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Advanced Regional SDI in Europe: Comparative cost-benefit evaluation and impact assessment perspectives*

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Abstract

This paper reports the findings of two studies on the socio-economic impacts of the regional spatial data infrastructures (SDIs) in Catalonia, and Lombardia, and then compares the developments in these two regions with those in other nine advanced regional SDIs to explore the extent to which the findings reported for the two detailed case-studies could be generalised. The significance of this paper is that the studies it reports are to date the only ones substantiating with real evidence the costs and benefits of SDIs in comparable regions of Europe. With the implementation of INSPIRE requiring the development of SDIs at multiple levels across Europe, the findings of this paper become all the more critical to support the investment decisions of public administrators, particularly at a time of considerable financial strains.

Keywords: Regional spatial data infrastructure, Impact Assessment, Cost-benefits analysis

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1. INTRODUCTION

The growing diffusion of global, national and sub-national Spatial Data Infrastructures (SDI) worldwide has led to an increased call by policy-makers to provide evidence of the benefits generated by the investments made. This in turn, has resulted in an increased interest by researchers and practitioners on developing appropriate frameworks for evaluating ongoing initiatives, undertaking the studies necessary to understanding critical factors in the implementation process, and gathering the evidence required by the policy-makers (e.g. van Loenen, 2008; Grus et al., 2007; Crompvoets et al., 2008).

In Europe, a major impetus for the evaluation of SDIs has come from the INSPIRE Directive 2007/2/EC establishing an Infrastructure for Spatial Information in Europe, which was adopted in 2007. During the initial stages of the preparation of the Directive, it was necessary to undertake an Extended Impact Assessment (XIA) of the proposal ahead of its formal adoption by the European Commission. This XIA, undertaken in 2002-03 exposed how little we knew about the costs and the benefits of setting up, and maintaining an SDI, even though major initiatives had been going on from the early 1990s to develop SDIs in many countries of the world (see for example Craglia and Masser, 2002, and 2003; Masser, 1999).

In the absence of published evidence, the XIA made a set of transparent assumptions on the likely costs and benefits of INSPIRE, which to date have yet to be fully verified (Craglia et al., 2003; Dufourmont, 2004).

To move the field forward, the Joint Research Centre of the European Commission organised a workshop in 2006 in collaboration with the US Federal Geographic Data Committee, Geoconnection, and the Geoide network from Canada to analyse best practices on assessing the impacts of SDIs in North America and Europe. The results of this exploratory workshop (Craglia and Novak, 2006) indicated that most assessments were made at the ex-ante stage when there is a need to justify to senior decision-makers the investments required to establish the SDI. In such case, as indeed had happened for the XIA of INSPIRE, all one can do is to make a set of assumptions which may or may not turn out to be correct. Unfortunately, no evidence was found of studies done after this initial stage, either during the implementation of an SDI or at significant milestones after the initial investment to verify the assumptions originally made. Other key findings were: (i) that whilst it is relatively easy to estimate the investment needed to set up and maintain an SDI, it is very difficult to estimate the proportion of this investment compared to the total spent by governments in creating and maintaining geographic information (Lance et al., 2006), and to estimate the benefits, largely because it is difficult to have a clear understanding of who are the users of an SDI, or other major Internet-based infrastructures; (ii)

that even if the assumption on costs and benefits appear to justify the investment, there is no guarantee that the political decision will be favourable, largely because the costs tend to be upfront, and the benefits somewhere down the line, which of course does not play well with the 4-5 year cycle of elected policy makers. With these considerations in mind, the recommendations of the workshop were: (i) to conduct more studies on the social and economic impacts of SDIs already at the level of maturity necessary to deliver some of the benefits, and (ii) to conduct such studies at the sub-national level, where it might be less difficult to identify users, and elicit from them an estimation of the benefits accrued. On the basis of these recommendations, the JRC embarked on a programme of research activities to build the evidence necessary to support its role as technical coordinator of INSPIRE.

This paper summarises the outcomes of these activities, and is organised as follows. Section 2 clarifies the object of study, and, in particular, why we exclude from the analysis the costs incurred in data collection. Section 3 and 4 report the findings of the studies in Catalonia and in Lombardia, respectively. Section 5 compares these regional SDIs with other leading examples in Europe, while Section 6 concludes with an assessment of where we are to date, and indications for future work. The major contribution of this paper to this area of research is to move beyond the debate on possible theoretical approaches to the study of social and economic benefits of SDIs (see for example Genovese et al., 2009; Grus et al., 2007), and report the findings of recent empirical work in this field, which is still relatively immature.

2. DEFINING THE UNIT OF ASSESSMENT

Given the European focus of this paper, we adopt the definition of a spatial data infrastructure provided in the INSPIRE Directive (2007/2/EC), which establishes the legal framework at the European level. In the Directive: "'infrastructure for spatial information' means metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures..." (Art 3-1).

During the XIA of INSPIRE an important task was to reach agreement that the XIA should focus on the *additional* costs and benefits of establishing and implementing the infrastructure for spatial information, excluding therefore existing process of data collection and maintenance that would take place anyway. This is because INSPIRE does not require by itself the collection of new data. The requirements for the collection of (environmental) data are set in place by thematic directives (on water, air, waste, biodiversity, and so on) and not by INSPIRE.

In a broader context, it is equally arguable that when assessing an SDI one should focus only on those *additional* elements that create the infrastructure, i.e. metadata, discovery, view, transformation, download and invoke services, policy agreements on data access and use, and coordination measures that tie together the otherwise heterogeneous and disconnected data stores, and suppliers. This is justified in the sense that the collection of data, and their maintenance and publication by individual suppliers (in our case mainly public sector agencies) are required and funded by existing statutory requirements (e.g. the collection of official statistics, environmental data, topographic and geological databases and so on) and would take place anyway, whether one invests in establishing an SDI or not. The added value of an SDI is in making existing data easier to find, access, and use; not in creating the data in the first place.

To reinforce the point, it has long been recognized that coordination, and political commitment are two absolutely crucial elements of any SDI (see for example Masser, 1998). This is also recognized by the INSPIRE Directive, which argues that:

> *The effective implementation of infrastructures for spatial information requires coordination by all those with an interest in the establishment of such infrastructures, whether as contributors or users. Appropriate coordination structures which extend to the various levels of government and take account of the distribution of powers and responsibilities within the Member States should therefore be established (Preamble para. 27)*

Without this important component of coordination, one could have plenty of data, and services, but no coherent infrastructure. This is no different from other major infrastructures like transport, where a distinction is made between the physical component (rails, trains, stations, signals etc.) and the organizational component (i.e. the layer of rules, and agreements, that make the transportation service available and usable by users) (see e.g. Cascetta, 2008). In an SDI sense, the physical component includes the Internet, and the data and services running onto it, the organisational component includes the coordinating structures, agreements on policy and standards, and that layer of network services that help “glue” together the infrastructure.

It is with these considerations in mind that the case-studies described in the following sections focus on assessing the added value of the SDI, and do not include data collection costs (or benefits).

3. THE CATALONIA STUDY

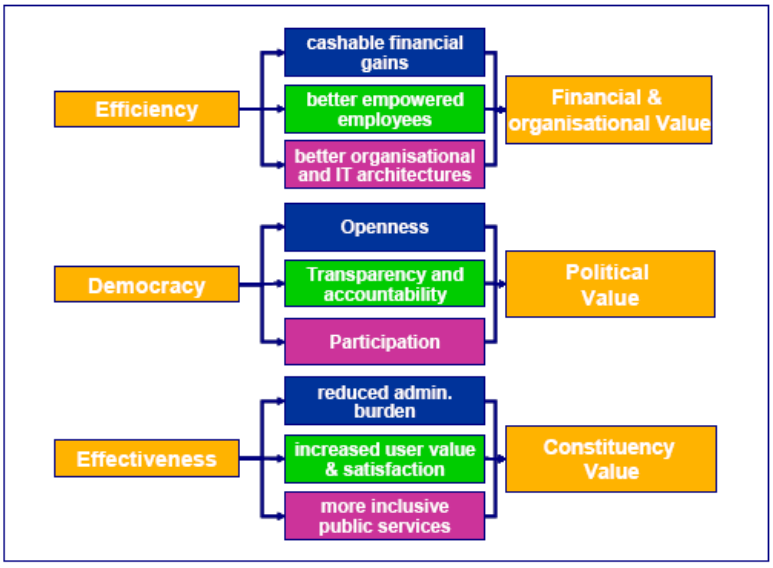
This study on the socio-economic impact of the spatial data infrastructure (SDI) of Catalonia was undertaken in 2007 by the Centre of Land Policy and Valuations of

the Universitat Politècnica de Catalunya. The Joint Research Centre (JRC) commissioned the study and recommended the methodology, which was based on the one developed by the e-Government Economic Programme (eGEP) (Codagnone, Boccardelli and Leone, 2006). The major advantage of the methodology proposed by eGEP is that it is based on a theoretical framework on the expected benefits of investments in e-government (Corsi et al., 2006), which then underpins the classification of benefits into three main categories (see Figure 1):

- Efficiency impacts;
- Efficacy impact;
- Democracy impacts.

The first category concerns economic and time savings in supplying services by the promoting organisations or the users, reduction in management and maintenance costs, improvement of personnel skills, etc. Efficacy impacts concern better quality of services (i.e. better management of taxation, improved management and decision support, etc.). Democracy benefits include positive impacts such as innovation, knowledge sharing, access to information, business opportunities, better quality in research and development, creation of added-value services.

Figure 1: eGEP project, impact assessment framework for the evaluation of e-government initiatives (Codagnone, Boccardelli and Leone, 2006, pg. 15)



On the costs side, the main categories proposed by the JRC as a result of the 2006 workshop (Craglia and Novak, 2006), and the review of the literature focused on: A) technology, and B) processes, including, but not limited to:

A) Technology

- Implementation set-up costs (including design, hardware, and software development);
- Management costs;
- Maintenance costs.

B) Processes

- Changes in organisational models;
- Training;
- Coordination;
- Consultation;
- Normative development and control.

The eGEP measurement framework identified some 90 indicators to measure the impacts of e-government based on a range of available data sources, including official statistics, administrative records, user surveys, and web crawlers (see Appendix 2 in Codagnone, Boccardelli and Leone, 2006). As argued by the authors:

> *we want to stress that the full template of indicators is meant to provide a large choice for Member States and/or single public agencies for them to select those most appropriate to their needs and therefore:*
>
> 1. *We do not suggest that all indicators should be used simultaneously, but leave the selection of the indicators best suited for their purposes to the users of our framework;*
> 2. *The indicators of the full template are not mutually exclusive and in some cases may seem redundant. This apparent redundancy arises from the fact that the proposed indicators provide different ways to measure the same target, usually with a different degree of complexity* (page 25-26).

With these considerations in mind, the Catalonia study selected a range of indicators that were relevant in the context of their SDI, and then convened a meeting with a panel of local authorities and representatives of the user community to discuss the proposed methodology and indicators.

The feedback from the panel introduced some modifications to the indicators proposed and crucially indicated to the study team that it was necessary to collect the information needed through face to face interviews rather than surveys, or official statistics, which in this field are poorly developed. This change to the methodology proposed by eGEP was necessary because the concept of an SDI is still rather fuzzy in the mind of local government officials. Therefore, relying on surveys directly filled by the users would run the risk of misinterpretation of many of the questions leading to results of unverified quality. Face-to face interviews make it possible to provide the necessary context to the respondent, and ensure higher quality of outcome. On the down side, they are more time consuming and therefore the number of users that can be reached within a given time and budget is reduced. The final list of indicators selected is shown in Table 1.

Table 1: Indicators selected for the Catalonia study

EFFICIENCY

Impact	Indicator
Monetary gains	Savings in time (hours/month)
	Expected or predicted savings in consumables (qualitative)*
Better prepared personnel	More motivated employees with new training (qualitative)*
Improvements in the organisation	Time saved in the redesigned processes (hours/month)
	New processes (*e.g.* cadastre maintenance, license teams) (list-qualitative)
	Interoperable services (*e.g.* public service, permits) (list-qualitative)
	Interdepartmental data sharing (list-qualitative)
	Better planning of actions and decisions (list-qualitative)
	GIS services accessible from municipal websites (list-qualitative)

EFFECTIVENESS

Impact	Indicator
Benefits for residents	Time saved by residents (hours/month)
	Time saved by companies (hours/month)
User satisfaction	Repeat users of services (qualitative)*
	Volume of data queries and downloads (number)
	User satisfaction (qualitative)
Extension of services	Use of new services by businesses (qualitative)*
	Use of new services by residents (qualitative)*
	Uses enabled exclusively by SDI (qualitative)

DEMOCRACY

Impact	Indicator
Openness and transparency	Interactive services and web access (number)
	Available metadata records (number)
Participation	Complaints, queries, suggestions, errors, etc. transmitted electronically (number/month)*

NOTE: The indicators marked with * were originally meant to be quantitative but during the survey it became clear that it was not possible to quantify them at the current state of development, and therefore were assessed in qualitative terms.

The study was based on a sample of 20 local authorities participating in the Catalan SDI (IDEC) together with three control local authorities not participating in the SDI, and 15 end-user organisations, of which 12 are private companies operating in the Geographic Information (GI) sector, and three are large institutional users of GI. The findings of the interviews were presented in two separate workshops to the participating local authorities and end-user organisations, to validate the findings and discuss the outcomes. The key findings are reported below.

Costs:

The total direct cost of establishing and operating the IDEC over a five year period (2002-06) was of €1.5 million, of which €325,000 for each of the first two years (2002-03) necessary to launch the SDI, and €283,000 per annum to operate and develop the infrastructure in the three subsequent years (2004-06). Human resources represented 76% of the costs during the launch period (the rest being capital investment), and 91% during operation. These costs do not include the creation and updating of topographic data, which is under the responsibility of the Cartographic Institute of Catalonia (ICC), and would happen regardless of the development of the SDI, nor the indirect costs associated with the physical and technological infrastructure (e.g. office space) provided by the ICC. They do include the following: metadata creation and maintenance, development of geo-services (including geoportal, catalogue, Web Map Service client), preparation of data for publication, applications, hardware and software, and management (for more details of costs see Garcia Almirall et al., 2008)

Benefits:

The evidence collected for 2006 through the face-to-face interviews with local officials clearly shows that the main benefits of the IDEC accrue at the level of local public administration through internal efficiency benefits (time saved in internal queries by technical staff, time saved in attending queries by the public, time saved in internal processes) and effectiveness benefits (time saved by the public and by companies in dealing with public administration). Extrapolating the detailed findings from 20 local authorities to the 100 that participate in the IDEC, the study estimated that the internal efficiency benefits account for over 500 hours per month. Using an hourly rate of €30 for technical staff in local government, these savings exceed €2.6 million per year. Effectiveness savings are just as large at another 500 hours per month. Even considering only the efficiency benefits for 2006 (i.e. ignoring those that may have accrued in 2004-05, as well as the effectiveness benefits), the study indicates that the total investment to set up the IDEC and develop it over a four year period (2002-05) is recovered in just over 6 months. Wider socio-economic benefits have also been identified but not quantified. In particular, the study indicated that web-based spatial

services allow smaller local authorities to narrow the digital divide with larger ones in the provision of services to citizens and companies (see also Garcia Almirall et al., 2008).

4. THE LOMBARDIA STUDY

The study on the socio-economic impacts of the SDI in Lombardia took place during 2008-09 and was undertaken by the authors as part of a collaborative agreement between the JRC and Regione Lombardia (the regional government authority) in which the JRC acted as advisor in the development of the regional SDI, and used it as a pilot for the development of INSPIRE. The methodology deployed was the same as that for Catalonia, and therefore was mainly based on face-to-face interviews with key stakeholders. In this study, they were identified as being: the regional government, local authorities, technology providers, local utility companies providing services to local government, professionals (architect, planners, engineers involved in spatial planning preparation), the association of developers, and representatives of the academic sector. The indicators used in Catalonia (Table 1) provided the guidance for the interviews. However, given the outcomes of the Catalan study, which had focused primarily on efficiency and effectiveness benefits, it was decided to make an extra effort in focusing the attention on the wider social and economic benefits (or democracy as defined in eGEP), with particular emphasis on the private sector.

To this end, we decided to repeat in the region a European-wide survey commissioned by DG Environment in 2002 of 50 private companies undertaking Environmental Impact Assessments (EIA), and Strategic Environmental Assessments (SEA). That study (Vanderhaegen and Munro, 2005) had identified a wide range of problems that these companies experienced in finding, accessing, and using the geographic and environmental information necessary to complete their assessment studies. These problems were estimated to account for an increase of 5-6% in costs and 8-10 % in time to do the studies, which on average cost € 73,000 each, and took 6 months to prepare. As it was estimated at the time that some 35,0000 studies were done each year in the (then) EU-24, for a total investment of € 1.9-3.5 bn., the total economic cost of poor data access and use was estimated in the order of € 100-200 million per annum. In addition, the quality of the EIAs/SEAs was reduced due to poor data quality. As SDIs like INSPIRE are promoted to address these problems, it seemed reasonable to replicate the survey in Lombardia, with the same questionnaire as in 2002 having the European normative framework not substantially changed since then. The survey aimed at evaluating if the problems still persisted, and assess the extent to which the regional SDI had provided tangible benefits by eliminating or reducing these additional costs.

The survey was distributed on-line (using http://www.limesurvey.org/) to 60 companies for which we had contact details from Regione Lombardia. Of these, 27 replied to the questionnaire (response rate of 40%). The average number of full time equivalent staff employed to work on EIAs/SEAs was 7.6 (compared to 10 FTEs in the 2002 survey). The average turnover of each company was € 700,000 per annum (€ 1.4m. in 2002 survey due to presence of few larger companies). The average cost of each EIA/SEA was of € 60-90,000 (€ 73,000 for 2002 study) and the average time to do the studies was of 3 months (6 months in 2002).

Data from the Regione Lombardia indicated that each year some 350 EIAs are undertaken in the region (average 2004-08) and some 270 SEA were ongoing in 2008, including in this figure both the preliminary assessments, and the full studies as both require the use of spatial data. More crucial is the finding that since 2002, the number of EIAs had more than doubled, while the number of SEAs increased 90 times since 2004. This is due to the fact that European legislation on EIAs was introduced in 1985, while that on SEA in 2001, but with detailed guidelines issued at the national level in Italy only in 2006.

The findings of the survey showed that although some problems on data availability were still present, the existence of the regional SDI had resulted in average saving to find and access the data needed for the EIAs/SEAs of 11% in terms of cost, and 17% on time (with 44% of respondents estimating savings in costs greater than 20%, and 50% estimating savings in time greater than 30%). This resulted in net benefits to the companies doing these studies of approximately € 3 m/year in this application domain alone. Moreover, a wider social benefit reported by the face-to-face interviews is that the use of the same base of data and knowledge between developers and regulators facilitates the dialogue between the two and results in more effective management of the regional development process.

The figures above should be compared with the total investments of the Lombardia SDI development and operation, which for the first three years (2004-2006) account for € 1.36 million per annum. The costs in the Lombardia case study include technology development (48%) and management and maintenance costs (52%). As in the case of Catalonia, the costs for data production were considered separately as they rely on Regione Lombardia periodic investments within its data production institutional responsibilities.

5. EUROPEAN REGIONAL SDIS: A COMPARATIVE ANALYSIS

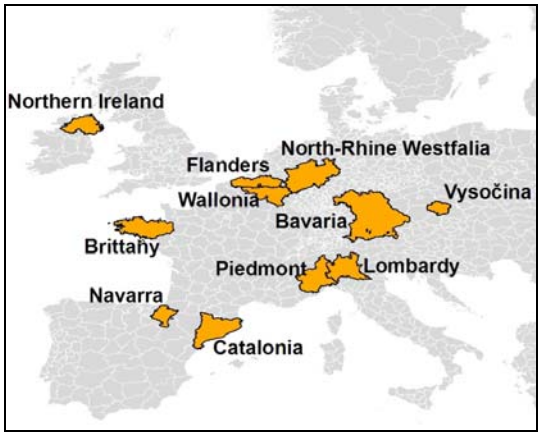
The findings of the Catalonia and Lombardia case-studies indicate that it is possible to measure tangible economic benefits, as well as less tangible but important social benefits of the investment made in SDIs. However, this requires

detailed studies which take time. So it is useful to consider the extent to which the experiences of Catalonia and Lombardia can be generalised, or put another way the extent to which they are unique in the landscape of regional SDIs. To address this issue, we organised a workshop in May 2008 of some of the more advanced regional SDIs in Europe. The selection of SDIs analysed was based on personal knowledge, expert opinion, and availability to participate in the workshop held in Ispra, since the outcomes of the extensive survey undertaken by the eSDInet plus project were not yet available (http://www.esdinetplus.eu/). The comparative analysis of these regional SDIs is presented below and is organised in terms of socio-economic characteristic, administrative context, technology, legal frameworks, organisation, resources, user involvement, and impacts. More details for each region, as well as two case-studies from the US and Australia, are reported in Craglia and Campagna (2009)

5.1. Socio-Economic and Administrative Characteristics

The eleven regions analysed (Figure 2) share many similarities, particularly in respect to technology deployed, but differ considerably in territorial size, and population as shown in Table 2. In respect to population, North-Rhine Westfalia and Bavaria clearly stand out, followed by Lombardia, Catalonia, and Flanders, with Vysocina and Navarra being the smallest. In respect to area, Bavaria is by far the largest, while in economic terms Lombardia tops the table of GDP per capita being 30% above the EU average while the Czech Republic is some 25% below (Table 3).

Figure 2: Advanced Regional SDI: geographic distribution



Most regions have a large number of small municipalities and other administrative territorial organisations, which include a middle tier like Provinces in Italy, Comarques in Catalunia, Regierungbezirke in Germany, Département in

France, and/or sovracommunal bodies associations of small municipalities like the Comunità Montane in Italy, and the Communautés Urbaines and Syndicats Intercommunaux in France. This is significant because engaging users in the development of a regional SDI requires significant efforts when so many different actors are present in the territory, with different levels of resources and technical skills, political orientations, and priorities. It is thus not surprising that developing and sustaining partnerships is a major objective and measure of success of several of the experiences presented.

Whilst this "vertical" (national to local) collaboration among different level of government affects some regions more than others, the challenge of developing partnerships horizontally across different departments of public administration and with other stakeholders (in both public and private sectors) is shared by all.

Table 2: Key features of selected regions

REGION	POPULATION [* 1 million]	AREA [*1,000 square kilometres]	N° of Local Authorities
Lombardy	9.5	23.0	1,546
Piedmont	4.4	25.3	1,206
Catalonia	7.1	32.0	946
Navarra	0.6	10.4	272
Wallonia	3.4	16.8	262
Flanders	6.1	13.5	308
North-Rhine Westphalia	18.0	34.1	396
Bavaria	12.5	70.5	2,056
Northern Ireland	1.7	14.0	26
Brittany	3.1	27.2	1,268
Vysočina	0.5	6.8	704

Source EUROSTAT

Table 3: GDP per capita selected regions

GDP (PPS per inhabitant in %. EU 27 = 100)		
Region	Regional GDP 2005	National GDP 2005
Lombardy	136.5	104.8 (Italy)
Piedmont	114.7	
Catalonia	122.1	102.6 (Spain)
Navarra	129.2	
Brittany	99.5	112 (France)
Wallonia	90.9	120.7 (Belgium)
Flanders	117.3	
North-Rhine Westphalia	112.4	114.6 (Germany)
Bavaria	124.8	
Northern Ireland	97.0	120.6 (United Kingdom)
Vysočina	na	76.2 (Czech Republic)

Source EUROSTAT

5.2 Legal Framework

The existence of legal frameworks to support the development of the regional SDI is in a state of transition. Some regions already have such a framework as is the case of Lombardia, Catalonia, Bavaria, North-Rhine Westphalia, and Flanders. Others do not have such legal backing but have developed strategies, and partnerships on the basis of government initiatives or programmes. These variations are likely to narrow as the INSPIRE Directive gets transposed into national legislation, thus providing an overall legal framework at the national level, and in case of Germany also at the State level.

5.3 Characteristics of the Infrastructures

The technical characteristics registered analysing each of the SDIs share many similarities and indicate the current state of the art in the field. They have all adopted distributed and Service Oriented Architectures (SOA) and are managing a transition between many GIS systems in different organisations towards a shared SDI. OGC-based services and ISO-compliant metadata (either already in that format or transitioning towards it) provide the glue linking together existing datasets and applications.

In some cases, like Navarra the starting point is a corporate GIS that is being opened up to external use via a linked geoportal, in others like that of Vysočina and Brittany, web services are providing an opportunity to link different GI Systems at the local and national level with a relatively weak regional core, while in other still the regional dimension is very strong (e.g. Germany, Belgium, Italy, Spain) partly as a result of the institutional mandates and attributions for data collection and maintenance.

Geoportals are widespread in all regions as an entry point for discovery view, and download services, while there are only few cases of advanced geoprocessing services providing data analysis. To note that whilst most regions provide public access to the geoportal, and to discovery and view services, with more advanced services restricted to registred paying users, Brittany's portal is internal to the project partners and not open to the public.

Linking and sharing existing datasets and applications appears to be the main focus of most SDI under investigation. Lombardia and Flanders however stand out for the efforts in developing large scale topographic databases for their region. These efforts are significant from a financial and organisational perspective, and challenging because they are long term projects during which it is important to maintain momentum and show also quick wins.

Whilst a solid topographic database is clearly important, particularly when maintained locally through administrative processes, the case of Navarra also shows the enormous value of the cadastral layer for so many local applications, and for the financially important real-estate business. The value of the cadastre is indicated by the difference in usage of the Navarra geoportal (SITNA) compared to all the others: while usage figures are in the range of a few thousands (Piedmont) to tens of thousands of hits per month (Wallonia, Catalonia), in the case of Navarra, the usage is one order of magnitude higher (hundred thousand hits per month) for the IDENA portal, and two orders of magnitude higher (1-2 million per month) for the SITNA portal. This clearly indicates the value of having the institutional responsibility for this key layer for local applications, as well as a system already institutionalised in daily practice.

5.2. Resources

The level of financial resources varies significantly depending whether the SDI is intended as only including data preparation, documentation, and publishing through web services or it also includes data production and maintenance. The "weight" of data production is indicated by comparing the cost of setting up and maintaining an SDI without data costs (in the order of €300,000 per annum in the case of Catalonia to €1.4m in the case of Lombardia) with those of an SDI with data included (approximately €10 million per annum for Lombardia and Flanders). In many cases the funding of the SDI is embedded in e-government programmes.

The level of human resources also reflects the different perspectives (with or without data production), and organisational model. At one end of the spectrum, Flanders employs over 100 people to develop the SDI and the large scale topographic database. At the other end of the spectrum, Catalonia employs only 4 people. To note that three regions (Lombardia, Piedmont, and Navarra) use an external IT public agency to support their technical development, while the other regions appear to operate with in-house staff, sometimes part of the mapping and cadastral agency or the regional council.

Partnerships with the private sector are very rare and limited in scope while Universities can play an important supportive role as in the case of North-Rhine Westphalia, Lombardia, and Catalonia. Whilst it important to note that it is possible to set up and maintain an SDI with a small group of very committed individuals and a relatively small budget as shown in the case of Catalonia, it is also clear that small teams are vulnerable to organisational and personal changes so that a strategy for human resource development and management must be in place as argued by the representatives of Northern Ireland, Brittany, and Piedmont who emphasized the lack of adequate human resources as a barrier to further development.

5.3. User Involvement

Masser (2005) and Rajabifard et al. (2003), identified two “generations” of SDIs when reviewing the evolution of these infrastructures: the first largely driven by data producer and focused on the completion of the national databases (product-driven), while second generation SDIs underlie a more complex context for impact evaluation since they are characterised by extensive involvement of users and by a process-oriented approach which emphasizes partnerships, agreements, and a broad set of applications, and not just the completion of national databases (Craglia and Novak, 2006). In this respect, it is clear that all the experiences under analysis qualify as Second Generation SDIs as all of them have spent significant time and resources to build alliances, partnerships, agreements, and user involvement from the local level, through to regional, and national. These efforts have taken place with or without formal mandate but are very significant as they are the basis for a sustainable future development.

Whilst it is relatively easy and quick to set up the technical infrastructure, building and maintaining these relationships and trusted partnership is much more onerous, and credit must be given for the inclusive way in which these efforts have been carried out. The difficulty of building relationship is due in no small measure to the lack of awareness still widespread about the benefits of SDIs, and of sharing resources, particularly at the local level but also among many decision-makers in different government departments at regional level. An example of the obstacles often faced is that one of the first building blocks of an SDI is a catalogue of the resources available. This requires the creation of metadata, which is an onerous task for those organisations, particularly in local and regional governments, that have no tradition of documenting or sharing their resources. Hence, these stakeholders are often asked to undertake a time consuming task, which to them has little visible benefit, as a first step in building an SDI, with the promise that in the longer run they would also benefit. This is clearly very challenging, and different strategies have been deployed in the different cases to overcome this initial hurdle. They include the centralisation of metadata creation by a support agency, as in Lombardia, Piedmont, and Navarra, the creation of dedicated teams in other organisations, or the payment of a small amount (€30 per metadata record) in the case of Catalonia. This is just an example of one of the obstacles in setting up and maintaining an SDI: costs are upfront (in financial and human terms) while benefits are down the line. In the light of these considerations, it is surprising that so few studies have been undertaken to date of the impacts of SDIs, even among the advanced examples considered in this study.

5.4. Impacts

Of the 11 regions considered, only two, Catalonia and Lombardia have been the subject of a socio-economic impact study, in both cases through collaboration with the JRC. The remaining regions have expressed only qualitative assessments of the benefits perceived including:

- Positive cultural change in the stakeholder organisations with greater willingness to cooperate and share resources;

- More coordinated initiatives at the local level in data collection, and reduction of duplication and costs;

- Agreement on the common usage and maintenance of reference datasets;

- More evidence-based applications, particularly in land use planning and infrastructure planning and maintenance;

- Time and cost reduction in finding and accessing data held by other organisations. For example, in the case of utilities in Northern Ireland it takes now 5 minutes on the web to do what used to take 5 weeks in writing to find out where the utilities of other organisations are;

- Improved shared understanding among public agencies of the problems and issues affecting the region.

These are all important benefits that must not be underestimated. Nevertheless, they should also be supported by more quantitative evidence of benefits and their relationship with the investment made to maintain political support and user engagement. In this sense the Catalonia and Lombardia studies not only provides good evidence of how quickly the investments made can be recovered (if data production costs are not included), but also point to the direction SDIs should take, i.e. towards those applications that are routine, and that save time and money, even in small quantities, to large number of users among citizens, businesses, and the public sector. Small savings, times many users, can amount to larger and more durable benefits that one-off large (potential) savings. In this sense, it is very interesting to see how all the experiences presented are making a real effort to engage local authorities, which are the one closer to the citizens in providing essential services. This bodes well for achieving positive impacts. It is also worth noting that the benefits reported by all the regions analysed (either quantitative or qualitative) are in terms of increased efficiency, effectiveness, and broader social and economic development outcome. No significant benefits are reported as accruing from data sales. In fact, in the case of Piedmont, it was

argued that the cost recovered through sales of data is worth less than the salary of the one member of staff assigned to administer the process.

6. CONCLUSIONS

This paper has reported the findings of two recent studies on the socio-economic impacts of SDIs in Europe. Both studies are part of a research programme in this field by the Joint Research Centre of the European Commission, and have been underpinned by the theoretical framework proposed by the eGovernment Economics Project (Corsi et al., 2006). The study in Catalonia focused primarily on the internal efficiency benefits of the SDI, and the effectiveness benefits derived by the public and local businesses in dealing with their local public administration. The Lombardia study was deliberately targeted at the analysis of wider social and economic benefits provided by the regional SDI for the studies done by consultants on Environmental Impact Assessment and Strategic Environmental Assessments. In both cases quantitative evidence of the benefits has shown how quickly the investment made could be recovered. Less than one year in the case of Catalonia, and less than two in the case of Lombardia just in one application area (EIAs/SEAs). Moreover, the sets of benefits identified in the two regions are in principle additive, i.e. there will be benefits in Catalonia from the SDI for the preparation of EIAs and SEAs which add to those identified already, and likewise, some of the efficiency benefits identified in Catalonia will also be present in Lombardia, over and above those analysed. Of course, the size of the benefits will vary depending on the local circumstances. For example, most of the benefits in Catalonia (both quantitative and qualitative) stem out of the applications at the level of the small communes, as these are the closest to the every day needs of citizens and businesses. In Lombardia, the involvement of local administrations has so far been mainly focused in establishing new topographic databases rather than building services over them, so the full extent of the benefits will emerge only in a few years. Similarly, EIAs and SEAs are undertaken in Catalonia as in Lombardia since they stem out of European law. However, the extent of the benefits is proportional to the number of studies undertaken each year, and in Lombardia that number (particularly for SEAs) is particularly high as all the local plans are in a phase of revision. The benefits in Catalonia for this type of application may therefore be smaller than those found in Lombardia, but present none the less.

The significance of these two studies is that at the present time they are the only two we are aware of that document the social and economic impacts of a SDI. In the absence of other studies, it is therefore useful to consider whether their findings may be generalised to other similar context. For this reason, we have compared these two regions with another nine, which have advanced regional SDIs in Europe. The comparative analysis reported in Section 5 above shows that although these eleven regions vary considerably in size and population, and have some difference in application focus and institutional setting, their similarities are much greater than the differences. Crucially, they all have a wealth of digital information layers available, which the SDI then documents, and

makes easier to find and access. It is therefore possible to consider the costs and benefits of the SDIs separate from the data creation and maintenance process, which would take place anyway, even without an SDI. This approach would not necessarily be appropriate for those countries or regions in which major reference data layers are not available in digital form, and for which the priority for investment would clearly be the completion of these layers as in the "first generation" SDIs (Masser, 2005). As the eleven regions considered are all "second generation" SDIs, we can indeed consider the SDIs separate from the data production process. As the SDI technologies and services provided across all eleven regions are very similar, and do not vary that much by land area or population size (while the cost of data production and maintenance of course does) it is reasonable to assume that the costs born by the public administrations to establish and maintain their SDIs are likely to be broadly similar, or at least of the same order of magnitude i.e. in the range € 500,000-1.5 m. per annum as in Catalonia and Lombardia.

On the benefit side, it is also reasonable to generalise the findings of the two case-studies presented in this paper with the caveats already discussed earlier i.e. the extent of efficiency and effectiveness benefits will depend on having developed applications that are routine and with many users, typically those closer to the public, while the socioeconomic benefits accrued in the area of EIAs and SEAs will depend on the number of studies undertaken each year in the region, which is partly a function of economic development for EIAs, and of the number of local authorities and stage in the planning process for SEAs. As indicated, the numbers of Lombardia seem particularly high but we need to develop further this line of enquiry as EIAs and SEAs are very good "lenses" to analyse the benefits of SDIs to the private sector (developers and consultants bearing the cost of these studies), and society at large through improved environmental assessment of development.

If we are correct in assuming that the findings of the Catalonia and Lombardia studies can be generalised to these "second generation" SDIs, then we have a good basis to justify the investment in SDIs. Of course, only new detailed studies with shared methodologies like the ones reported here can verify these assumptions, but while waiting for such studies to appear, we have at least a starting point. Compared to five year ago, we are now in a much better position to make claims about the costs and benefits of SDIs which are supported by real evidence. Moreover, a community of practitioners and researchers on this topic has started to come together and share ideas, methodologies, and experiences, as shown in the AGILE workshop on GeoValue from which this special issue of the International Journal of Spatial Data Infrastructures Research originates. Only this enhanced research collaboration will make it possible to make real progress in this field, which is all the more urgent as the implementation of INSPIRE requires the development of SDIs at multiple levels across Europe.

REFERENCES

Cascetta, E. (2008) *Transportation systems analysis: models and applications* 2nd ed., London: Springer.

Codagnone, C., Boccardelli, P. and M. Leone (2006). *eGovernment Economics Project (eGEP): Measurement Framework Final Version*, eGovernment Unit, DG Information Society and Media, European Commission, at http://82.187.13.175/eGEP/Static/Contents/final/D.2.4_Measurement_Framework_final_version.pdf , [Accessed 27/10/2009].

Corsi M., Gumina A., and C. D'Ippoliti (2006). *eGovernment Economics Project (eGEP): Economic Model Final Version*, Rome: Luiss, at http://82.187.13.175/eGEP/Static/Contents/final/D.3.3_Economic_Model_Final_Version.pdf , [Accessed 27/10/2009].

Craglia M. et al. (2003). *Contribution towards the Extended Impact Assessment of INSPIRE.* Technical Report, at http://inspire.jrc.ec.europa.eu/reports/fds_report.pdf , [accessed 31/10/2009].

Craglia M. and I. Masser (2002). Geographic information and the enlargement of the European Union: four national case studies, *Journal of the Urban and Regional Information Systems Association (URISA)* 14(2) pp 43-52.

Craglia M. and I. Masser (2003). Access to Geographic Information: a European Perspective, *Journal of the Urban and Regional Information Systems Association (URISA)*, 15(APA I) pp 51-59.

Craglia M. and M. Campagna (Eds.). (2009) *Advanced Regional Spatial Data Infrastructures in Europe*. Luxembourg: OPOCE, at http://ies.jrc.ec.europa.eu/uploads/SDI/FINAL%20REPORT.pdf , [accessed 31/10/2009].

Garcia Almirall P., Moix Bergadà M. and P. Queraltò Ros (2008). *The socio-economic impact of the Spatial Data Infrastructure of Catalonia*. Luxembourg: OPOCE, at http://ies.jrc.ec.europa.eu/uploads/fileadmin/Documentation/Reports/Spatial_Data_infrastructures/EUR_2006-2007/EUR_23300_EN.pdf , [accessed 31-10-2009].

Craglia M. and J. Novak (2006). *Report of International Workshop on Spatial Data Infrastructures' Cost-Benefit / Return on Investment*. Luxembourg: OPOCE, at http://ies.jrc.ec.europa.eu/uploads/fileadmin/Documentation/Reports/Spatial_Data_infrastructures/EUR_2006-2007/EUR_22294_EN.pdf , [accessed 31-10-2009].

Crompvoets, J., Rajabifard A., van Loenen B., and T. Delgado Fernández (Eds.) (2008), *A Multi-View Framework to Assess Spatial Data Infrastructures*, The University of Melbourne. http://www.csdila.unimelb.edu.au/publication/books/mvfasdi.html [accessed 2010-04-22]

Dufourmont H. (Ed.). (2004). *Inspire Exteded Impact Assessment*. European Commission: EUROSTAT, at http://inspire.jrc.ec.europa.eu/reports/inspire_extended_impact_assessment.pdf , [accessed 31/10/2009].

Genovese E., Cotteret G., Roche S.,Caron C. and R. Feick (2009). Evaluating the socio-economic impact of Geographic Information: A classification of the literature, *International Journal of Spatial Data Infrastructures Research*, Vol. 4. 218-238, at http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/view/120/187, [accessed 27/10/2009].

Grus L., Crompvoets J. and A.K. Bregt (2007). Multi-view SDI assessment framework, *International Journal of Spatial Data Infrastructures Research*, Vol. 2, 33-53, at http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/viewFile/27/21, [accessed 31-10-2009].

Lance K., Giorgiadou Y. and A. Bregt (2006). Understanding how and why practitioners evaluate SDI performance, *International Journal of Spatial Data Infrastructures Research*, Vol. 1, 65-104, at http://ijsdir.jrc.ec.europa.eu/index.php/ijsdir/article/viewFile/19/13 , [accessed 27/10/2009].

Masser I. (1998). *Governments and Geographic Information*. London: Taylor & Francis.

Masser I. (1999). All shapes and sizes: the first generation of national spatial data infrastructures, *International Journal of Geographical Information Science* 13:67-84.

Masser I. (2005). *GIS Worlds: creating spatial data infrastructures*, Redlands: ESRI Press.

Rajabifard A., Feeney M.E.F., Williamson I. and I. Masser (2003). National SDI Initiatives, in Williamson I., A. Rajabifard A. and M.E F. Feeney (Eds.). *Developing spatial data infrastructures: from concept to reality*, Boca Raton, FL: CRC Press. pp. 95-109.

Vanderhaegen M. and E. Muro (2005). Contribution of a European spatial data infrastructure to the effectiveness of EIA and SEA studies, *Environmental Impact Assessment Review*, 25 (2): 123-142.

Van Loenen B. (Ed.) (2008) Assessment and socio-economic aspects of geographic information infrastructures, *Proceedings of the Workshop on Assessment and Socio-economic Aspects of Spatial Data Infrastructures*, Delft: Nederlandse Commissie voor Geodesie 46. http://www.ncg.knaw.nl/Publicaties/Groen/46VanLoenen.html [accessed 2010-04-22].

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