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Estimating benefits of Spatial Data Infrastructures: A case study on e-Cadastres

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ABSTRACT

The investments of public administrations and organisations for the development of Spatial Data Infrastructures (SDIs) should be informed by the analysis of the concrete benefits that such infrastructures may bring to their providers, their users, and society at large. Bibliographic evidence suggests that very little has been done in this respect, apart from theoretical hypotheses and some ex-ante assessments using the few data and experiences available. On the other hand, recent studies on regional SDIs have indicated that the application related to the Cadastre may have a big impact on society, due to the large number of users recorded. Indeed, e-Government services, including the ones providing access to Cadastral activities, have seen a big development in recent years. This paper analyses the case study of e-Cadastre, focusing on the benefits that society may obtain, in comparison with the traditional paper-based Cadastral service which still coexists with the e-Cadastre. The paper will present and analyse the results of a survey to several European Cadastral Agencies, focusing on the benefits for the users, in terms of time and cost saved. The findings show that the shift from the paper-based alternative to the electronic alternative helps citizens save time and money, and therefore provides partial justification to the required investments.

1. Background

1.1. Introduction

During the last 20 years we have witnessed concerted efforts worldwide to develop Internet-based infrastructures to make data and information products more widely accessible and shareable to support science, public policy in different thematic areas, and provide improved services to public sector, citizens and business.

Along these lines, the e-Government phenomenon, intended as the use of Information and Communication Technology (ICT) to improve services provided by public government to businesses and citizens, has transformed the way in which citizens and business interact with the public sector and access public sector data, while allowing a more efficient management of government service delivery.[2] As pointed out by Nogueras-Iso, Latre-Abadía, Muro-Medrano, and Zarazaga-Soria (2004), public sector administrations (PAs) are the main providers of geographic information, representing great part of the public sector data needed to deliver governmental services. For this reason, they need Spatial Data Infrastructures (SDIs) to manage and coordinate the use of such spatial data. We intend SDIs as the "relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data" (Nebert, 2004, p. 8[3]).

In Europe, the INSPIRE Directive (European Commission, 2007) has accelerated the pace of SDIs implementation as it requires that all Member States of the European Union develop their own infrastructures and make them interoperable through agreed technical specifications.

The Joint Research Centre (JRC) of the European Commission is the overall technical coordinator of INSPIRE. One of its responsibilities is to identify suitable frameworks that may be useful to the Member States in assessing the impact of their infrastructural investments in INSPIRE. With this in mind, the JRC, which was involved in the early impact assessment of the INSPIRE proposal in 2003–04 (Dufourmont, 2004; INSPIRE FDS & Craglia, 2003) launched a programme of activities to verify whether the assumptions on costs and benefits made at that time could be verified in practice. This programme is still in progress but has yielded some interesting results, largely validating, so far, the assumptions made in 2003 (Craglia & Campagna, 2010; Craglia & Nowak, 2006; Craglia, Pavanello, & Smith, 2010; Garcia Almirall, Moix Bergadà, Queraltó Ros, & Craglia, 2008).

In parallel, the international community, involving experts from Australia, Canada, US, Europe has organised various workshops since 2006, in order to share experiences and discuss the rationale

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[2] http://go.worldbank.org/M1JHE0Z280.
[3] Available at http://www.gsdi.org/docs2004/Cookbook/cookbookV2.0.pdf.

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and the steps for a sound assessment of the value of geoinformation, Earth observation and Spatial Data Infrastructures. Detailed reports are available in Craglia and Nowak (2006), Macauley and Laxminarayan (2010), HafenCity University (2010), the Special Issue of the International Journal of Spatial Data Infrastructures Research about the Value of Geographic Information (Borzacchiello & Craglia, 2011; Various authors, 2010).

In the course of these studies, three elements emerged that are at the basis of the work reported in this paper. Firstly, that estimating benefits is even more difficult than estimating costs; secondly, that to do so it is worth focusing on specific application areas rather than generic SDIs, and on small benefits taking place many times than looking for the big one-off benefit. Thirdly, that of the many application areas, those based on land and property are some of the most widely used. Evidence in this respect emerged from a comparison of advanced regional SDIs in 2010 (Craglia & Campagna, 2010): those who did not provide access to cadastral services had users in the range of a few thousand or tens of thousands; those who provided access to cadastral services had millions of users.

The objective of this paper is (i) to study whether there are benefits deriving from the usage of e-Government services, compared to traditional non-electronic services and (ii) to present a methodology to estimate these benefits. For the reasons outlined above, we have focused on the case study of the e-Cadastre, namely the electronic system delivering the services traditionally provided by the Cadastral Office. As defined by Williamson, Enemark, Wallace, and Rajabifard (2010), the Cadastre "is at the core of Land Administration System". It provides "large-scale representations of how the community breaks up its land into usable pieces". This spatial information traditionally has been stored in paper format, but with the advent of GIS has been digitalised and made available in electronic format. e-Cadastres use digital cadastral information to provide governmental services to the citizens, business and other PAs (G2C, G2B, G2G[4]), within an e-Government framework, and they may be supported, or not, by SDIs. However, Williamson et al. (2010) argue that "efficient and effective Land Administration Systems" – including the Cadastre component – "that supports sustainable development require an SDI to operate".

The remainder of the paper is organised as follows: the rest of Section 1 provides a synthetic review of the studies on the impact of Spatial Data Infrastructures, e-Government and e-Cadastres. Section 2 presents the methodology used to seek information about the usage of Cadastral services, the main variables investigated in the study and the survey design. The main findings are then explained in Section 3, in terms of survey results, and their extrapolation to the whole of Europe, while in Section 4 some reflections on outcomes and conclusions close the paper.

1.2. The value of public sector data

Support to e-Government exists in many countries and continents and is being monitored for example by the Organization for Economic Cooperation and Development (OECD).[5] Recently the European Commission launched its Open Data Strategy for Europe, which is "expected to deliver a €40 billion boost to the EU's economy each year"[6] by making existing Public Sector Information (PSI) more widely re-usable also for commercial purposes, creating added value services, products and new jobs.

Claims as the one above are very important to justify the large investments made, and organisational changes that these investments imply, particularly at times of financial austerity. To retain credibility, these claims need to be backed up by evidence. For this reason, during the last five years we have witnessed a slow but sustained increase in research activities aimed at measuring the impacts of these investments. Examples in the area of Earth Observation include for example Bernknopf, Rabinovici, Wood, and Dinitz (2006), Macauley and Diner (2007), Khabarov, Moltchanova, and Obersteiner (2008), Fritz, Scholes, Obersteiner, Bouma, and Reyers (2008), Smirnov and Obersteiner (2009), Rydzak, Obersteiner, and Kraxner (2010), and Moltchanova, Khabarov, Obersteiner, Ehrlich, and Moula (2011). Examples of works related to Geographic Information (GI) include case studies in US by Smith and Tomlinson (1992), Bernknopf, Brookshire, Mc Kee, and Soller (1997), Gillespie (2000), Baltimore County Office of Information Technology (2001); and in Australia by Price Waterhouse Coopers (1995), ACIL Tasman (2008). More specific to SDIs is the work fostered in Europe by the adoption and implementation of the INSPIRE Directive, which places requirements on the Member States to report regularly on the costs and benefits associated with the implementation of the Directive. Progress in over 30 European countries on the implementation of "inspired" SDIs has been reported in a set of studies by Vandenbroucke et al. (2012), while Crompvoets, Rajabifard, van Loenen, and Fernandez (2008) have collected a range of theoretical perspectives informing the work on SDIs.

1.3. The spreading of e-Government

The adoption of e-Government services has grown rapidly in the last decade (Rowley, 2011), firstly as isolated pilot cases, then following institutional and national strategies. The first country adopting an e-Government national strategy was Canada with the "Government online" initiative in 1999[7] (Reddick & Turner, 2012), followed by the e-Japan strategy in 2001 (Yamada, 2010), the American e-Government Act in 2002,[8] the European PSI Re-use Directive in 2003 (European Commission, 2003), and the Australian e-Government strategy in 2006[9] (Australian Government, 2006). The spreading of e-Government strategies is monitored by the EU ePractice portal (http://www.epractice.eu/en.), which has collected more than 1500 cases of best practices from 2008 to 2011 in 35 countries, including African, Oceanian, Asian and North/South American countries, in the field of e-Government, e-Health and e-Inclusion.

Attempts to assess the impacts of e-Government include for example the US Report to the congress about the benefits of e-Government initiatives (OMB, 2011), containing interesting "descriptions of each e-Government initiative, related objectives, costs, benefits, risks and development statuses as well as sources and distribution of e-Government funding", also in quantitative terms. In Europe, the EU funded e-Government Economic Project (eGep) developed a framework to measure the benefits of e-Government, based on the findings of an extensive survey of 64 e-Government projects within and outside EU. According to this framework, benefits of e-Government could be viewed along three dimensions: (i) efficiency, looking at benefits within organisations, in order to understand financial and organisational value; (ii) effectiveness, looking at benefits outside the organisations, to understand the "constituency value"; (iii) democracy, to see whether there is impact on the society as a whole, i.e. to understand the political value.

[4] Government to citizens, Government to Business, Government to Government.

[5] See OECD e-Government project at http://www.oecd.org/department/0,3355,en_2649_34129_1_1_1_1_1,00.html.

[6] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/1524&format=HTML&aged=0&language=EN&guiLanguage=en.

[7] http://www.tpsgc-pwgsc.gc.ca/apropos-about/fi-fs/ged-gol-eng.html.

[8] http://www.archives.gov/about/laws/egov-act-section-207.html.

[9] http://www.finance.gov.au/publications/2006-e-government-strategy/index.html.

Based on these dimensions, Codagnone, Boccardelli, and Leone (2006) propose 90 indicators to measure the impacts of e-Government. This measurement framework is underpinned by an economic model, whose basic assumption is that "e-Government activities result in an improvement in labour productivity of the public sector", thus contributing to better service quality, time and cost savings, and hence GDP growth.

More recently, Srivastava (2011) proposes a value framework for assessing e-Government impacts on two categories of stakeholders, the "government", affected by e-Government in the areas of policy-making, program administration and compliance, and the "citizens", impacted in the areas of finance, politics, society, ideology and stewardship, and calls for a more systematic future research on the impact of e-Government. As this contribution suggests, the e-Government success is closely linked to the role of its stakeholders groups, and the "democracy" dimension of the eGep framework confirms this relation. Rowley (2011) recognises this role and proposes a categorisation of stakeholders in 12 typologies, based on previous literature, trying to identify benefits from e-Government for each stakeholder category, thanks to a stakeholder benefit analysis tool. Relevant to the interests of this paper, the main benefits identified to users of e-Government services were easiness to use, accessibility and inclusivity, confidentiality and privacy. Verdegem and Verleye (2009) also focus on the central role of users in e-Government. Following some criticism on the development of e-Government services, which are driven by the supply and by the availability of technological possibilities and not by user needs, they propose methods to measure users' satisfaction for e-Government services, taking into account variables of accessibility, usability and functionality. The aim of this study was to provide Public Administrations with the tools to design future e-Government strategies based on real user needs. Reddick and Turner (2012) compare traditional service delivery to e-Government by means of an extensive survey of Canadian population, investigating level of satisfaction of the different alternatives and factors informing their choices. Their main findings suggest a general positive experience with service delivery; a preference towards the phone alternative to solve problems, and to websites to get information.

1.4. e-Cadastres and their impact as e-Government services

Cadastres represent a special case both for SDIs and for e-Government. In 1999, the Bathurst Declaration promoted by the United Nations (UN) and the International Federation of Surveyors (FIG), recommended to recognise the need for land administration to evolve beyond the traditional cadastral paradigms, and to embrace initiatives such as decision support systems and SDIs (Williamson & Grant, 2002). Since then, there has been worldwide the development of cadastral information systems, both at the national and local level.

Already in 2004, a study on Australian and American SDIs (Nedovic-Budic et al., 2004), performing an empirical analysis at the state and local level, pointed out that it was still early to recognise benefits from SDI on local planning. However, the only exception recorded was the Australian Cadastral data in Victoria County, "a state-wide development providing benefits to the local level". Rajabifard (2008) argues that Land Administration and Spatial Data Infrastructures cannot be separated if we want to achieve a sustainable decision-making process. Rajabifard, Williamson, Steudler, Binns, and King (2007) recognise the importance of the role of the cadastral system as part of a national SDI, proposing a technique to evaluate and benchmark cadastral systems and the role they play in SDIs. Williamson et al. (2010), see Cadastre and SDI as two of the principles for achieving a sustainable Land Administration. According to them, the next generation of Land Administration Systems will depend on SDIs to facilitate the integration of built and environmental data. As noted also by Çağdas and Stubkjær (2011), "cadastral information is a reference data component of any SDI".

One of the most stunning examples in Europe is the electronic cadastre of Spain, the website of which received more than 8,000,000 visits per day in 2010 (EIPA, 2011). If we are looking for large number of users, then cadastral on-line services offer an ideal case study. Moreover, the cadastre underpins a very large sector of the economy. For example, according to Eurostat (2010), in Europe the sector "Real Estate, renting and business services" generated in 2007 EUR 1396.6 billion of value added in the European Union, employing 27.8 million persons, therefore accounting for over one fifth of the non-financial business economy employment and value added.

Based on these considerations, we report in this paper the findings of research we undertook in 2011 to gain more insights about the costs and benefits of SDIs' products and services, by means of a case study based on cadastral services. A survey was conducted among several Cadastral and Land Registry administrations, asking relevant information about their Cadastral services delivery systems, namely the traditional paper-based approach, delivering services via physical offices, and the services offered by means of Cadastral information systems. The objective of the survey was to understand whether the users do obtain benefits when choosing the e-Cadastre alternative.

Before discussing the methodology and findings of the research, we review previous studies in this area.

Chimhamhiwa, van der Molen, Mutanga, and Rugege (2009) outline a review of land administration system evaluation, indicating that, in the Cadastral case, the most used methodologies include measuring the success of a Cadastral system according to predefined criteria (FIG, 1995), benchmarking and comparison of cadastral systems among different countries (Rajabifard et al., 2007; Steudler, Williamson, Kaufmann, & Grant, 1997). In the same paper, Chimhamhiwa et al. (2009) propose a performance-based measurement framework, based on cross-organisational business processes, to assess and improve land administration processes.

However, while these studies represent important contributions to the theoretical framework of Cadastral systems evaluation, there are few studies applying a quantitative approach to evaluate the impacts of e-Cadastre on society. We are aware of only two studies, both at the European level.

Firstly, EuroGeographics, the Association of European national mapping, land registry and cadastral agencies,[10] carried out two rounds of surveys (EuroGeographics, 2008, 2010), addressed to its members. The aim of this study derived from the necessity to monitor the application of a series of vision statements agreed by EuroGeographics partners, aimed, among other things, at providing state of the art services to the real property market and market for land information, and contributing to the National and European SDIs.

In summary, Cadastral/Land Registry Agencies were asked to describe the current characteristics of their e-Cadastre, both technically and in terms of links with INSPIRE and relevant European policies. Moreover, respondent countries reported time and costs needed for registering a mortgage and subdividing a parcel. The outcomes of this exercise showed big differences among countries, but a general trend towards shorter delivery times, between 2008 and 2010. In the following, we will refer to this study as a complementary source of information to our data and conclusions.

A second relevant study dealing with the impact of e-Cadastre can be found in RSO SPA (2009), report of a project funded the 7th European Framework Programme for Research and Develop-

[10] http://www.eurogeographics.org/.

ment (R&D) under a set of e-Government initiatives. The project carried out three pilot studies analysing the implementation of e-Government activities. One of them was dedicated to the measurement of efficiency gains of Cadastral Administrations, following the introduction of the e-Cadastre. The study focussed on three Cadastral Agencies, respectively in Italy, Spain and Sweden, and developed a set of indicators to measure efficiency gains derived from the introduction of the e-Cadastre. They looked at two different time-horizons, before (2001) and after (2008) the introduction of the e-Cadastre in the three countries, and developed a questionnaire to measure four indicators of social and internal efficiency and benefits, following the e-Gep approach presented in Codagnone et al. (2006).

In particular, they calculated the service demand growth between 2001 and 2008 and an internal efficiency indicator, by considering the difference between the staff savings expressed in FTEs[11] savings, due to the automatisation of activities after the introduction of the e-Cadastre, and the major expense for setting up and maintain the information system. The social indicators were calculated considering the time saved by users that, thanks to the e-Cadastre, are no longer forced to go to the cadastral offices and spend long time queuing. Methodologically, the social indicators were calculated monetising the internal indicators. The main findings of the study highlighted significant benefits from the internal and social perspective, in terms of demand growth and time saved by users. However, due to the large investments needed to set up the information system, the internal efficiency indicator did not always score positively for the three agencies under consideration.

Given these earlier studies, the objective of our work was to analyse the case study of e-Cadastres, focusing for now on the benefits that citizens may obtain, in comparison with the traditional paper-based cadastral service which still coexists with the e-Cadastre. The paper will present and examine the results of a survey to several European Cadastral Agencies, focusing on the benefits for the users, in terms of time and cost saved.

2. Methodology

2.1. Definition of the main variables

With reference to the services provided by a cadastre, two different types of service delivery were identified: face-to-face services in cadastral offices open to the public (in the remainder "the Office alternative") and digital services offered via a dedicated information system on the Internet (in the remainder "the e-Cadastre alternative").

The main variables considered in the study are cadastral services, access time and waiting time, and price of services to users.

2.1.1. Cadastral services

As regards cadastral services, in RSO SPA (2009, p. 27), they are defined as "the opportunity of researching and downloading cadastral data queries or, in other words, the request and certification of cadastral data. Furthermore, for cadastral data it was intended: cadastral unit typology, level of productivity, size, cadastral revenue, address, identification code, type of right and share, owner's personal data". As online cadastral services, they include information/data certification, updating procedures, maps and others. In our survey, we asked the respondents to give information about the cadastral services they offer to citizens, in terms of their typology, the number of services issued (i.e. provided) yearly to the public, and the number of services requested yearly by the public, in the two alternative delivery methods (office and electronic). Later in the paper, we will compare the received answers about the typology of cadastral services issued, with the definition reported above.

2.1.2. Access time and waiting time

In accounting for the time spent by users for obtaining the cadastral service, the following components are considered:

- *Access time*: the time needed by users to access and request the service. In the case of cadastral offices, this includes the average time needed to reach the office plus the average time spent in the office to provide the necessary documentation. Similarly, for the e-Cadastre alternative, this includes the average time needed to complete the request.
- *Waiting time*: the time the users have to wait until the service is issued, either by the Office or by the e-Cadastre alternative. As it will be shown in the remainder, this is not a small component of the time spent by users.

2.1.3. Price of services to users

The price users have to spend to obtain a particular service is also considered as a relevant variable in the study because there might be a difference in services' price if they are requested on-line or going physically to the office. In general, this may not always mean that e-services are charged less. European Commission (2011) reports that the pricing policy applied to PSI may differ very much from country to country, and every agency has a different business model. In some US counties, on-line services request higher fees (see Douglas, 2011). Hence, in the survey we asked respondents to give information about the price asked to the users requesting a cadastral service.

2.1.4. User distribution

A question was also formulated in the survey to identify categories of users of the services and their scope of use. Following DPLI Working Group (2002), a position paper preceding INSPIRE Directive, users were classified in (i) Public Institutions, (ii) Utility services, (iii) Research sector and not for profit organisations, (iv) Private sector (professionals and companies) (v) Citizens. Respondents were asked to indicate whether the users were asking for data; for information (elaborated data); for services; and what was the scope of use of their requests (see survey template in the Annex).

2.2. Survey design

To obtain relevant information about cadastral services in terms of the number of current users and the performances of the service itself, namely time, costs and accessibility, we designed a survey to national public administration in charge of Cadastral and Land Registry activities throughout Europe.

The survey template is reported in Annex. Synthetically, it has the following structure, with two sets of questions, concerning the Office alternative, as opposed to the e-Cadastre alternative, respectively:

1. Questions about the organisation and time period relevant for the answers.
2. Questions about services offered:
   a. catchment area of the cadastral office;
   b. number of accessible offices on the spatial extent, opening hours (only for Office);
   c. number of cadastral services requested annually by users and issued annually by the organisation;
   d. access time;
   e. waiting time;
   f. price to the users of services delivered;
   g. user distribution.

[11] Full Time Equivalent.

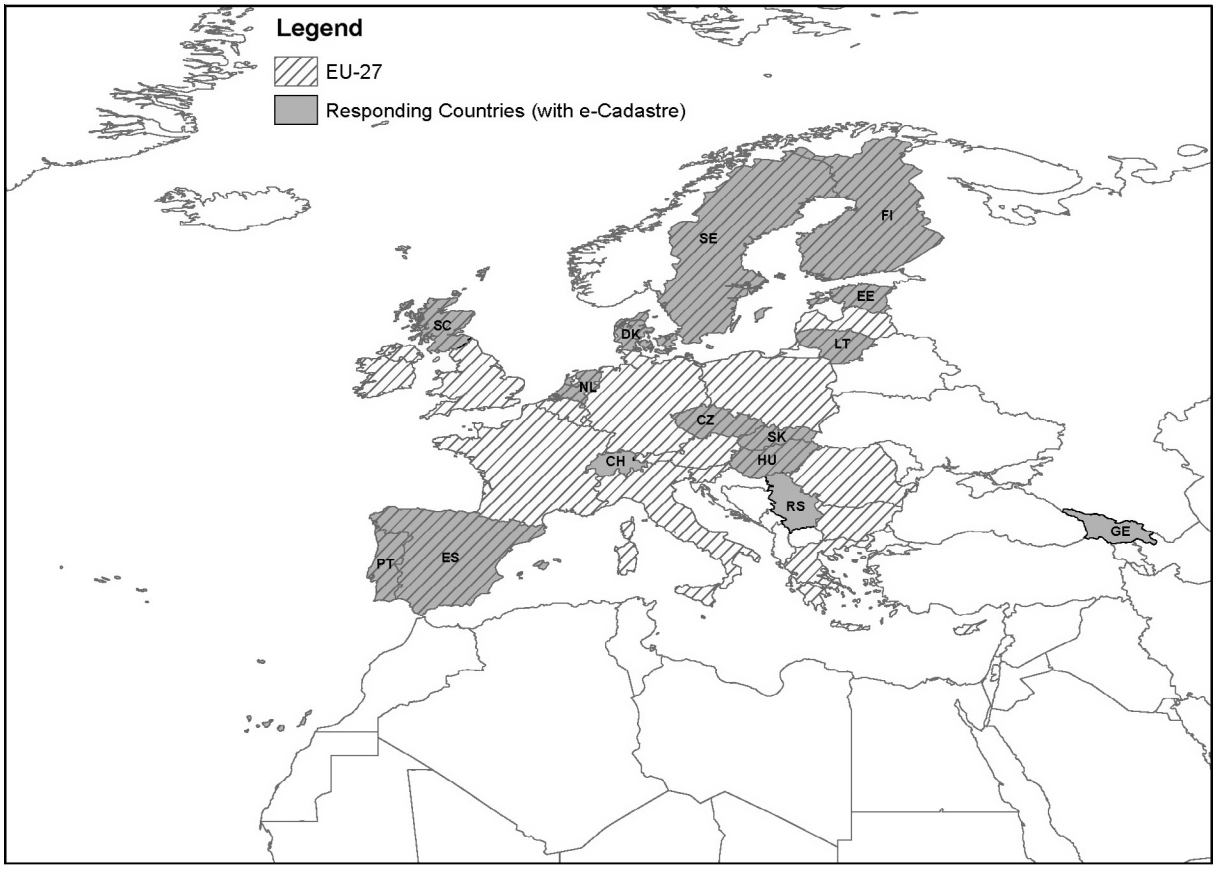

Fig. 1. Map of the responding countries having an e-Cadastre in place.

The scope of our study case is to assess the benefits of e-Cadastre in the 27 Member States of the European Union. However, thanks to the collaboration with the EuroGeographics Association, we were able to address cadastral institutions covering a wider area.[12] As not all the countries we were interested in reported back their answer, we have applied a methodology that allowed extrapolating the results obtained from the survey respondents to all the 27 European Union Member States. For the sake of clarity, both the methodology followed for the extrapolation and the results will be explained together in Section 3.2.

3. Main findings

3.1. Survey results

3.1.1. Distribution and response rate

We sent the survey by e-mail to 44 organisations in charge of Cadastral/Land Registry activities, indicated by the EuroGeographics association. The response rate was 55%, as replies came from 24 countries.[13] The answers relate to the most recent years' details, with most covering the years 2009 or 2010. In the remainder, we will refer to "the reference year", without specifying whether it is 2009 or 2010.

The online presence of the respondents varied (Fig. 1) with 15 respondents (63%) declaring they had an information system in place, delivering Cadastral/Land Registry services, while 6 (25%) had a system in place for only particular categories (e.g. notaries or a sample of the local communities) and 3 (13%) were still planning to put an information system in place. Only one contact did not include any comment to the second part of the survey. The

Table 1
Typology of cadastral services mentioned by the respondents.

Category	Examples
Maps and plans	Copies of maps Cadastral maps Cadastral plans
Certification, registration and reports	Certificates Property certificates Issuing title certificates Providing copies of title certificates Searching certificates Registration of deeds Boundary reports
Verification and amendment	Spatial changes to parcels of land Verification of survey sketches Correction of mistakes
Surveying and valuation	Cadastral surveying Property valuation
General	Responding to requests for information Contributions, records and notes in connection with registration, inscription, change or expiration of ownership or other rights to properties (mortgages, encumbrances, real burdens etc.)

[12] For reasons of space, the list of institutions members of EuroGeographics is not reported. The complete list, covering 45 countries in 2012, may be found at: http://www.eurogeographics.org/about/members.

[13] Although Scotland is not a country, it has a national Registry, different from England and Wales.

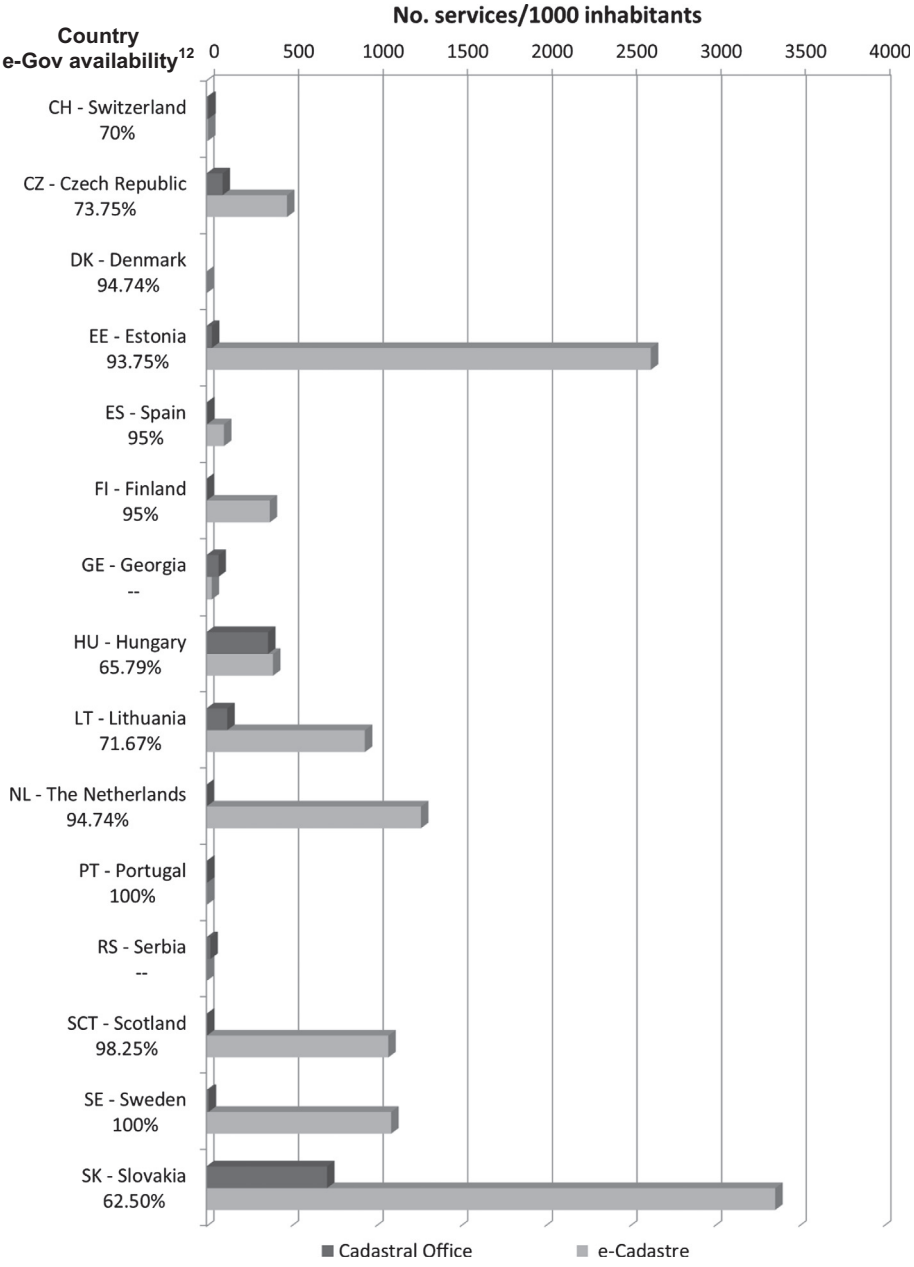

Fig. 2. Number of services issued per year per thousand inhabitants – comparison between Office and e-Cadastre (reference year: 2009 or 2010, sorted by country code).

analysis in the following subsections will include only the 15 respondents having in place an e-Cadastre, to allow for meaningful comparisons to the traditional service delivery system. In Fig. 1, the spatial distribution of the responding countries having in place an e-Cadastre is shown, compared to the 27 Member States of the European Union.

3.1.2. Cadastral service definition

Table 1 provides an overview of all the main services mentioned by the respondents to our survey. With respect to the definition provided in Section 2.1, only the typology of services "verification and correction" seems missing from this definition. This means that it was broad enough, despite the ambition of providing a definition fitting all the different services in the different European countries.

The main variable considered to compare the usage of Cadastral Office alternative and the e-Cadastre, is the number of services issued by each of the two alternatives, in the same year. However, while reading about the findings in the following sections, it is worth keeping in mind that the variable "cadastral services issued" may refer to different typologies of services.

3.1.3. Level of service delivery

The respondents were asked to provide the number of services requested by users and the number of services issued for both the Office and the e-Cadastre alternative, where available, for a fixed time interval. The latter was variously specified as year, week, month or day, then aggregated to obtain annual estimates. 218 working days per year were considered, consistently with a study conducted by EuroFound,[14] and similar to both the OECD countries' average of 222 days and the RSO SPA study (2009), which considers 220 working days per year. Although the e-Cadastres most of times were said to be available 24/7, in the study we used the same

[14] European Foundation for the Improvement of Living and Working Conditions, http://www.eurofound.europa.eu/eiro/studies/tn0903039s/tn0903039s.htm.

Table 2
Basic indicators for respondent countries, having in place an e-Cadastre (sorted by country code).

Country	Territorial extent covered (km^2)	Country surface area (km^2)[a]	Population (millions)	GDP (€/in.)[b]	EU-27	e-Gov availability (%) [c]
CH – Switzerland	41,285	41,285[g]	7.8	40,100	N	70
CZ – Czech Republic	70,000	77,300	10.5	7800	Y	73.75
DK – Denmark	–	43,100	5.5	33,500	Y	94.74
EE – Estonia	43,400	43,400	1.3	6700	Y	93.75
ES – Spain	480,700	506,000	46	16,800	Y	95
FI – Finland	304,500	304,500	5.3	29,500	Y	95
GE – Georgia	69,700	69,700[d]	4.6	17,103	N	–
HU – Hungary	93,000	93,000	10	6200	Y	65.79
LT – Lithuania	62,700	62,700	3.3	7778	Y	71.67
NL – The Netherlands	33,800	33,800	16.6	28,800	Y	94.74
PT – Portugal	45,950	91,900	10.6	12,800	Y	100
RS – Serbia	88,400	88,400[e]	7.3	4099	N	–
SCT – Scotland	78,772	78,772	5.2	29,600	Y	98.25[f]
SE – Sweden	410,300	410,300	9.3	35,000	Y	100
SK – Slovakia	49,000	49,000	5.4	6500	Y	62.50

[a] Where not else specified. *Source*: http://europa.eu/abc/keyfigures/sizeandpopulation/howbig/index_en.htm.
[b] In current and constant prices. For EU-27 countries, source is Eurostat, year 2010, or 2009 where not available; for non EU-27 countries, source is World Bank database and year 2009, at http://data.worldbank.org/indicator/NY.GDP.PCAP.CD.
[c] http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/tsiir120_esms.htm only available for EU.
[d] *Source*: http://www.aboutgeorgia.ge/profile/index.html/People.
[e] *Source*: http://www.arhiva.serbia.gov.rs/cms/view.php?id=1021.
[f] UK data.
[g] *Source*: http://www.eda.admin.ch/eda/en/home/doc/infoch/chgeog.html.

assumptions of the Office alternative, thus obtaining conservative estimates for the e-Cadastre alternative.

Fig. 2 shows the difference in the number of services issued per inhabitant (to homogenise the different country sizes) across the 15 countries having an e-Cadastre in place. Only three countries (Switzerland, Georgia, Republic of Serbia) declared issuing more services via their offices compared to the e-Cadastre, while Portugal reported exactly the same numbers for the two alternatives. Considering the Eurostat's e-Government indicator of online availability[15] (see Table 2), it is interesting to note that low values of this index do not always relate to scarce use of the e-Cadastre (e.g. the e-Gov availability in Slovakia is 62.50%).

In 71% of the countries having an e-Cadastre in place the annual number of services issued per year by the digital alternative were much higher (by more than 50%) than those of Cadastral Office alternative (see Fig. 3).

Exceptions are Switzerland and Portugal, with around 50% of their annual number of services issued by the e-Cadastre, while Serbia and Georgia show an inverse trend with much higher office transactions. This is, perhaps, to be expected as their internet penetration rates[16] are 55.90% and 28.30%, respectively. One exception is Denmark, as it has only one central cadastral office, and services are requested and issued solely online.

Table 3 shows the total amount of reported services issued per year for the countries having in place an e-Cadastre. Interesting is the case of Slovakia, which reported more than 18 million services issued in 2010 through the e-Cadastre. These include "search for owner, search for cadastral map and search for certificates and documents". Only certificates account for 8,105,094 services.

3.1.4. Access time and waiting time

The results described in the previous section seem to suggest that, at least in most of the countries having an e-Cadastre in place, this makes a difference. In order to understand the underlying reason of the apparent preference of users for requesting services on-line and obtaining digital services, it is worth investigating the differences in the amount of time and cost spent by users in both alternatives, during the same time period.

An overview of the responses regarding time savings is provided in the bar charts in Fig. 4. Where missing, for the office alternative the average access time of 120 min was considered, while for the e-Cadastre alternative, the most frequent value of 2 min was taken.

Access time includes the time needed to reach the office for most of the respondents. For the ones who did not give this detail, we decided not to make any assumption because it would have not been meaningful, given the approximation of the study.

In particular, for access time we use minutes as measurement unit, as normally the cadastral office location may be reached by the users in maximum half a day, while for the e-Cadastre the connection to the website, the login phase and the request of the service is a matter of minutes, after the first registration.[17]

On the other hand, the waiting time for obtaining the services is less or equal in most countries when an e-Cadastre is involved. This makes sense if one considers the back-office services that need to be provided by employees regardless how the frontline service/interaction is delivered. It is noteworthy that Denmark did not provide data for the Office alternative, because the process in that country is already completely automated. They reported an average waiting time of 8–12 days to issue a service with the e-Cadastre, due to the presence of only one central office dealing with all the requests. On the other hand, Estonia reported higher waiting time for the e-Cadastre alternative, probably because, as stated in the answers, people going into the office have the possibility to immediately print and obtain the map/certificate requested.

EuroGeographics (2008, 2010) had put in place a working group that collected similar information for two specific services (registration of a mortgage and subdivision of a parcel). It is interesting

[15] See http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/tsiir120_esms.htm, only available for the EU.
[16] See http://www.economywatch.com/economic-statistics/economic-indicators/Internet_Penetration_Rate/.
[17] In some cases, the registration process for the first time may take even a week, to gain all the needed authorisations.

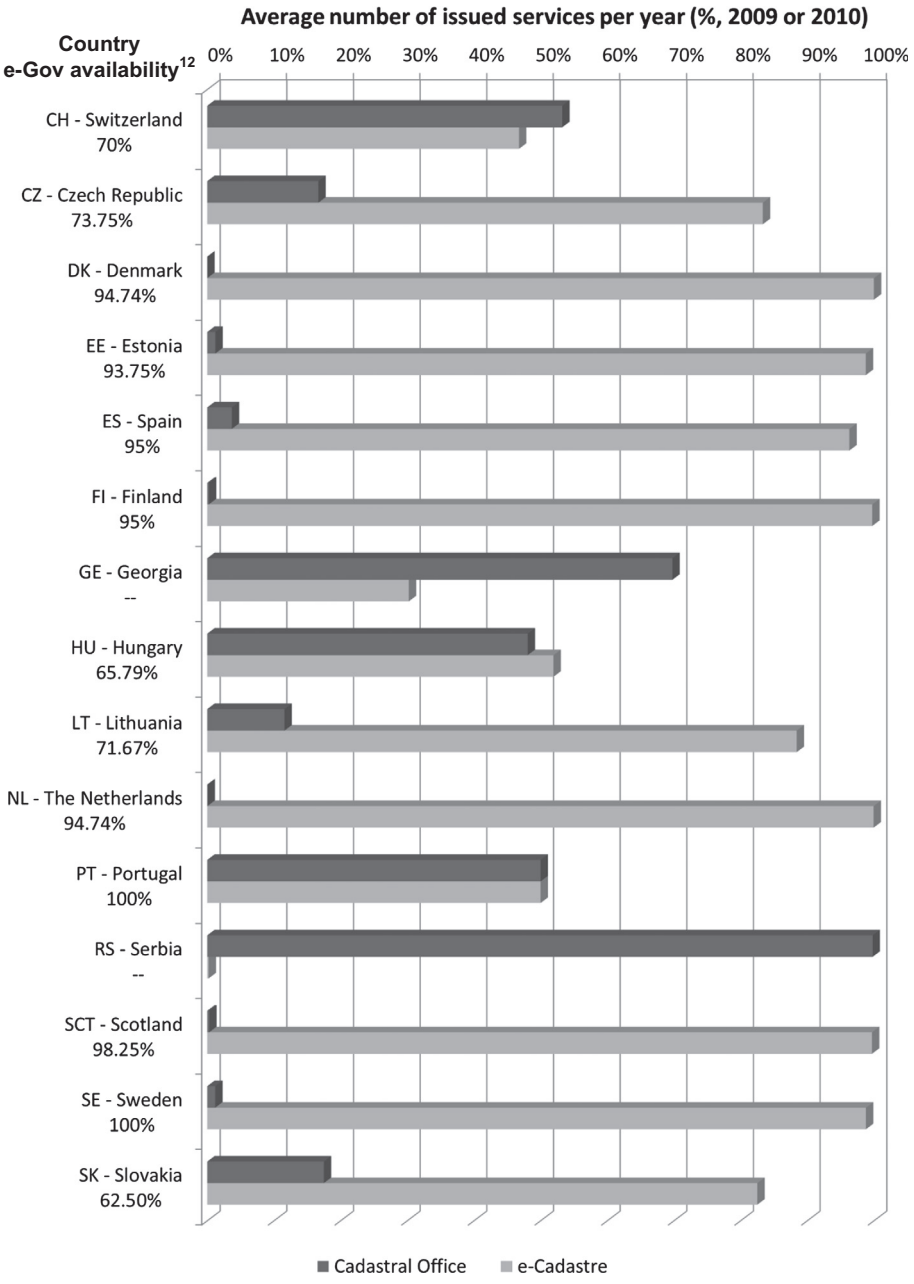

Fig. 3. Services issued per year (%) – distribution between Office and e-Cadastre alternatives (reference year: 2009 or 2010, sorted by country code).

to note that times recorded then (2008, repeated in 2010[18]) were very much higher than the averages reported in Fig. 4. Table 4 reports minimum and maximum waiting and access time for the two alternatives: the high variability shown very much depends on the type of service issued. For example, in 2010, the time needed to register a mortgage was recorded between 1 and 20 days, while the time needed to execute a parcel subdivision was reported to be between 20 and 316 days. Those figures were recorded from the user's perspective. Similar information (also from the user's perspective) may be found in the World Bank database (http://www.doingbusiness.org/), in which it is possible to retrieve data about costs and time of registering a property for all countries. From this source, on average in the OECD countries it takes 32.7 days with 4.8 procedures to register a mortgage, for an average cost of 4.4% of the property value.

On average, the waiting time indicated by the responding agencies was 5.5 days for the office alternative and 4.3 days for the e-Cadastre alternative. The MEPSIR study (Measuring European Public Sector Information Resources) set up in 2006 a methodology to measure the re-use of public sector documents following the PSI Directive (European Commission, 2003). Twenty-five European Member States were surveyed in the thematic subdomain of business, legal, meteorological, social, transport and geographic information held by public bodies, the latter including cadastral information. Similarly to our study, MEPSIR sought the "average response time" for cadastral information services: from the assessment by users, this variable was estimated as 16.1 days; from the assessment by public content holder (i.e. the Cadastral Agency, in our case), it was estimated equal to 6.8 days, closer to the averages of the present study.

[18] See http://www.eurogeographics.org/content/expert-groups-cadastre-and-land-registry-document-registry.

Table 3
Average number of cadastral services issued per year. Comparison between Office and e-Cadastre alternative (sorted by country code).

Country	Average number of services issued per year (2009 or 2010)	
	Office	e-Cadastre
CH – Switzerland	81,300	71,400
CZ – Czech Republic	1,000,000	5,000,000
DK – Denmark	0	1000
EE – Estonia	43,200	3,518,639
ES – Spain	180,838	4,736,771
FI – Finland	4860	2,000,000
GE – Georgia	327,000	141,700
HU – Hungary	3,640,762	3,934,338
LT – Lithuania	408,353	3,116,419
NL – The Netherlands	7665	21,000,000
PT – Portugal	40,000	40,000
RS – Serbia	166,058	327
SCT – Scotland	16,350	5,552,983
SE – Sweden	122,935	10,191,500
SK – Slovakia	3,863,709	18,230,202

The shorter time we record in the responses of our survey may probably be related to the fact that we have asked content holders in 2011, 5 years later than the MEPSIR study. In the meantime, technology has advanced and probably has allowed shortening times, confirming the trend identified by EuroGeographics (2010).

Table 4
Minimum and maximum access and waiting time indicated by respondents. Comparison between Office and e-Cadastre alternative.

	Access time (min)		Waiting time (days)	
	Min	Max	Min	Max
Office	10	360	0.5	30
e-Cadastre	2	60	0.5	10

3.1.5. Cost of services

In relation to the costs of the service to the users, there are some countries adopting the same policy for the services requested through office and e-Cadastre, and others for which the e-Cadastre allows users to save money, possibly due to lower reproduction (e.g. printing) costs for maps and reports.

As noted above, 15 countries have an e-Cadastre in place as of 2010. Of these, it is possible to make significant estimation of unitary costs per service for 12 countries. For the others, the unitary price of services for either the Office or the e-Cadastre alternative (or both) have been extrapolated using averages corrected using comparative price level indices provided by Eurostat, reported in the first two columns of Table 6. Such average cost value equals €15.23 for the Office alternative and €8.89 for the e-Cadastre alternative. It must be noted again here that these prices are for "average" services, and that a focus on a particular service would be needed to obtain more accurate scores. By the way, already these coarse figures indicate that the

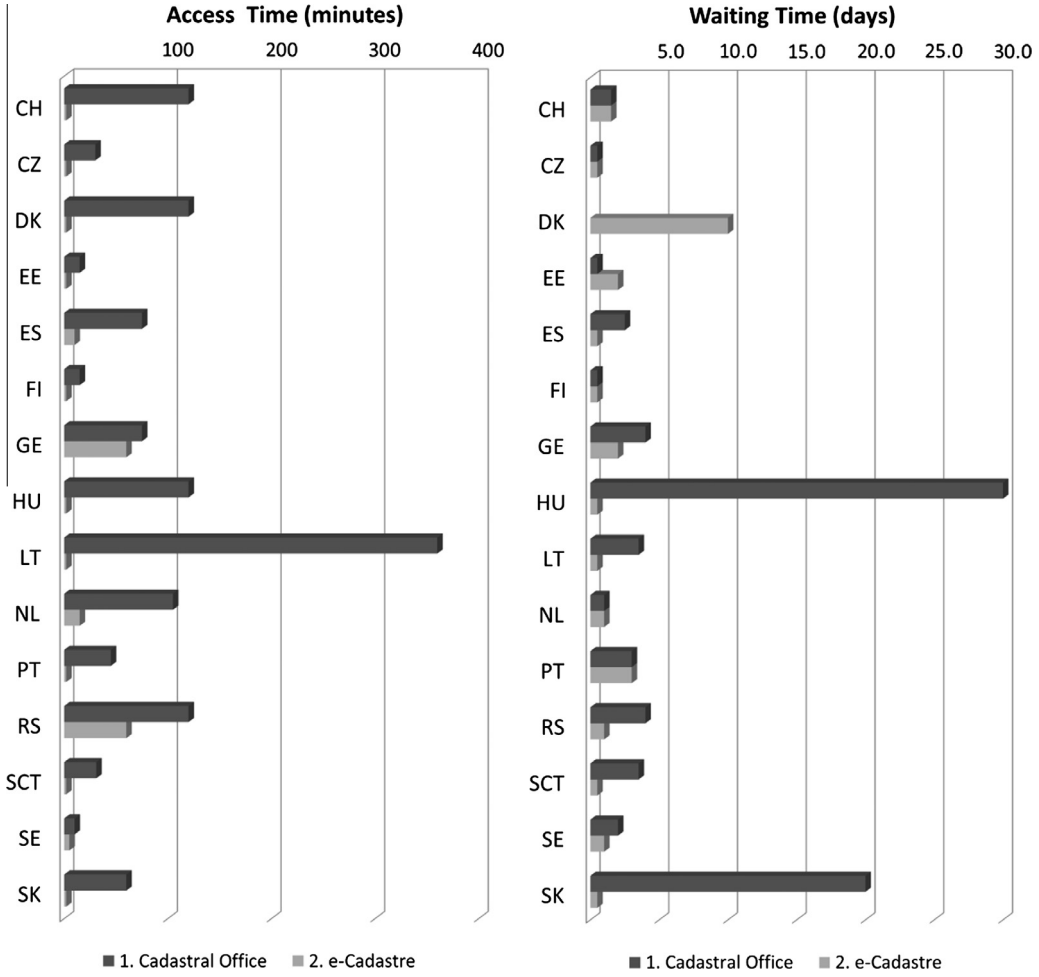

Fig. 4. Average time spent by users in accessing the service (min) and in waiting for the service to be issued (days). Comparison between Office and e-Cadastre alternative (sorted by country code). For the e-Cadastre alternative, it is considered the access time after the first registration to the e-Cadastre.

Table 5
Proportion of users, by typology and alternative, in the respondent countries.

		Public institutions (%)	Utility services (%)	Research (%)	Private sector (%)	Citizens (%)
Office[a]	Poland	5	5	5	10	75
	Scotland	10	5	0	50	35
	Slovenia	33	10	2	30	25
	Averages	*16*	*7*	*2*	*30*	*45*
	Standard dev	*12*	*2*	*2*	*16*	*22*
e-Cadastre	Czech Republic	75	0	1	24	0
	The Netherlands	7	2	1	89	1
	Poland	5	5	5	10	75
	Scotland	6	1	0	58	35
	Sweden	15	5	1	79	1
	Averages	*22*	*3*	*2*	*52*	*22*
	Standard dev	*27*	*2*	*2*	*31*	*30*

[a] Poland and Slovenia answers were reported for completeness, even if they were excluded from the discussion in the present paper, as they do not have an e-Cadastre fully in place.

Table 6
Estimated annual costs to users per service and corresponding savings using an e-Cadastre (sorted by country code).

Country	Average unitary price for services (€/service)*		Difference ($a - b$) (€/service)	Annual savings using e-Cadastre (€, ref. year)
	Office (a)	e-Cadastre (b)		
CH – Switzerland	35.24	35.24	0.00	–
CZ – Czech Republic	4.24	2.83	1.41	7,072,136
DK – Denmark	8.07	4.40	3.67	3665
EE – Estonia	16.42	0.01	16.40	57,713,947
ES – Spain	16.09	6.55	9.55	45,233,114
FI – Finland	9.40	5.13	4.27	8,544,996
GE – Georgia	20.00	20.00	0.00	–
HU – Hungary	36.45	20.56	15.89	62,515,251
LT – Lithuania	3.15	1.38	1.77	5,509,265
NL – The Netherlands	13.62	2.39	11.22	235,694,572
PT – Portugal	13.60	7.42	6.18	247,202
RS – Serbia	21.98	6.59	15.38	5031
SCT –Scotland	11.35	3.59	7.76	43,070,854
SE – Sweden	0.81	8.14	−7.33	−74,693,404
SK – Slovakia	17.99	9.09	8.90	162,286,315
Average	*15.23*	*8.89*	*6.34*	*36,880,196*

* Adjusted with comparative price levels 2010, source Eurostat. For the responding agencies not giving details, the price has been considered equal to the average price amongst the 15 respondents, and then adjusted by the comparative price level index.

price of the average service is lower if requested via e-Cadastre than if requested by the Office alternative.

3.1.6. User distribution

Unfortunately, very few respondents were able to provide details about users in the questionnaire. The few responses provided gave details about the percentage of usage of their services by the different user categories. They are presented in Table 5, which shows that details are too sparse and dispersed to extrapolate from them and model the values for other countries, because the variation in estimates (expressed in Standard Deviation measures) is too great. Indeed, in some countries citizens are the most frequent users, while in others the private sector or the public institutions figure as major users of the cadastral services. This is probably related to different institutional and organisational framework, specific from country to country, e. g. sometimes requiring a compulsory intermediary to perform the bureaucracy of the cadastral service, other times open to citizens.

3.2. Savings estimation and extrapolation

This section explains the methodology used to estimate costs and time savings and then to extrapolate them to the whole of Europe, from the data obtained by the respondents to our survey. As previously explained, for the purposes of our study, we are interested in estimating the benefits at the European level. Regarding costs, from the results of the estimation shown, the average users' savings per service was calculated (see Table 6), simply subtracting the price of the service (corrected using comparative price level (CPL) indices) in the two cases of the Office and e-Cadastre alternative. Only in Sweden, this balance appears to be negative, in the sense that on average, e-Cadastre services appears to cost more to the users than the services issued with the traditional office. This average saving per country was multiplied by the number of services issued yearly by the e-Cadastre, thus obtaining the total amount of money saved by users thanks to the use of the e-Cadastre in the reference year (see fourth column of Table 6). A null value occurs for those respondents specifying the same price for the services of both alternatives, while for the remaining countries, savings for users range from about €3600 (Denmark[19]) to more than €235 million (The Netherlands) in the reference year.

Given that the distribution of the respondents covers only part of the Member States of the European Union (for example, France, Germany and Italy, densely populated countries, are missing), to extrapolate these savings to the whole EU, we considered an extended EU (EEU), composed by the 27 European Member States (EU-27) plus Switzerland, Georgia and Serbia, which represent

[19] The Danish values for the price of services were extrapolated.

Table 7
Annual monetary and time savings estimated from the survey.

Price savings	€2.0 billion/year	
Access time savings	€4.8 billion/year	167,000 working years
Waiting time savings		7.7 million working years
Total	€6.8 billion/year	7.9 million working years

countries responding to our survey and having in place an e-Cadastre, but not belonging to EU-27.

The total annual cost saving for the Extended European Union has been calculated simply weighting the total savings by the economically active population[20] (chosen because active citizens are the most likely to benefit from these savings) of the respondent countries, and multiplying this for the total extended EU active population, according to the following equation:

$$s_p^{EEU} = \frac{\sum_{i=1}^{15}(p_i^j - p_i^k)\cdot N_i^k}{\sum_{i=1}^{15} Pop_i}\cdot Pop_{EEU}$$

In which: s_p: annual savings due to differences in price; *EEU*: Extended EU; i: country; j: Office alternative; k: e-Cadastre alternative; N_i: no. services issued in country i; p_i (€/service): average service price in country i; *Pop*: active population.

The result is $s_p^{EEU} = €2.01$ billion, meaning that in the reference year EEU citizens save 2 billion euros thanks to the use of e-Cadastre.

Regarding the monetary savings attached to access and waiting time, the methodology to extrapolate waiting time and access time savings to the whole Europe is the same as for cost savings, as shown in the equations below:

$$s_a^{EEU} = \frac{\sum_{i=1}^{15}(t_i^{aj} - t_i^{ak})\cdot N_i^k\cdot\gamma}{\sum_{i=1}^{15} Pop_i}\cdot Pop_{EEU}$$

$$s_w^{EEU} = \frac{\sum_{i=1}^{15}(t_i^{wj} - t_i^{wk})\cdot N_i^k\cdot\gamma}{\sum_{i=1}^{15} Pop_i}\cdot Pop_{EEU}$$

In which variables are the same as in the first equation, plus: s_a, s_w (€): annual savings (respectively due to differences in access time and waiting time); t^a (h/service): average access time; t^w (h/service): average waiting time; γ: value of time for European active citizens.

The main uncertainty in these equations is represented by the monetary value to be assigned to time, γ. As the users' typology breakthrough is so disperse (see Section 3.1.6), we could refer to the average EU income and therefore consider an average value of time for the average EU active citizen. Indeed, knowing the average salary for European countries estimated using Eurostat data,[21] which is 28,721 euro per annum, it is possible to estimate an average value of time for EU active citizens, in €16.5 per hour. The result of the estimation for EEU is almost $s_a^{EEU} = €4.8$ billion in monetary terms, or in temporal terms, almost 167,000 working years.

Following the same procedure used for access time, the differences in waiting time have been computed, refraining from monetising them because reduced waiting time is more an indicator of increased efficiency perceived by the users, than actual time saved by them. In fact, while waiting for the service to be issued, the users may continue to carry on their own activities. The result obtained in temporal terms is 7.7 million working years for the EEU.

Overall, the annual total saving for users in EEU considering services' prices and access time has been estimated to be €6.8 billion (Table 7).

It is worth reminding that these are conservative estimates, because the number of working days per year for the e-Cadastre alternative has been considered the same as in the Office alternative. On the other hand, this gross benefit is related to the economically active European population, whose individuals are not supposed to necessarily use cadastral services every year. Hence, it has to be made clear that the waiting time savings are a proxy to estimate the benefits coming from the use of the e-Cadastre, and are not effective monetary savings, as users continue to carry on their activities while waiting for the certificate to be issued. However, it is also true that in some cases (e.g. professionals), higher waiting time could negatively affect the work scheduled.

4. Conclusions

Starting from the need to justify large investments in Spatial Data Infrastructures, this paper has presented a case study on the cadastral subdomain, in which the usage of cadastral services has been indirectly investigated surveying several Cadastral Institutions, asking them about the level of service delivered both via the traditional office alternative and via e-Cadastre. The outcomes of the survey have been used as starting point to estimate social and economic benefits arising for users of the Cadastral Information system, in terms of time and cost saved.

Some methodological issues need to be taken in mind when considering the findings. Firstly, the appropriate definition of "cadastral services" should be clarified. In this study, we accept the one proposed by the RSO SPA (2009), which anyway raises some reservations on its suitability, given the national and local peculiarities in handling different cadastral activities. We also base all our calculations on a sort of "average service" throughout Europe. This may affect comparisons between countries. Secondly, a clear distinction should be made between services issued and the consultation (or visits) to the website, which can be much higher, as in the case of Spain. Thirdly, it is also worth reminding that in this study all the estimates made for the e-Cadastre alternative are conservative, because the e-Cadastre has been considered working in the same hours as the office alternative, despite the fact that many respondents highlighted the 24/7 availability of their e-Cadastre. This confirms that the temporal accessibility is one of the main advantages of the e-Cadastre alternative.

Moreover, the benefits estimated from waiting time must also be taken as a proxy of the real benefit, as users do not waste their time in waiting for the services to be issued, but they continue to carry on their own duties. Anyway, this estimate has a sense because higher waiting time may delay professional and personal activities planned, for which the cadastral service was needed.

When an e-Cadastre is available, as in the case of the 15 countries analysed in this paper, the rate of usage is definitely shifted towards the digital alternative: almost all countries reported that the number of digital services issued outweighs the number of the paper-based services by more than 50%, despite not all the countries record high e-Government availability. This could reveal the strong need from users to obtain quicker and easily accessible spatial (cadastral) data, regardless of the technological barriers that they may encounter. The practice of issuing digital property certificates may improve traceability and transparency of processes, raising nevertheless privacy concerns that need to be addressed.

The estimated savings are considerable, especially for what concerns time needed to access the service and to have the service delivered. Although gross estimates, they already reveal a huge untapped potential from the development and deployment of elec-

[20] Eurostat definition: The labour force or the economically active population, also shortened to the active population, includes both employed and unemployed people, but not the economically inactive, such as pre-school children, school children, students and pensioners.

[21] Eurostat gross earnings by occupation, 2010.

tronic services in government departments that could increase the efficiency of public administration and facilitate the activities of both economic and social operators.

In particular, access time and waiting time are found responsible of the main differences between the Office and the e-Cadastre alternatives, and presumably with the increasing computing power and the progressive shift of public administrations to e-Government, such differences will continue to increase in the future. However, it has to be pointed out that the e-Cadastre may not entirely substitute the Office alternative in the future. In fact, if it is true that services like quick viewing of the property boundaries were impossible before the introduction of the e-Cadastre, some other services may still only be obtained by going physically to the Cadastral Office (e.g. the ones requiring signatures). This should be taken into account when considering the derived benefits. Moreover, for some typology of users (e.g. people not familiar with ICT, digital illiterates) probably there is still the need to maintain the front-office alternative. Secondly, the complete shift from the office-based alternative and the digital one would require a cultural and social change which is difficult to achieve, also by policy makers, who still are keen on the face-to-face alternative, in some cases. Linked to this, the reliability of the digital service should be also considered, and compared to the traditional one, and an ad-hoc cost–benefit analysis should be deployed to understand the costs and benefits if not everyone is able to use the services. It is also worth noting that the time saved by users would likely correspond to more time available to the public offices to provide a faster service to those preferring the office alternative. In other words, the digital alternative has a positive impact both on its direct users and indirectly on the users choosing the traditional paper-based approach.

Although the paper focused on the case study in Europe, the results are of relevance to other countries as well, where e-Government, and in particular e-services linked with land information systems, are more and more spreading, and, as seen in the literature review, have the ambitious scope to achieve, finally sustainable development.

It would be interesting to validate the preliminary findings of this study with a survey addressed directly to the users of the Cadastre, to see whether these assumptions and estimates are confirmed. Probably this would be possible by choosing a limited number of case studies to be analysed in-depth. This could help deepening the understanding of the factors driving users' preferences. On the other hand, having more information about users and their needs could help in targeting the features of the system.

In order to properly consider the results of the study, it would be also relevant to understand the gains in efficiency of the cadastral administration itself, if any. The costs of implementing and maintaining an e-Cadastre should be taken into account to see which is the return on investment rate and whether the investment would lead also to financial benefits. However, a survey approach may not be the suitable one to inspect the investments and the financial returns of the Cadastral Agencies. For this purpose, the organisational structure of the Cadastres should be considered, and appropriate in-depth case studies should be put in place, to gather more information about increased efficiency of cadastral administrations, and the technologies applied, which represent relevant factors to explain national and local differences.

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Appendix A. Supplementary material

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