



Article

# Advances in the Coordination between the Cadastre and Land Registry

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**Abstract:** A necessary and effective coordination between cadastre and land registry has always existed in Spain, but the difficulties have only been specifically addressed in the last few years. The aim of this study is to illustrate, analyse, and evaluate advances in this coordination in Spain from the beginnings of the current system in the early twentieth century, with the cadastre and land registry operating as separate organisations. A preliminary study was made in 2002 of the difficulties that needed to be overcome to achieve an ideal coordination of mainly mapped information. The study was made by gathering and analysing the opinions of various specialists who have dealt with the issue of coordination. For this research, qualitative information (current and historical) was gathered by querying documents about cadastre and land registry coordination in Spain. This information was studied and compared to identify the problems and challenges. A survey in 2012 analysed the relationship between the cadastre and land registry from the point of view of the general public in the city of Gandia. The Spanish government enacted the first specific and effective legislation on coordination in 2015 (Act 13/2015), and much has changed since its introduction. During the last five years of application, each of the problems initially highlighted has been monitored and analysed, and the difficulties that have arisen have been noted. In this study, each of these problems and challenges is analysed from various perspectives: querying documents (norms, budgets, official news, etc.), websites, digital applications, observation, and interviews. The main results of the case study in Spain are as follows: coordination is generally indispensable and cannot be postponed; there is a difficult understanding between the organisations involved; the general public associate the word “cadastre” with taxes and not with security in the demarcation of property; political will and understanding is necessary; the process is slow and requires long-term agreements; an improvement in the quality of maps is fundamental; and technology is not a problem.

**Keywords:** cadastre; land registry; coordination; land administration system; demarcation of property; boundaries; geo-referenced; cartography; Spanish case study



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## 1. Introduction

Cadastrals and land registries are basic elements in the management of territory, and their proper functioning and coordination enables a secure system to be developed that generates confidence and encourages economic growth with the sale and purchase of property [1]. The issues of land ownership and land-use rights are high on the 2030 Global Agenda [2]. More than 50% of the United Nations Sustainable Development Goals are directly related to land [3,4], and “land administration and cadastre has an obvious role to play” [5]. The first statement of the 2014 Cadastre [6] warned that all the facts about a territory must be evident in the future cadastral system to guarantee secure property rights, and that the cadastre should cover a wider field than it has since its foundation. In addition, good mapping coordination would enable better political decisions to be made in many diverse fields [7].

Internationally, there are many and very diverse land administration systems and “there is no single best institutional model for carrying out registry and cadastre functions” [8].

There are many studies and compilations on the various systems operating in Spain [9,10], in Europe [11,12], and other regions [13–16]; or other specific studies [17–19].

There are countries that follow a Latin model similar to Spain, such as many South American countries that inherited the Spanish model with separate cadastres and land registries: Colombia; Ecuador; Guatemala; Uruguay; and Paraguay [20]; and some regions in Mexico [21], Brazil, and Argentina. In these nations, coordination between both organisations is vital. There are other nations with a unified cadastre–land registry such as El Salvador, Costa Rica, Nicaragua, and some Argentinian provinces [22]. Cuba is currently examining an integration or greater coordination between both [23]. Much more information on the above nations is available in Spanish. As an example of the importance of coordination, a Latin American network of cadastres and land registries [24] was formed at the end of 2014, and coordination is frequently discussed in its meetings (Spain participates in these forums).

In Europe [25], there are countries where both agencies are integrated, such as the Netherlands [26,27], Bulgaria, Romania, Czech Republic, Finland, and Slovakia. In these years, Slovakia faces a critical period in land and property management [28]. In other nations, there are varying levels of coordination between independent cadastres and land registries, and these include Spain, Germany, Austria (where they share a database), and Poland [29]. In the case of Spain, these organisations have existed separately for more than a century. Coordination has been discussed since the earliest days, but it has not been earnestly pursued until very recently. In various other nations, the subject of land administration and cadastre is being widely discussed, and these nations include Namibia [30], Rwanda [31], Ghana [32], Indonesia [33], and Ethiopia [34].

In international forums, the need for coordination between both organisations has been raised at the cadastral level: *“The information registered in the cadastre and in the property registers must be properly coordinated and connected”* [35] and at the registry level: *“The establishment of coordination procedures between both institutions is advisable in order to more accurately define the object of property rights and how they interact with public limitation rights”* and *“coordination between the land registry and the cadastre is desirable to prevent situations of property overlapping and duplicate entries in the land registry”* [36].

The aim of this study is to illustrate, analyse, and evaluate the advances in the coordination of the Spanish experience from the beginnings of the current system in the early twentieth century with the cadastre and land registry operating as separate organisations. For readers who are unfamiliar with the Spanish land administration system, we will start with a description of its main and distinctive characteristics and the reforms introduced by Act 13/2015 on the coordination and mapping of the cadastre and land registry [37–39]. This article shows how the historical problems of coordination were defined, and it examines how each has been resolved over time and with the current regulations, and what still remains to be done. In short, the article analyses the problems and challenges to overcome and the effectiveness of the solutions proposed in Spain to achieve coordination under the new legislation (which aims to improve the physical description of properties in the land registry).

Much progress has been made in recent years, especially after the legislative reform in 2015. Although this reform was introduced five years ago, the changes it introduces are still at an early stage because the proposed model is very long-term. For readers in countries with different systems, it may also be useful to understand these experiences.

## 2. Cadastre and Land Registry in Spain

Spain is a country in south-western Europe and has been a member of the European Union since 1986. It has a total area of 505,944 km<sup>2</sup> [40]. The population is approximately 46.5 million, and the gross domestic product is some 1.8 trillion USD—the economy being ranked 15th in the world [41].

Since their founding, the cadastre and land registry have been independent and pursued different objectives; the cadastre has been based on maps, and its basic aim has

been to levy tax (it reports to the tax ministry). Its basic unit is the “cadastral parcel”. The land registry (reporting to the ministry of justice) is a voluntary register of rights (the Spanish system is very similar to the registration of title system) [42]. When it was founded, the land registry lacked any mapped records [43]; and the basic unit is the “land registry unit”. This unit would often coincide with the cadastral parcel, but not always; as, for example, in Cuba [44].

### 2.1. Cadastre in Spain

The cadastre, formally known in English as the Spanish Directorate General for Cadastre (DGC), manages land in 7603 Spanish municipalities (of a total of 8.124 municipalities in Spain) and holds details on some 78 million urban and rural properties as well as other properties with special characteristics [45]. The DGC manages all of Spain, with the exception of the provinces in the Basque Country and Navarre, in the north—which are managed by an independent but similar system. The DGC has digital maps covering the whole nation. These maps have been freely available since 2004 on the website of the Electronic Office of the Cadastre (SEC) (Figure 1), which is similar to other countries [46]. These digital maps were updated with open source technology at the end of 2018 (currently OpenLayers 4). [47]. The SEC enables any citizen (after identification) to download vector maps in SHP and DXF formats—and in 2019, more than 398 million downloads were made. “The availability of a digital, up-to-date and easily accessible cadastral database has become a primary requirement for undertaking efficient land administration and/or spatial planning decisions for any country” [48].



**Figure 1.** Cadastral map for printing available from the Electronic Office of the Cadastre (SEC), and based on an orthophoto from the Aerial Orthophotography National Plan (PNOA). Source: Directorate General for Cadastre (DGC).



The Descriptive Cadastral and Graphic Certification (CCDG) is the document that confirms tax, legal, and economic data about real estate properties appearing in the cadastre. This certificated document includes a map. In consultation mode (without access to protected data), the general public may freely download alphanumeric information from the SEC without being registered users. Registered users can download more complete information [49]. Some 7.55 million CCDGs were downloaded in 2018, and more than half of these were downloaded by public officials such as notaries and land registrars.

## 2.2. Land Registry and Notaries in Spain

Land registrars and notaries are regulated by the General Directorate for Registries and Notaries (DGRN), which is part of the justice ministry. Both professions are organised within associations. The land registrars are organised nationally by the Spanish Land and Trade Registrars Association (CORPME), and its 1058 members may only practice within geographical territories. Notaries belong to a number of regional organisations under the umbrella of the General Council of the Notariat (CGN).

Toward the end of the 1990s, the land registries realised the importance of maps for defining the location of land registry units. The registries signed an agreement with the DGC to use cadastre maps as a reference, and at the same time, they designed their own application (Geobase) to show the land registry units [50]. Various versions of the Geobase software were being used at various levels by the land registries. Currently, the association is using just one version of the application (Geobase 4), and all the land registries should be using this version (Figure 2).

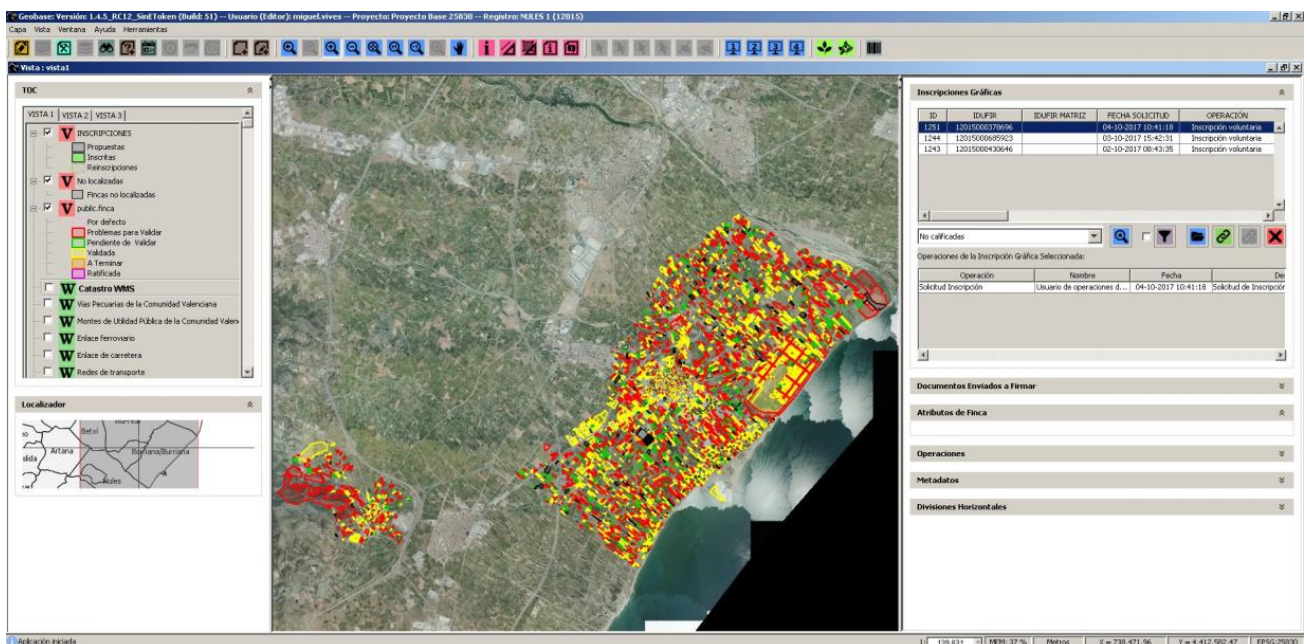


Figure 2. Software Geobase 4. Source: Land Registry Nules 1, Castellon, Spain.

## 2.3. Comparative Scheme Cadastre–Land Registry in Spain

Table 1 shows the key characteristics of the cadastre and land registry in Spain.

**Table 1.** Comparative scheme cadastre–land registry in Spain. Source: authors.

<i>Concept</i>	<i>Cadastre</i>	<i>Land Registry</i>
<i>Ministry</i>	Tax	Justice
<i>Supervisory organisation</i>	General Directorate for Cadastre (DGC)	Spanish Land and Trade Registrars Association (CORPME)
<i>Main objective</i>	Tax (+ other purposes)	Legal (preventive legal security)
<i>Role</i>	Collect property tax	Register of rights
<i>Type of management</i>	State administration	Private management (land registrars are publicly appointed self-employed professionals)
<i>Year of legislation originating current system</i>	Cadastre Act 1906 (current legislation 2004)	Registration Act 1861
<i>Basic unit</i>	Cadastral parcel	Land registry unit
<i>Basic unit identifier</i>	Cadastral reference (RC)	Unit registry number—IDUFIR Current: CRU (Unique Registration Code)
<i>Registration</i>	Obligatory	Voluntary except when a mortgage exists
<i>Maps</i>	From the beginning. Rural: 1/2000 and 1/5000 Urban: 1/500 and 1/1000 Various techniques	Mainly written descriptions. Cadastral maps have started to be included by some land registries since the 1990s
<i>Territorial continuity</i>	Continuous	Discontinuous
<i>Organisation</i>	DGC in almost all of Spain Rest: four independent regional systems (in provinces of Navarra, Vizcaya, Álava and Guipúzcoa)	1058 land registries within geographical territories
<i>Access and confidentiality</i>	Data on ownership and tax value is confidential	Public data

### 3. Spanish Regulations on Map Coordination between the Cadastre and Land Registry

Coordination has been necessary and indispensable for decades and was touched on in the Cadastre Act of 1906. However, none of the early legislative attempts were effective. The significant year for improvements in mapping was 1980 when the Geographic and Cadastral Institute (which was responsible for cadastral issues) was sub-divided into what is now the National Geographical Institute (IGN) (responsible for mapping) and the Directorate General for Cadastre (DGC) (responsible for cadastre). The DGC currently has 2265 employees [51] and only employs a few specialists in mapping (most of the specialists were transferred to the IGN).

Act 13/1996 [52] was not specifically directed toward the cadastre, but it represented a turning point in the area of coordination between the cadastre and land registry. The act required urban cadastral references to be used as links between the cadastre and land registry (rural land was similarly linked in 2003). All notary and land registry documents from this date were required to include a cadastral reference. Although the act of 1906 had mentioned this form of coordination, it took another 90 years before effective legislation was finally introduced.

This cadastral reference often enables the identification of the cadastral parcel corresponding to one or several land registry units, and in this way, the mapped information of the cadastral parcel begins to be associated with the written descriptions corresponding to the land registry unit; although this did not signify that the mapped cadastral indications were correct. For this reason, several years were spent drafting new legislation that would enable coordination between the cadastral maps and the land registry units. Better legal security could be offered if the indicated land registry units coincided graphically with

cadastral parcels. To this end, the government concluded three years of discussion by introducing Act 13/2015 that enabled mapping to be coordinated between both organisations. This act modified both registration legislation and cadastre legislation. The land registry began to base its registrations on cadastral maps, although it overlaid an auxiliary software (Geobase) to identify land registry units. When a coordination is achieved between a land registry unit and a cadastral parcel, the demarcation of the property is clearly mapped, and so the location and size specified in the cadastral data is recognised legally. This means that the cadastral parcel boundary becomes the ownership boundary, and this offers greater legal security for owners [53].

This coordination is obligatory in certain cases and requires a geo-referenced graphical representation (RGG) that could be the cadastral itself, or if a modification is required or the cadastre is incorrect, then an alternative geo-referenced graphical representation (RGA) is required [54]. These map representations must comply with technical requirements defined in regulations published in Act 13/2015 [55–57]. These regulations also specify that the GML Inspire format must be used [58]. This legislation has generated considerable change in the processes involved in real estate transactions. It has also meant a change in the objectives of many people using cadastral maps—for many users, the main objective is now to obtain greater legal security in the demarcation of property, rather than to resolve questions related to tax.

In addition, according to the cadastral regulations, the CCDG must be included in all the documents authorised by notaries that contain deeds or legal transactions that may lead to changes in the cadastre or the land registry (meaning changes in ownership and physical alterations to real estate). The DGC redesigned its CCDG following the introduction of Act 13/2015 [59] (see Figure 3).

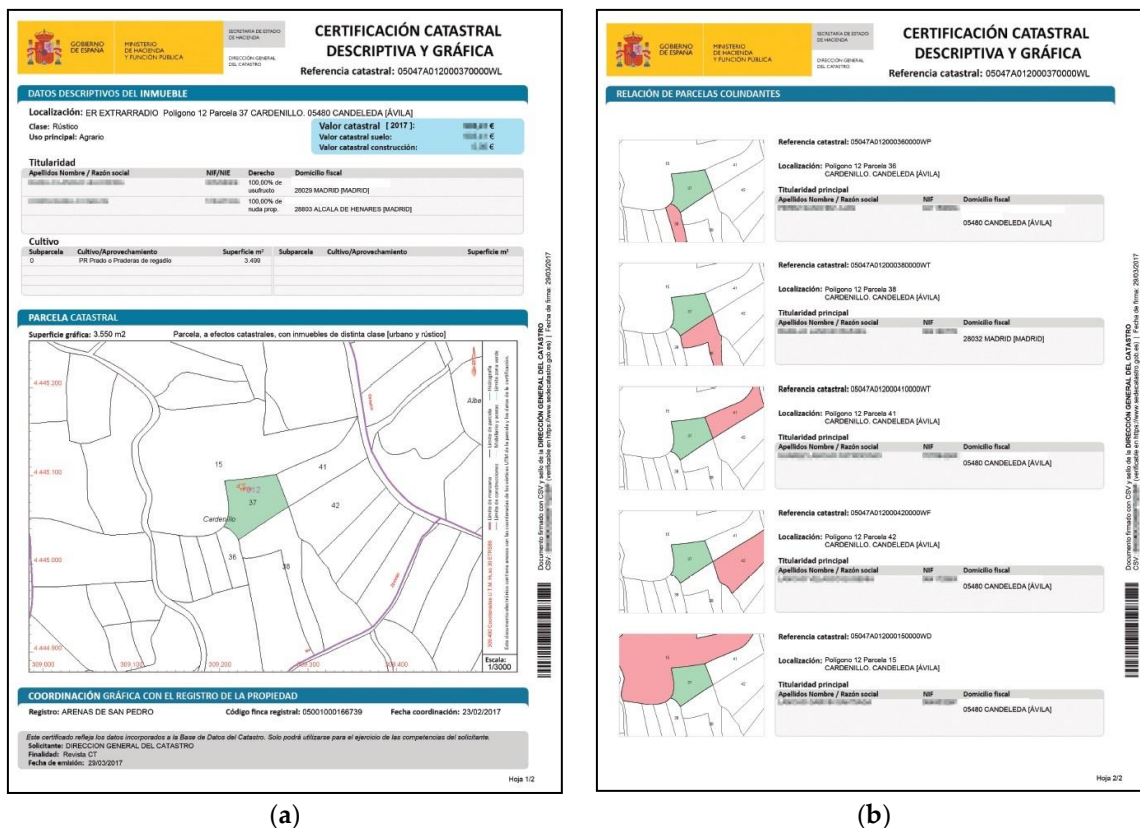


Figure 3. Descriptive Cadastral and Graphic Certification (CCDG) of a cadastral parcel according to the design 11 November 2016. Front (a) and back (b) Source: DGC.

The European INSPIRE Directive refers to cadastral parcels. The cadastral parcel model establishes the dataset for a minimum of homogenisation in European cadastral data. The INSPIRE Directive also sets the SDI (Spatial Data Infrastructure) services (such as WMS, WFS, and GML formats) for sharing cadastral data in a standard way, as well as the WMS map symbology. Spain has adopted all these standards, and Spanish cadastral data can be obtained in accordance with the INSPIRE cadastral parcel model and symbology. It is important to remark that the Spanish cadastre manages much more information than specified in the mandatory INSPIRE cadastral parcel dataset.

#### **4. Study Made Prior to the Coordination from the Perspective of Various Specialised Authors**

There are clear differences between the cadastre and land registry, and so, to achieve a successful coordination, it is necessary to know which problems needed resolving. A study was made in 2002 of the aspects that needed overcoming to reach an ideal level of coordination. This study gathered the opinions of various specialists who had addressed the issue of coordination in Spain [60,61]. A study had been previously made of all the historical cadastral legislation that referred to coordination with the land registry [62]. A legislative compilation prepared by [63] was used for gathering legislation passed before the 1950s. In Finland, [64] explored different user groups' perceptions.

##### *4.1. Methodology*

For this research, qualitative information (current and historical) was gathered by querying documents about the cadastre and land registry coordination in Spain. This information was studied and compared to identify the problems and challenges.

Some of the relevant literature has been gathered from specialist journals and presentations given in conferences and workshops. The emphasis has been on the mapping of cadastral parcel and land registry units. The journals and workshops focussed essentially on cadastre, civil law, and surveying. Research in land administration is multidimensional [65]. These documents have been ordered chronologically and mostly appear from the 1980s onwards. The names of authors are noted together with the post occupied; type of publication; name of publication; and year of publication. Most of these documents were printed on paper given the period in which they were published.

There is some relevant legislation from before the 1980s. The Cadastre Act of 1906 referred to coordination between the cadastre and land registry, and much subsequent legislation touched on the issue (but in the vast majority of cases, it remained a simple declaration of intentions). A conference held 75 years ago and referred to in [66] is one of the oldest documents. It is notable that many of the observations made then were similar to observations made in subsequent years—and comments made even today.

From the gathered information, the 46 documents that broadly discuss the subject of coordination were studied more thoroughly. Information was extracted on the authors' opinions on the obstacles to coordination and its relation to mapping; the consequences of this problem; possible solutions; and the various attempts at legislation. Being specialised texts, many authors provided considerable detail on every aspect. Independently of the author, we looked for common themes to identify the problems.

The documents were divided into the following three periods and then studied considering that the key legislative change was Act 13/1996:

- Late 19th and early 20th century
- Early 20th century up to Act 13/1996
- Subsequent to Act 13/1996.

##### *4.2. Analysis of the Information Gathered*

The analysed authors were considered specialists because the majority held various positions in relevant organisations or had contributed extensive experience on the subject. These contributors can be classified into three groups: a first group of staff from the



cadastre; a second group with a legal background (mostly land registrars); and a third group of technical staff (mainly land surveyors) who traditionally marked the ownership boundaries. This third group has always been the most vocal about the lack of mapping coordination and remain so today. The analysis reveals clear differences between these three groups on the same subjects, with different points of view; although in most cases, they tend to agree on the issues raised. Each group perfectly understands its reality but is largely unaware how others work. This was recently observed by [67], who said, “The legal people do not understand the technicians, and the technicians do not understand the legal people’.

Various authors insist that a modern cadastre should be multifunctional and multi-purpose, in accordance with the international trend [68]. These authors explain that the word “cadastre” should be understood as a territorial register, rather than just a concept linked mainly to tax collection.

The main problems associated with coordinating maps between the cadastre and land registry are shown in the first column of Table 2. The general situation is first defined, which is followed by subjects such as land registry, cadastre, IGN, and mapping. All the problems raised at various times are described, although some have now been resolved.

**Table 2.** General outline of the challenges to be overcome in order to achieve cadastre–land registry coordination in Spain. Source: authors.

<b>Challenges to Be Overcome for Improving Cadastre–Land Registry Coordination</b>				
<i>Problem-Challenge</i>	<i>Aspect Analysed</i>	<i>Solved</i>	<i>Partly Solved</i>	<i>Unsolved</i>
1. Economic aspects given priority over social-political aspects.	Creation of specific budgets.		X	
2. Lack of funding and search for lower costs and faster processing.			X	
3. Difficulty integrating territorial information generated from different sources.	Use of standards and technological advances to integrate territorial information from various sources.		X	
<b>Cadastre and land registry</b>				
4. Under different supervisory organisations.	Under different ministries.			X
5. Lack of legislation on coordination.	Specific legislation on coordination.	X		
6. Lack of a connection element.	Introduction of connection element.	X		
7. Regulatory efforts are just statements of intentions.	Effective normative attempts. Approval and majority support in parliament.		X	
8. Different criteria of expression.	Current system and improvements.		X	
9. Duality land registry unit/cadastral parcel.	Current system with improvements.		X	
10. Lack of coordination.	Joint meetings and events.	X		
11. Different organisational purposes.	Cadastre is adapting so that its maps serve as a basis for legal security		X	



Table 2. Cont.

<b>Challenges to Be Overcome for Improving Cadastre–Land Registry Coordination</b>				
<i>Problem-Challenge</i>	<i>Aspect Analysed</i>	<i>Solved</i>	<i>Partly Solved</i>	<i>Unsolved</i>
<b>Cadastre and IGN</b>				
12. Lack of coordination.	Shared initiatives.	X		
<b>Land registry</b>				
13. Lack of map base.	Maps indicate land registry units.		X	
14. Description of estates through written declarations.			X	
15. Voluntary registrations.	Current system.		X	
<b>Cadastre</b>				
16. Traditional slowness to adapt.	Adaptation to new international initiatives.	X		
17. Tax-based nature.	Current system.			
18. Problem: Tax/topographic perfection.	Greater metric precision demanded.		X	
19. Lack of public awareness of the role of the cadastre.	Initiatives planned to heighten public awareness.		X	
20. Cadastre demarcations have no legal value.	Current situation.		X	
21. Cadastral maps are very diverse.	Existence and classification of sources of surveying of cadastral maps.		X	
22. Limitations on the accuracy of cadastral information.	Improvements in the quality of cadastral information.		X	
23. Cadastre updates not given sufficient priority.	Collaboration agreements for updates are being studied.		X	
24. Slow to respond.	Efforts being made to reduce response times.		X	
25. Lack of control mechanisms.	Study current control mechanisms.		X	

Table 2. Cont.

Challenges to Be Overcome for Improving Cadastre–Land Registry Coordination				
Problem-Challenge	Aspect Analysed	Solved	Partly Solved	Unsolved
<b>Cadastral maps</b>				
26. Lack of legislation on mapping.	Specific legislation regarding mapping.	X		
27. Interest in increasing the rate of obtaining and using cadastral information.	Study of related projects based on mapping techniques used, budget, and response time.			X
28. Interest in obtaining a quality map database.	Historical study of the evolution of mapping in terms of quality improvements.		X	
29. Ignoring solutions proposed by experts.	Considering as experts the analysed specialist authors and studying if the problems and solutions proposed have received consideration.		X	
30. The IGN has stopped making cadastral maps.	Who currently does cadastral mapping?			X

## 5. Analysis of the Relation between Cadastre and Land Registry from the General Public Perspective

The subject of mapping coordination between the cadastre and land registry was studied until 2003 by experts who understood the existence of two different organisations and believed that coordination was necessary. Several years previously, a report had been published by the Spanish ombudsman on the reality of the cadastral, and this followed a large number of complaints made about the services of the DGC [69].

A survey was made in 2012 on a representative sample of people in the city of Gandia on the eastern coast of Spain. The survey was a personal study, and it was carried out for an academic work with the collaboration of two students. Gandia has a population of about 82,000 and is one of the larger cities in the region of Valencia [70,71].

### 5.1. Methodology

Firstly, the objectives of the survey were established, which was followed by how the information would be gathered, and finally the design of the questionnaire. It was considered that such a survey must be made in the street with a diverse range of respondents, and so an easy-to-understand questionnaire with short closed and open questions was designed.

The population to be studied was determined, and a random sampling was carried out: the representative sample size was determined with data from the Spanish Statistical Office (INE) for 1 January 2011. As the survey was related to the cadastre and land registry, the population living in the registry demarcations of the three land registries covering the area around the town of Gandia were considered. The sample was reduced to the range of inhabitants aged between 25 and 74. From a total population of 133,169, it was calculated that 368 interviews would produce a confidence level of 95%. However, during data collection, it was possible to increase the sample size, and a total of 406 people were surveyed (including 240 women).

Once the questionnaire was designed and the number of necessary interviews calculated, the fieldwork was carried out to gather the information. The surveys were conducted in the main avenues of the city near the cadastre and land registry offices in order to find individuals who were dealing with these offices and could offer their opinions.

### 5.2. Analysis of the Results of the Survey in the City of Gandia

Regarding educational level, the respondents were divided into low (32% of the sample), medium (34%), and high (34%). Many foreigners live in Gandia, and therefore, it was considered worthwhile interviewing foreign citizens to discover their opinion, although only 4% of the total sample were foreigners.

The most significant results were as follows:

- People were asked which words they associated with the cadastre and land registry. Most of the words associated with the cadastre were related to property, tax, money, census, and cadastral values. The land registry was associated with documents, money, properties, and public registration. Some people confused the cadastre with the land registry.
- Almost 60% of respondents said that the organisations do not work in coordination: on a scale of 1 to 10, some 56.5% of respondents selected the low level of 1 for coordination and said that the technical resources existed for a better coordination. Some 30.5% of the sample gave a score higher than 5 for coordination, and 12.5% believe that there was a certain level of coordination that could be improved for the benefit of the public.
- Many of the procedures could be completed online through the SEC, but not everyone is able to use the internet for these procedures.
- For a standard profile, the words associated with the cadastre were property tax, and the words associated with the land registry were property deeds or payment due. People reported that they had needed to visit the same office twice to complete a single procedure, and that when at the office, they needed to queue for between one and two hours. Once they had reached the head of the queue, they reported that the procedure was completed in a period of between 2 and 30 min. People considered that the quality of service was good.

### 5.3. Other Questionnaires

A survey was also made of university students who were just about to start their third year of studies in cadastre [72]. Students were asked about the words associated with cadastre and the land registry. Similar to the citizens of Gandia, the students tended to confuse the concepts, associating both with economic as well as mapping aspects (these students had spent more than two and a half years studying the subject of cadastre and had technical backgrounds). In general, the students found it strange that they would study concepts and legislation related to land registry in a technical subject. They also often assumed that coordination existed between the organisations and were surprised to discover that such coordination did not exist.

Comments from land surveyors in the province of Alicante are also available. Alicante was in 2017 the Spanish province with the highest percentage of foreign buyers—40.76% [73]. It is quite common for foreigners to struggle to understand the Spanish system [74], and this can be seen reflected in a television programme [75].

## 6. Analysis of the Solutions Proposed in Spain for the Problems of Coordination

Since the first attempts at coordination at the beginning of the last century, more than 120 years have passed, and society, technology, and regulations have advanced considerably. This has meant that many of the problems initially raised regarding coordination have already been resolved. It was the incorporation of cadastral references into notary and registration documents following Act 13/1996 that represented the first step in effective coordination. However, there was still much to left to do, and the subsequent Act 13/2015 took the decisive step of changing the land registry into a registry of rights superimposed on cadastral maps. This approach enables a property to be clearly delimited and so provides greater legal security—providing that the cadastral parcels are coordinated with land registry units.

This recent legislation has advanced the coordination by overcoming several problems—while leaving others pending. Fresh problems have appeared as coordination has pro-

gressed. For all these reasons, we have attempted to study the effectiveness of the advances and measures proposed in Spain to overcome these initial problems—and identified the main obstacles to full and effective coordination.

In this study, every one of the problems and challenges has been analysed from different perspectives, such as querying documents (norms, budgets, official news), websites, digital applications, observation, and interviews.

### *6.1. Methodology*

Each of the problems identified since the first attempts at coordination at the beginning of the last century—including those in Section 4—are considered. The monitoring has mostly been carried out during the five years since the introduction of Act 13/2015 (1 November 2015), given its great importance. The immediately previous years during which the act was being drafted are also studied. All types of information have been gathered on the new regulations, such as new legislative developments; appearance and development of software; courses taught; workshops and conferences; declarations by individuals and organisations involved; change in procedures; and pilot tests on coordinating cadastral parcel and land registry units to study problems that have arisen, and the time periods involved. An important aspect to highlight for the study has been the opinions of various specialist authors. A wide range of opinions have been gathered regarding the progress of the legislation. Three clearly differentiated groups emerge: a first group of cadastre staff; a second group of legal practitioners (mainly land registrars and notaries); and a third group of map surveyors.

The most recent opinions by authors and organisations are studied through articles published in various media—mostly social networks given the immediacy of the changes and opinions. Social networks open the door to almost instant opinions from the moment an event occurs; and various blogs, LinkedIn accounts, and Twitter feeds have enabled us to gather the opinions of legal and technical personnel. The cadastre has a news release policy regulated by its ministry with official opinions published through its videos or in its workshops. The discussions in these workshops are generally very lively, and this has enabled us to gather more opinions. The latest major changes in coordination are reflected in the constantly improving websites of the cadastre and SEC.

Opinions on social networks can sometimes be biased and critical—and opinions that would be impossible to obtain by other means have been gathered through direct interviews or discussions. In the same way, the most recurrent questions and comments have been gathered from several forums.

### *6.2. Results Analysis*

To offer the most concise information, Table 2 shows all of the results in a condensed form. The left column (numbered 1 to 30) shows the problems and challenges to be overcome, the middle column shows the aspects analysed to describe the current situation, and the right column shows to what extent the challenge has been resolved.

For challenges that are unresolved or half-resolved, some brief notes may describe pending or alternative solutions. Some aspects were resolved a long time ago, and some aspects have been added with others so that they can be studied together. In some cases, the current situation is simply described (Table 3).



**Table 3.** Alternatives solutions for the pending challenges in Table 2 in order to achieve cadastre–land registry coordination in Spain. Source: authors.

<b>Alternatives Solutions for the Pending Challenges in Table 2</b>	
<i>Challenges</i>	<i>Alternative Solutions</i>
1,2.	Although cadastral maps are complete, budgets are needed to improve procedures, computer applications, and the metric quality. A budget of €4,530,000 was included in 2018 to improve the positional accuracy of urban cadastral mapping using orthophotos. This is considered insufficient.
3.	International standards and new technologies enable the integration of territorial information from various sources. The Spanish Spatial Data Infrastructure (IDEE) is managed by the IGN. Adaptation to European INSPIRE Directive [76]. Following Act 13/2015, the standard GML format adapted to the INSPIRE regulations is being used. Applications continue to be developed to integrate territorial information with international standards. At the international level, there is an ISO 19152 standard on the Land Administration Domain Model for integrating information, and actions are needed for the design and development of implementation standards in this domain [77]. Not currently used in Spain, although it is being studied, and a first step was the participation of DGC staff in the Spanish translation of the ISO standard [78].
<b>Cadastre and land registry</b>	
4.	Continue in different ministries. Proposed solution: the maximum possible coordination is sought with information exchange agreements.
5.	Existing specific legislation: first step taken with Act 13/1996 and then with Act 13/2015.
6.	Since Act 13/1996, the 20-digit cadastral reference is unique for each cadastral parcel.
7.	The effectiveness of Act 13/1996 depends on the land registries—and the act is generally complied with—although not uniformly. Act 13/2015 was widely supported in parliament, which implies that a change of government will not mean its repeal. Compliance between notaries and registrars, and its application in the cadastre, is still being studied. Its final implementation has not yet happened, and the coordinated cadastral parcel–land registry units that show changes in the cadastral maps are still in test phase. The managers responsible for these issues at DGC and CORPME have changed posts several times in recent years, and this has slowed communication. Proposed solution: effective communication between the organisations so that agreements can be reached.
8.	There are different ways to register and identify alterations such as aggregations and groupings of units between the two registries Proposed solution: the legislation for registering units between two registries has been modified [79] so that an entry is made in just one land registry in a similar way to cadastral parcels in the cadastre.
9.	There are still two different basic units. Proposed solution: Since Act 13/2015, the land registry has also changed its own identifier (registration number or IDUFIR), and it is now unique throughout Spain and known as the Unique Registration Code (CRU).
10.	In recent years, there has been a rapprochement between both organisations, and they now participate jointly in many forums and events, as well as jointly presenting the theme of coordination in international forums [58,80–82]. Such cooperation did not occur in previous decades.
11.	Although the ultimate purpose of each organisation remains the same, there are continuous improvements in the cadastre that serve many other uses and purposes. The cadastre is adapting to greater demands so that its maps serve as a basis to provide legal security in the demarcation of property of land registry units (challenges 1 and 2).
<b>Cadastre and IGN</b>	
12.	Coordination in mapping subjects is led by the IGN through the Spanish Spatial Data Infrastructure (IDEE) and in the technical working groups on the LISIGE-INSPIRE regulations. The cadastral parcel group is led by a representative of the DGC. There is also representation of the DGC in Eurogeographics.
<b>Land registry</b>	
13,14.	Cadastral maps have been used as an auxiliary graphical base by the land registry since the end of the 1990s (Geobase Project), and these maps were recognised as the official map reference following Act 13/2015. Map referencing is not mandatory in all cases, and purely written descriptions are still allowed. Proposed solution: there is the possibility of voluntary mapped registration of the land registry units in the land registry in cases of non-compliance.
15.	Continued voluntary registration in the land registry, except in cases of mortgages where registration is mandatory. Registration involves a cost that the state does not wish to force people to pay. Proposed solution: The possibility of mandatory registration in areas of public domain is being studied.

Table 3. Cont.

Alternatives Solutions for the Pending Challenges in Table 2	
Challenges	Alternative Solutions
<b>Cadastrre</b>	
16.	Continuous maps of all Spain are now freely available in digital format through the SEC. Maps adapted to international standards and standard formats (such as INSPIRE and GML) are available using open source collaborative environments [83] (challenge 3). The cadastre and the land registry already have uniform resource identifiers (URI) [84], which are known as CSV [59], to identify documents that can be accessed online.
17.	See challenge 11.
18.	See challenge 11. There are two descriptions in the cadastre (one written and the other mapped) with a tolerance level of up to 10% [85], and Act 13/2015 stated that a mapped description is the only description that can be registered in the land registry. The positional accuracy of the cadastral maps is to be improved (challenges 1 and 2).
19.	Citizens continue to have their own interpretation of the role of the cadastre, depending on their country of origin. Spaniards see the cadastre as closely linked to collecting taxes, and so the DGC is not generally popular. No citizen awareness campaign has been carried out by the cadastre or the administration, although there are initiatives led by organisations such as CORPME or the Spanish Official Corporation of Engineering in Geomatics and Land Surveying (COIGT) to make Act 13/2015 better known for its usefulness in preventive legal security.
20.	Cadastral maps were never legally valid for indicating boundaries. Proposed solution: under Act 13/2015, the registration of an RGA that means creating a new boundary, or modifying an existing cadastral boundary, implies the participation and consent of neighbouring owners—and so finally the land registry unit can be coordinated. An RGA cannot be registered without this consent. This is why adjoining parcels are generally cited in documents by notaries and/or registrars. Although there are still problems of interpretation between legal practitioners about when, whom, and in which cases, it is necessary to notify neighbouring owners.
21.	There are still maps made with different techniques in the same database in digital format with various and unknown metric precisions. Old cadastral maps are frequently demanded in the courts to resolve conflicts: especially the Topographical Cadastral Map (MTP), as it was made using classical topography and offers greater metric precision. Proposed solution: The possibility of including metadata, including precision, in cadastral maps is being studied, as it is employed in the Czech Republic [86]. The possibility of making cadastral maps available to the public is also being studied.
22.	For alphanumeric information, there is collaboration with notaries and registrars in reporting changes of ownership: recent automatic changes have been made in just one minute in tests. For maps, improvements have been proposed (challenges 1, 2, 11, and 18). Due to insufficient budgets, these improvements do not cover all of Spain, and according to technical specialists and jurists, greater metric precision is also necessary.
23.	Cadastral project for the detection of unregistered buildings [87]. Signing of agreements with city councils and professional associations [88]. Agreements with local administrations are being improved and expanded.
24.	A lack of resources (fundamentally people) means slow responses. Proposed solution: Cooperation agreements (challenge 23). The automation of processes is planned with direct access to the cadastral database for collaborators to make modifications. To accelerate modifications of cadastral maps in accordance with Act 13/2015, an alternative map validation system has been devised that helps avoid errors (prior to checking) when loading GML files sent by notaries and registrars. The system is already widely used, although the exchange of graphic information between land registry and cadastre still does not work completely [89,90].
25.	There is an inspection process in the cadastre, although due to lack of resources, very few inspections are made. A specific updating campaign was made to detect unregistered buildings between 2013 and 2017; and the cadastre also uses cooperation agreements to detect unregistered activity (challenge 23).

Table 3. Cont.

Alternatives Solutions for the Pending Challenges in Table 2	
Challenges	Alternative Solutions
<b>Cadastral maps</b>	
26.	The most important specific legislation: mapping regulations (1986) on geodetic reference system (2007); National Mapping System (2007); transposition of INSPIRE Directive: LISIGE (2010); and the first National Mapping Plan (2017-2020) [91].
27.	The last two major DGC projects have been studied (challenges 1, 2, 11, 23, and 15). Both were for constructions and urban cadastre (not for rural land) given its greater economic value. Photogrammetry techniques were used because they are quicker and cheaper than classical topography; budget limitations (challenges 1 and 2).
28.	Efforts being made to improve the quality of maps and clear improvements can be seen, although much remains to be done [92].
29.	The list presented in the table mostly includes problems raised by experts; although in general, the proposed solutions revolve around solving problems that have been analysed in this table. Many of the solutions are still in process.
30.	Since the 1980s, the DGC has handled cadastral map-making (previously done by the IGN) mostly using collaborating companies and aerial photography (photogrammetry, orthophotos, etc.).

Spain is currently making the greatest advances in coordination between the cadastre–land registry in its history. Much has been achieved, but new and significant problems have arisen that were previously unimaginable. Current themes under discussion include the following:

- Design of a good protocol for the provision of reciprocal information between both organisations and adaptation of operational techniques.
- Define and agree mapping elements such as positional accuracy improvement [93,94], the margins of technical tolerance, and displacement in cadastral maps.

This last aspect has been the most discussed, especially from the technical point of view, since it involves deciding on the mapping techniques [95], and this has an impact on the cost of work, how maps are presented, and their final precision. Technical surveyors consider it essential that they assume responsibility in this regard, although this opinion is not shared by the cadastre [96].

## 7. Conclusions

There is broad agreement that cadastre–land registry coordination is necessary and urgent among the cadastre, legal practitioners (generally land registrars and notaries), surveyors, and the general public. The general opinion is that Act 13/2015 has been the most effective legislation passed to date (although it has been criticised and is improvable).

Among the organisations and their staff, on the other hand, there is a lack of understanding and general knowledge—and this is reflected in how each group sees the same reality differently. Vocabulary and objectives vary considerably, and there is no common language. Training is fundamental for understanding how to apply the legislation, and surveyors need a greater understanding of the legal aspects, while legal practitioners need a better understanding of the technical aspects. In this case, a larger shared understanding is needed between the different agencies and groups involved, and each group should train the others.

The general public is confused by the word “cadastre”, and in Spain, it is often associated with tax, rather than legal security in land ownership and a clear demarcation of property. Public awareness projects are needed, as launched in some Ibero-American countries—such as the Honduras [97]. It is necessary to show the public the work of the different organisations, and the benefits for society of these organisations.

It can be seen that some 30 problems analysed in Spain have been totally resolved. A willingness to coordinate has become apparent over the last five years, although the vast majority of challenges remain works in progress. Several of these challenges coincide

with examples of good practices from around the world for good governance and land administration [98]. This also brings to mind the slow pace of this process, since many of the problems need several years to resolve, and this exceeds the four-year terms of Spanish governments [8]. Many organisations, personnel, factors, and different processes are involved, and the consent of the public is fundamental. This is why it is important that the political will for continuous coordination between organisations is widely supported—as remarked in [99]: “*Highlighting the importance to decision makers of the need for timely and fit for purpose and administration and management*” [100].

Among the unresolved problems, we can see an increased interest in making greater use of information and a drive for lower costs and greater speed—instead of more funding to improve the heterogeneous quality of maps [92]. This aspect was highlighted by several authors when explaining how better coordination would provide the territorial administration system with greater legal security [101]. There is a lack of resources, and funding is crucial for the improvement of mapping quality—providing that the other problems are also resolved. As a World Bank expert [102] affirmed after a multitude of pilot experiences, the main problem is not money, nor technology, but the organisations (as is also the case of Peru and Honduras) [103]. Technology is not seen as having special relevance for better coordination, nor is it seen as an obstacle. It can be considered a tool that enables streamlining processes after they have been legislated and agreed upon. Funding for technology is needed. However, before investment, it is necessary to reach long-term agreements that are reflected in legislation.

This study compares different opinions that have been taken from different points of view: cadastre, land registry, technicians, and the general public. All these points of view give a broad overview of the situation. A study of how other countries have tackled the same challenges may offer solutions.

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