GeoAI4Land in Spain: Justification, Feasibility and First Steps

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SUMMARY

The use of artificial intelligence in general and applied geomatics is booming. Its application, research and development in land management and administration in any country is of great interest, as claimed in FIG Commission 7 This paper aims to present the first steps implemented for a subsequent use of GeoAI for Land in Spain, as well as its justification and feasibility considering the characteristics of the Spanish dual system of land administration. In the same way, this paper aims to demonstrate the fundamental role of geomatics in rural territorial development and in the reduction of inequality in the access, possession and control of land property. All this, within the framework of the doctoral thesis "Geolocation of land registries through genealogical and geodemographic studies at municipal scale".

RESUMEN

El uso de inteligencia artificial en geomática general y aplicada está en auge. Su aplicación, investigación y desarrollo en la gestión y administración de tierras de cualquier país es de gran interés, tal y como se reivindica en la Comisión 7 de la FIG. Esta ponencia tiene por objeto dar a conocer los primeros pasos implementado para un posterior uso de la 'GeoAI for Land' en España, así como su justificación y viabilidad teniendo en cuenta las características propias del sistema dual de administración de tierras español. Del mismo modo, dicha ponencia quiere evidenciar el papel fundamental que tienen los geomáticos en el desarrollo territorial rural y en la reducción de la desigualdad en el acceso, posesión y control de la propiedad. Todo ello, en el marco de la realización de la tesis doctoral “Geolocalización de fincas registrales mediante estudios genealógicos y geodemográficos a escala municipal”.

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1. INTRODUCTION

The geographic location of registered properties in Spain has been a difficult task throughout our history due to the deficient dual system of land administration and management (Durán-Boo and Velasco, 2007). The Cadastre, understood as an administrative registry of plots of land for tax purposes where the physical descriptions and ownership of the land were communicated verbally, was the only existing land management system until 1861, when the Mortgage Law was enacted and thus the creation of the Land Registry, a descriptive registry of ownership and other real rights over land, which to this day continues to be the legal guarantor of these registered real estate rights.

The professional work of the surveyor, today's geomatics engineer and/or topographer specialized in the delimitation of real estate property, for decades or even centuries has been to locate and delimit estates or plots according to the Cadastre and the Land Registry by carrying out geodetic, topographic and cartographic work (Antón Merino and Garrido-Villén, 2021). All this has been done on an individual ad-hoc basis for each boundary demarcation problem that has arisen due to particular interest, but has not been dealt with at a global or administrative level, for example at the municipal level, as proposed in this publication.

In this sense, it is necessary to look for new methodologies that allow to automate and solve in a massive way the geolocation of properties, especially of rustic type. This publication proposes the use of geospatial artificial intelligence (GeoAI) to solve this problem. The justification and feasibility of its use in a rural environment in the interior of Spain will be investigated, as well as the initial work carried out to obtain and process the population, genealogical and cartographic information at the municipal level that will be necessary to, in a later phase, apply the aforementioned GeoAI.

2. LAND MANAGEMENT IN SPAIN

The bicephalous system of Spanish land administration with one institution in charge of the fiscal field, Cadastre, and another one in charge of the legal field, Land Registry, has brought a series of challenges, problems and opportunities to coordinate both institutions over the years. Initially, that set of coordination elements was at the level of alphanumeric information with the Maura law in 1906 and since 2015 at the cartographic level (Trujillo-Cabrera, 2017), since today Cadastre has a continuous cartography throughout the Spanish territory thanks to the topographic, geodetic and cartographic work started at the end of the nineteenth century.

The right to ownership and possession has been and continues to be a source of conflict, since, according to the Civil Code, the owner has the right to enjoy or enjoy the entirety of the property of which he is the owner. These conflicts are derived from the non-existence of an official actor or agent, by law, whose main purpose is to delimit and define the boundaries of the properties in an unequivocal and permanent manner, since the Cadastre has a fundamentally tributary character and the Land Registry offers legal certainty regarding the ownership of the properties, but does not safeguard the literary description of such properties because they are not delimited by fixed and precise boundaries.

We observe that it is key to know and understand how the registered property is described and identified in our mortgage system in order to find a solution to the problem. In the case of rural properties, its location is determined by the municipal district, pago or partido and the nature of the adjoining properties, among other elements. In the case of urban properties, the location is determined by the municipal district and town, the name of the street or site and the current number, among other elements.

In the case of the description of the boundaries, it is done by the four cardinal points indicating the name and surname of the adjoining owners or by the use of fixed elements. As can be seen, the identification and location of rural properties is complex due to the imprecision of the literal description used and, in addition, in general, these descriptions have not been updated over the years, thus perpetuating this description indefinitely, thus contributing to making the identification and location of rural properties more difficult. It is worth mentioning that this situation is susceptible to give rise to the phenomenon of double registration, defects or excesses in the land and the registration of properties of ambiguous location (Arrieta-Sevilla, 2009).

Precisely, the professional work of the surveyor (currently a geomatics engineer specialized in the delimitation of real estate property) for decades or even centuries has been to locate and delimit the properties or plots according to the Cadastre and the Land Registry, acting as experts, if necessary, before the courts. To these two institutions must be added, since the establishment of Spanish democracy, the regional and local Public Administrations, entities with exclusive competence in urban and land planning and, therefore, generators of cartography. This professional work dates back to the middle of the 19th century when several commissions, laws and institutions were created, such as the Map Commission, the Land Measurement Law, the School of Topographers in Madrid or the National Geographic and Statistical Institute, with the purpose of carrying out geodetic, topographic and cartographic works in the cadastral field to improve the system by incorporating graphic and metric information and not only alphanumeric as the existing literal cadastres to date.

These geomatic works led to the creation of cartographic products such as the Kilometric Sheets (1860-1880), the Cadastral Advance (1900-1920) and the Parcel Topographic Cadastre (1930-1970), which is the best cadastral rustic cartography, in terms of geometric accuracy, existing in Spain, carried out by the National Geographic Institute (IGN). The Cadastral Plans (1980-1990) generated from vectorized orthophotographs, which constitute the current rustic cartography, were already elaborated by the General Directorate of Cadastre (DGC) when in

1977 it obtained the cadastral competences that had belonged to the IGN until then. The cartographic, geodetic and topographic (geomatics) competences remained with the IGN, the body with the aforementioned official competences in Spain.

It is for all these reasons that in 2015 the cartographic coordination law par excellence (Law 13/2015) emerged, which is trying to mitigate all the existing problems between both institutions, Cadastre and Land Registry, and implementing a working methodology for the legal-cadastral operations that will arise in the future. Here is a significant detail that, to my understanding, escaped from said law: what can we do to identify, locate and delimit the already existing and registered estates in the Land Registry or that are not registered, but that there is an extra-registral notarial document? (Collado and Buchón-Moragues, 2022).

3. MATERIALS AND METHODS

Therefore, as mentioned in the introduction, the objective is based on the definition of a methodology for the massive and/or joint geolocation of rural land registry properties based on descriptive registry boundaries, provided by the Land Registry or property deeds, cadastral information, such as current and old maps and lists of cadastral owners, and population information acquired from the Civil Registry and municipal, parish and provincial archives (Figure 1) (Collado et al., 2022a).

Figure 1. Sources of information for GeoAI

This methodology is based on the study of the descriptive boundaries of the property (Figure 2). These boundaries allow us to carry out a global geolocation, since they indicate the mortgage district, the municipality and a more specific area within it by means of the toponym of a place.

Likewise, the registered surface area is reported, which can be later compared with the cadastral and real surface area. In the same way, and with greater interest if possible, the literal description of the rustic property shows us a literal georeferencing from the boundaries (north, south, east and west) and the adjoining parties with name and surname. For this reason, we have used population data, whether population censuses or birth, marriage or death certificates, for the geolocation of the registered properties.

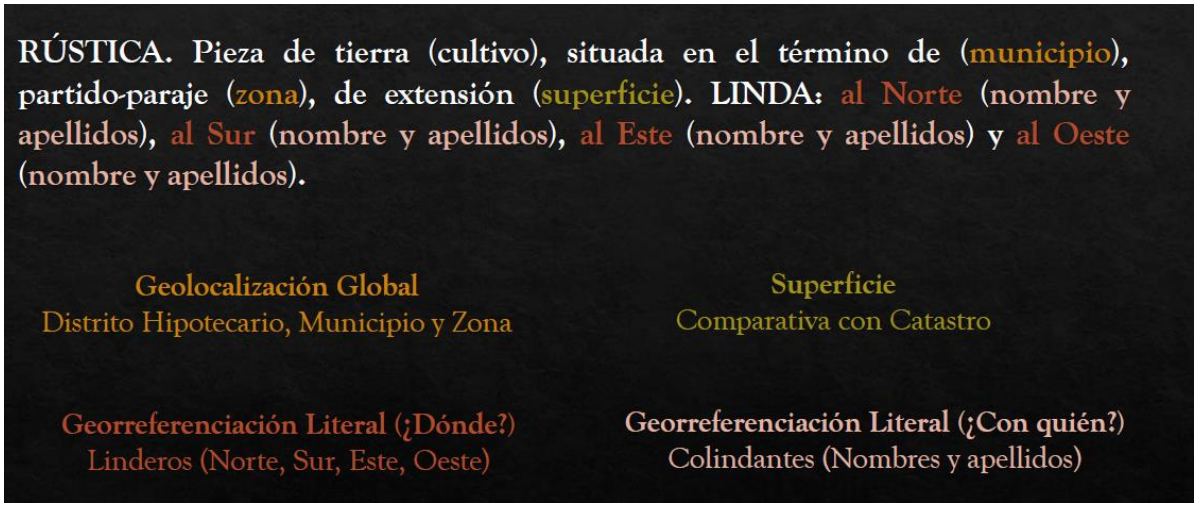

Figure 2. Prototype of descriptive boundaries of rustic properties

Let us remember that the final objective is to use a geospatial artificial intelligence (GeoAI) algorithm that allows us to find the correspondence between the owners of the registered properties with the names and surnames of the inhabitants of a town (Simón-García, 2005) thanks to the geospatial topology, genealogical information and the support of the cadastral cartographic base to find the location of those rustic properties whose geolocation is unknown.

Figure 3 shows the workflow of the indicated methodology. The population information of the municipality will be compiled from the Civil Registry, allowing us to georeference the births, marriages and deaths of the society and, in a later phase, to carry out the genealogy of the entire population. This will allow us to have the relationship of kinship of all the inhabitants since at least the beginning of the 19th century and to understand the transmission of properties by inheritance or sale and purchase, among other utilities. Thanks to the historical cadastral cartography and the alphanumeric information with the cadastral owners, we will have a reference with which to compare the current cadastral situation, both in the geometric and alphanumeric component.

All this, with the literal registry and/or extra-registral descriptive information of the rustic properties as indicated above, GeoAI can be applied to establish the correspondence of names and surnames and geometries that allow the geolocation of these properties. It is expected, at the moment of its obtaining, to implement a geoportal or web viewer that allows to see the work done around the geometric and ownership evolution of these rustic properties (Collado-Murillo, 2019).

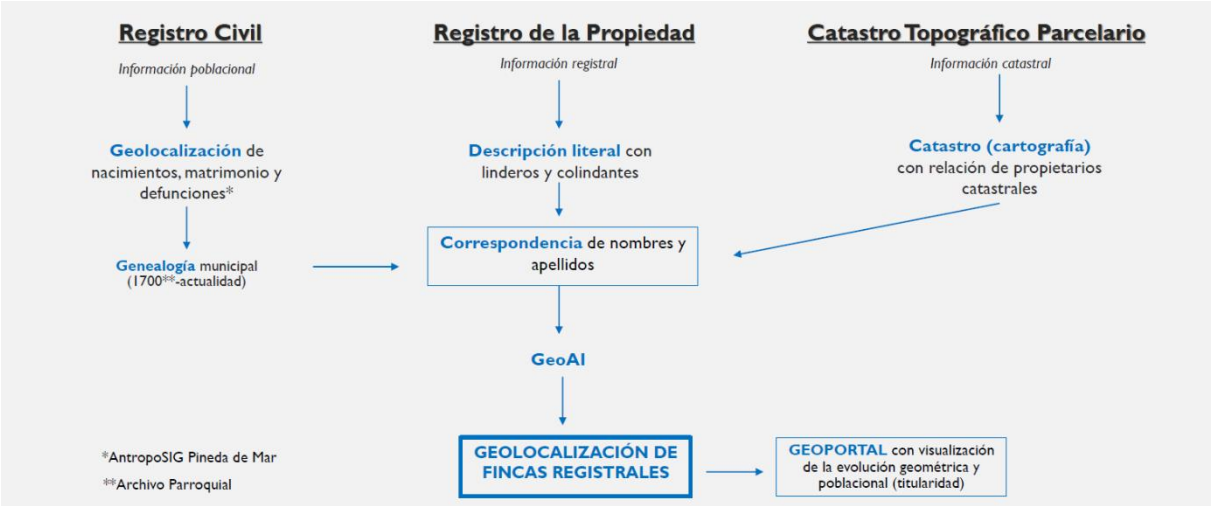

Figure 3. Workflow

4. PRELIMINARY RESULTS

Taking into account the aforementioned workflow, all the population and genealogical information is now available in a database (Collado et al., 2022b). It has been possible to transcribe more than 30,000 documents referring to births, marriages and deaths in the municipality under study (Figure 4), which has made it possible to obtain a municipal genealogy of more than 23,000 individuals in more than 300 years of history, from 1700 to the present.

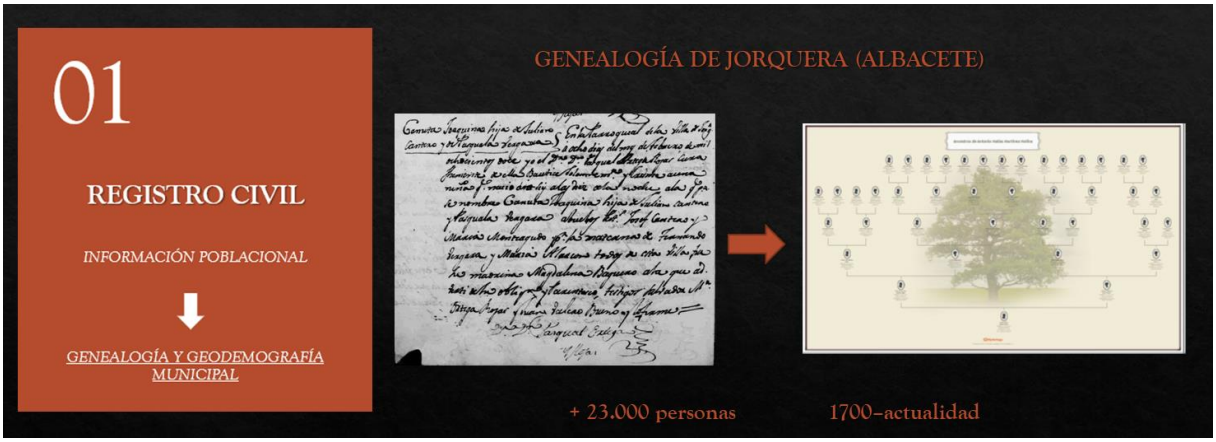

Figure 4. Results of the population component

Likewise, these tasks of digitization of the Civil Registry have made it possible to obtain an index of all these events. A web page has been created for this registry so that all the transcribed and existing information can be consulted (Figure 5).

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Figure 5. Civil Registry Indexing

Considerable progress has also been made on the cadastral part, and the first results are already available. The 27 maps of the 1965 Parcel Topographic Cadastre and the various feature sheets containing the list of cadastral owners have been digitized (Figure 6).

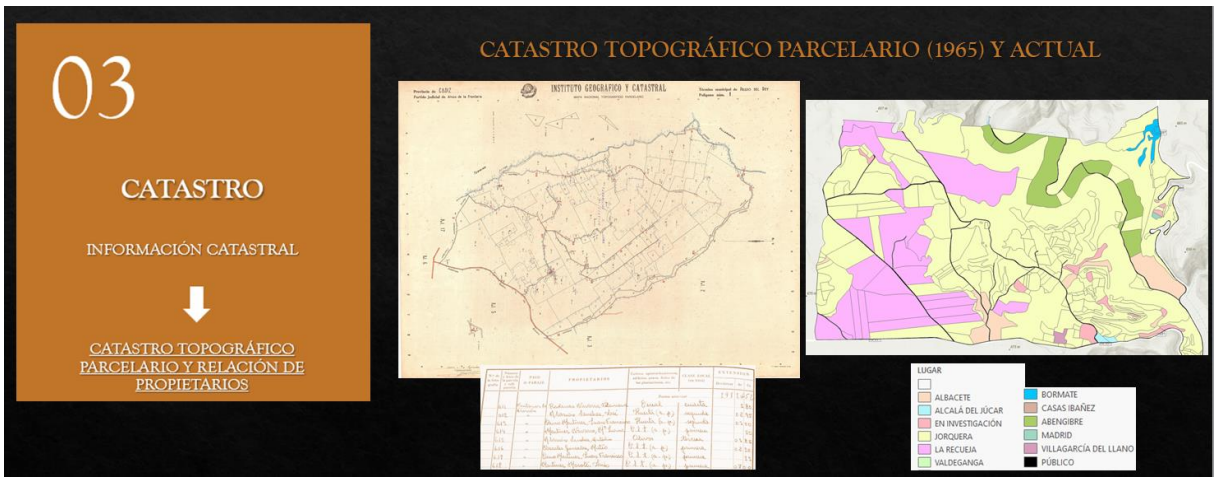

Figure 6. Results of the cadastral component

Figure 7 shows an example of georeferencing the historical cadastral cartography with a WMS of the current cadastre. Work continues on this and on defining transformation parameters between the different coordinate reference systems of each of the cartographies used.

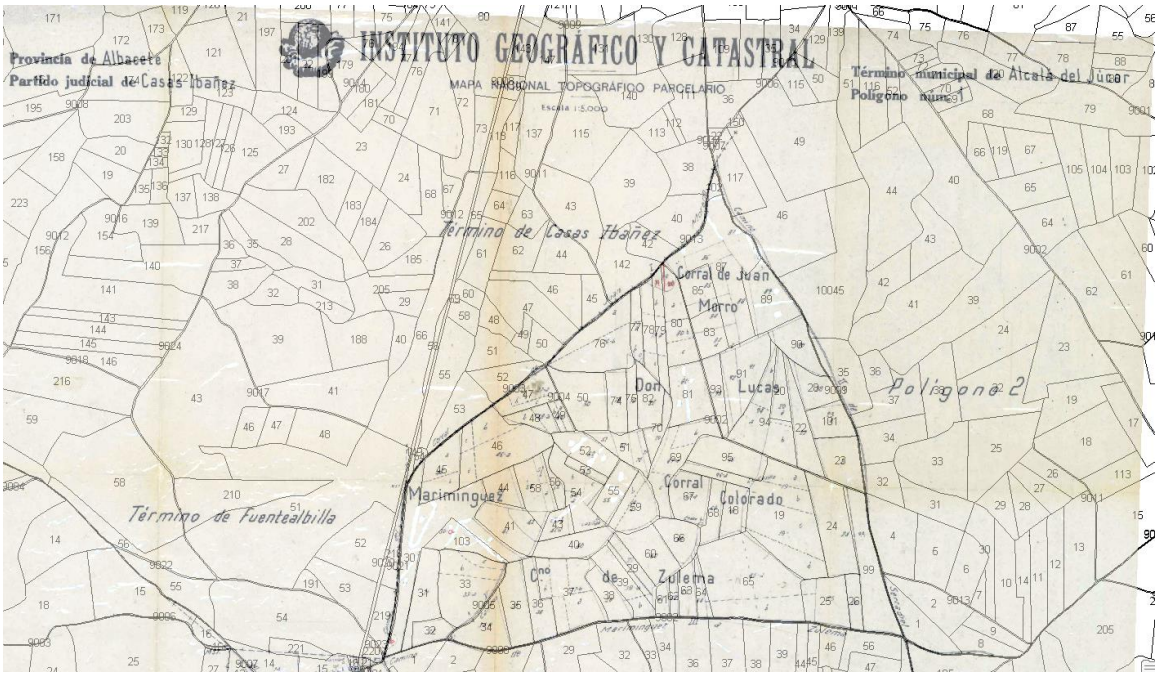

Figure 7. Georeferencing of Parcel Topographic Cadastre

In the coming months we expect to continue with all this work of digitalization, georeferencing and vectorization of the cadastral information. When all the information is complete, the first tests of the implementation of GeoAI will be carried out.

5. CONCLUSIONS

The search for a rigorous and efficient methodology for the geolocation of rural properties based on population and genealogical information and with the support of a cadastral cartographic base in different historical periods is being a priority in Spain. The importance of reaching coherent and useful results is awaiting the completion of the tasks of digitization, georeferencing and vectorization of all the old cadastral information. It is worth mentioning the large study area chosen with more than 4,000 cadastral parcels and more than 54 square kilometers of surface in the execution of these first steps.

Undoubtedly, all these arduous works of compilation and digitalization of population and cadastral information records and their transformation into manageable information in a GIS will allow in a later phase of the project to implement an algorithm that takes into account the geospatial topology in the so-called geospatial artificial intelligence.

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BIOGRAPHICAL NOTES

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He has been student representative of Geomatics in Catalonia (2015-2019) and in the Valencian Community (2019-2021). He is currently the Spanish Representative in the Youth Commission of APPAT (Pan-American Association of Professional Surveyors and Topographers), member of Commission 7 of FIG (International Federation of Geometers) and member of the Steering Committee of the Doctoral School and of the University Senate of the UPV.

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