2022). Despite its great interest, given that it compiles geospatial information on the

country, the significant internal differences in the various initiatives undertaken by the autonomous communities are evident and content is presented in multiple formats. The aim of the Spanish government’s open data initiative⁸ is to organise a common repository of spatial information on a national scale. Once more, the heterogeneity of data and mapping derived from the participation of the different administrations of the State of Spain is evident, with a high variance in the availability of information related to cultural heritage and, indeed, to any other topic.

The authority that has been officially responsible for developing, managing, and distributing geospatial information in Spain for the last 150 years is the National Geographic Institute⁹. Within this institute, the National Centre for Geographic Information (CNIG, in its Spanish acronym) is an autonomous body tasked with distributing geographic data, products, services and applications. In recent years, it has made a great effort to systematise a significant part of its resources and make them freely available to the public. Its cartographic repositories range from series of basic maps (1:25,000; 1:50,000; 1:200,000) and orthophotographs (historic or current) to a wide variety of thematic maps. Most of this documentation does not directly involve representation of cultural heritage but may provide necessary support for the generation of maps and other products related to our topic of study.

As part of the thematic cartography related to cultural heritage, the CNIG has resources on routes, leisure, and free time. These include cultural itineraries such as the Santiago Way, the Route of El Cid, cave paintings and others¹⁰. It can also supply information on natural heritage (natural parks, particularly). As mentioned, this information is thematically related or involves data from the base cartography that serves for urban studies. It does not provide, however, detailed, geographically referenced data on an urban scale related to the heritage sites that concern us.

As well as the CNIG, there exist other geoportals specialised in both rural and urban matters, such as the Electronic Cadastre Office¹¹. This administrative registry, which is part of the Ministry of Finance and the Civil Service, houses descriptions of rural and urban real property and property of special characteristics. Being an element designed for tax control, its updating and coverage is guaranteed (Sánchez, Cebrián, García-

⁶ <https://ec.europa.eu/eurostat>

⁷ IDEE in its Spanish acronym.

⁸ <https://datos.gob.es/es/>

⁹ <https://www.ign.es/web/ign/portal/qsm-cnig>

¹⁰ <http://centrodedescargas.cnig.es/CentroDescargas/index.jsp>

¹¹ Electronic Cadastre Office. <https://www.catastro.minhap.es/esp/sede.asp>

González 2021). Despite its being designed for tax purposes, it is also possible to identify detailed features of heritage assets. Nonetheless, this source has certain drawbacks that make it less useful. The specialised skills needed to manage the system mean that using the registry is not a simple task.

b) Georeferenced data on a national scale: the role of the autonomous communities

Under Spain's decentralised political and administrative model, the competences devolved to the autonomous communities include geographic information. Consequently, as well as the SSDI, the autonomous communities have also implemented their own spatial data infrastructures (SDIs)¹² which undertake all the spatial data projects for which the public organisations of the regional governments are responsible. In Castilla-La Mancha, this service is still somewhat underdeveloped. No base cartography directly related to cultural heritage is available in a downloadable format. The only information available refers to protected spaces (natural parks and others) and the viewer for the Landscape Atlas of Castilla-La Mancha. These shortcomings are made up for by the personalised attention offered by the Cartographic Centre for Castilla-La Mancha, which is responsible for producing, managing, and facilitating cartographic information on the autonomous community to whoever requests it¹³. It is worth noting that, since its inception, following the INSPIRE directive, the range of information it provides has grown considerably (economic, social, services, etc.¹⁴). This even further underlines the absence of geodata on cultural heritage sites, which other Spanish SDIs do in fact include.

c) Local-scale geodata

The SSDI facilitates and brings together spatial data from local-scale geoportals. Toledo, however, still has no local spatial data infrastructure or spatial information system run by the municipal administration, as is the case of other cities in the regions, such as Ciudad Real and Cuenca (GeoCuenca¹⁵), which limits the amount of geodata available. In the case of Toledo, the most exhaustive inventory of heritage sites undertaken was part of the Urban Development Plan, implemented in 2007, which listed a catalogue of protected assets and

spaces¹⁶. It includes the cataloguing criteria and a classification of the protected sites, supported by maps and photographs. However, it includes no geolocation with coordinates, nor a georeferenced file with such elements. The spatial information it provides, based on the cadastral reference of the property, is limited to data on the surface area it occupies.

Another, typically local source for cultural heritage studies is that of historic maps, which are of great interest as they permit the inclusion of the time variable in the analysis. In many cases, these are digitised but not georeferenced¹⁷. This problem can be easily solved, however, given that spatial coordinates can be simply and reliably generated by means of software programs. An example of geolocation based on the information available from the Cultural Heritage Database of the autonomous community is shown in Figure 2. The religious buildings of Toledo considered as assets of cultural interest have been georeferenced thanks to the QGIS software.

3.1.2. Private sector open sources and the contribution of volunteered geography

The most prominent of the fastest growing technology enterprises in recent years is undoubtedly Google, which has developed free applications, such as Google Maps and Google Earth, with these being frequently used in everyday life. By combining satellite images, maps and a spatial information database, Google Earth provides multiple functions that range from digitization to calculating parameters such as scale and geographic coordinates, among others (Arranz et al. 2013). Google Maps, meanwhile, is a simple tool that facilitates consultation of geographic information (Luque 2011). Other companies, including Microsoft and ESRI, also provide web browsers with similar applications and functions (Microsoft Bing Maps and ArcGIS Online, respectively). The latter enterprise provides a cloud-based software platform with which interactive web maps can be created and shared. One of its most widely used applications is ArcGIS StoryMaps, which combines text, interactive maps, and other multimedia content. These are not specific tools, however, but can be applied in our case study.

The shortcomings detected in the availability of local scale geodata on cultural heritage sites lead us to address other initiatives that may act as a substitute. This is the case of volunteered geography, which is considered to fall within the umbrella term of neogeogra-

¹² https://www.miteco.gob.es/es/cartografia-y-sig/ide/enlace_interes/idee-ccaa.aspx

¹³ <https://centrocartografico.castillalamancha.es/quienes-somos>.

¹⁴ Open geographic data portal (Castilla-La Mancha): <https://datos-abiertos-castillalamancha.opendata.arcgis.com/>

¹⁵ GeoCuenca. Spatial Information System: https://www.cuenca.es/_GeoCuenca/index.html

¹⁶ http://www.coacmto.com/documentos/2016/pom%202016/B_%20Catalogo%20POM%20Octubre%202015.pdf

¹⁷ <https://www.toledo.es/toledo-siempre/cartografia-historica/>



Figure 2. Geolocation of Cultural Heritage: religious buildings in Toledo. Source: authors' elaboration.

phy, and which, according to some authors, generates data and information, but not knowledge (Buzai 2015). This modality receives various names, each of which underlines different aspects of this collaborative format. If referred to as “volunteered geography” (or as “collaboratively contributed geographic information”), the emphasis falls on the change in the processes and relations that enable this geographic information to be generated. On the other hand, the use of the term “neogeography” or “ubiquitous cartography”, suggests a reformulation of the knowledge and skill sets around which this discipline has traditionally been built, underlining the growing everywhere-ness of spatial information in our daily lives (Elwood 2009, 2). In short, these terms identify a series of individual or group initiatives (not institutional ones) that all feature use of geographic techniques and tools by non-expert individuals and communities. The data they yield are useful as they are found in the knowledge base but are sometimes difficult to access, and therein lies their importance.

The possibilities of enhancing this data collection capacity have increased greatly with the advances of the technological revolution. Although without realising it, all mobile phone users generate information by means of the geolocation instruments their devices contain. A connection is thus established between social media, geolocation and even Big Data. This spontaneous generation of geolocated data is almost automatically represented in map viewers, giving rise to the notion of neo-cartography (Chabaniuk, Dyshlyk 2016).

Among the examples of volunteered geography, we can mention the well-known OSM platform (Open Street Map)¹⁸ which has emerged as a reference, especially in places where institutional cartography and private mapping are insufficiently developed or fail to cover specific needs. It is a highly detailed planetary cartographic database, which can be consulted online or downloaded. It can provide mapping on almost any location, which is

¹⁸ <https://www.openstreetmap.org/#map=15/39.8590/-4.0294>

often altruistically uploaded by “geovolunteers”.

The availability of so-called Volunteered Geographic Information (VGI) (Goodchild 2007; 2009) or Geocrowdsourcing (Guimet 2015, 176) have undoubtedly had a major impact. On occasions, the map obtained in this way surpass those from standard cartographic sources (García-González 2017). Some have the added value of associating coordinates with feelings and everyday experience. Among the advantages are their freshness and subjectivity, which adds an emotional component that individualises information and helps understand specific places. However, they also pose a risk in that they come close to the limits of privacy. There exist appealing contributions that help spread information on the cultural heritage of Toledo, such as *Leyendas de Toledo*¹⁹. As well as being an interesting blog on the city, it includes KML files with locations and information about monuments, events and legends hidden in the corners of this ancient city. It also provides useful information for visitors and tourists (car parks, tourist offices, etc.)²⁰.

4. Conclusions

Geotechnologies, in general, and GIS, in particular, are useful and increasingly necessary tools for the analysis, research and management of cultural heritage, which explains the need to enhance their role in training students involved in cultural heritage. The emergence of open resources, derived from the digital revolution and the changes it has enacted, facilitates the teaching-learning process, and brings it closer to a larger number of people. Nonetheless, the simple and swift availability of information and the active role of users enabled by the Web 2.0 have not improved knowledge nor have they led to geotechnologies being widely incorporated into learning environments, which requires a reflection on current needs.

The analysis of the changes in the different components of GIS reveals notable progress in the increasing democratisation of their use. This is evidenced by the expanding availability in these areas of a variety of devices, the ease with which we can obtain free software, and the opportunities for specialist training, often also delivered free of charge. There is still, however, a disparity in the availability of data, which continues to mark differences, especially in the maximum level of detail

required by the local scale in which many heritage studies are conducted.

Our case study has evidenced the difficulties involved in systematising sources of geolocated information related to cultural heritage in Spain. The different levels of administration, the diverse legislation and the division of competences mean possibilities vary substantially across regions and autonomous communities, and between the various types of heritage. Initiatives to normalise and standardise spatial information require thematic systematisation, especially when regarding aspects that are key for society, as is the subject of this research, that is, cultural heritage. The case of Toledo shows there is no correlation between the availability of geospatial information and the importance of the location or the quantity of heritage sites in the area. In short, completing the inventory and geolocation of cultural heritage is fundamental if the advantages of the technologies available are to be fully harnessed. In this question, the contributions of volunteered geography, facilitated by the possibilities on online collaboration, will continue to help generate information, emerging as a significant resource once the advantages and shortcomings have been evaluated.

To sum up, it is feasible to expect an increase in the role of geotechnologies in the study of cultural heritage. Apart from the possibilities of their practical application, geotechnologies must become a undisputed educational tool that promotes critical thought and leads the classic *sapere aude* (dare to know) to be replaced by *cogitare aude*: dare to think!

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¹⁹ <https://www.leyendasdetoledo.com/las-leyendas-de-toledo-en-google-maps/>

²⁰ https://www.google.com/maps/d/viewer?msa=0&ll=39.86245004189366%2C4.027089999999995&spn=0.023915%2C0.038581&mid=1iKImJg_3uPtB7Fr4_ugPLkC17Uw&z=15

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