



Lithuanian spatial information infrastructure: 20 years of evolution, milestones, costs and benefits

Giedrė Beconytė^{1,2} , Andrius Balčiūnas¹ and Inga Andriuškevičiūtė²

¹ Institute of Geosciences, Vilnius University, Vilnius, Lithuania

² State Enterprise “GIS-Centras”, Vilnius, Lithuania

Correspondence: Giedrė Beconytė (giedre.beconyte@gf.vu.lt)

Abstract. The paper presents the outline of development of the Lithuanian SDI from its initial idea in 2002 to the functional and mature system in 2022. The aspects of organizational co-ordination, spatial competencies and impact on the development of the society are briefly discussed. Evaluation of maturity of the SDI is evaluated using original method and presented in an aggregated form for the five milestones of the SDI development timeline. Economic and social benefits and accuracy of prognoses is retrospectively evaluated using actual numbers of users and use cases. Impact of new framework data services, new administrative services and provision of open data is demonstrated by different indicators of growth of use of the SDI. Future trends and threats are discussed.

Keywords. SDI, Lithuania, development, paradigm, benefits

1 Introduction

The first initiative related with building a spatial data infrastructure (SDI) in Lithuania was taken by the State enterprise *Centre for Geoinformatics and Remote Sensing* (GIS-Centras) and the *National Land Service under the Ministry of Agriculture* (NLS). A preparatory work was carried out in 2002–2004 by a team of GIS-Centras and five external experts. It resulted in a feasibility study (Feasibility..., 2004) that described spatial data policies and resources of Lithuania of that time, the goals and objectives of the SDI development, necessary interventions, opportunities and risks. The main insights about technological implementation were made and alternatives were discussed (Lithuanian ..., 2004). The main concepts were developed based on successful examples of SDI implementations in European countries

(Bulens et al., 2007; Chafiq et al., 2015; Masser, 2019), but, first of all, on the national needs. Also, preparatory phase of the Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE directive) had started by that time and gave the team additional inspiration related to sharing and opening of the data—whereas the absolute most of national spatial datasets in Lithuania were neither open nor easily available.

One of the main statements of the study, widely communicated nationally since 2004, was that geographic information has tremendous economic and social value for any society. Geographic information is based on geographic data that is expensive to collect process and maintain yet ever easier to disseminate relatively cheaply via web-based services and added value products. This initial paradigm, though without explicitly stated major changes, developed over time together with growing spatial competences in the organizations and society and accompanied by development of national information systems: Lithuanian Spatial Information Portal (geoportal.lt, LSI portal) and—later—Topographic and Engineering Infrastructure Information System (tiii.planuojustatau.lt, TEIIS).

The *aim* of the broader study is to understand the impact of spatial data availability, communication and spatial competencies on development of the SDI. The objectives are as follows:

- 1) conceptualization of the SDI and highlighting the changes in its paradigm over time;
- 2) parameter-based assessment of maturity of the SDI;
- 3) analysis of costs and benefits;

- 4) analysis of impact of the SDI on spatial awareness in the society;
- 5) defining focus points for future.

In this paper we share some principal results of the study—an overview of development of the Lithuanian SDI over 20 years and make a hint at what will happen in the near future. Presentation of the development in a chronological order and provided quantitative insights may be of interest to the developers of SDI in other countries. In the academic world, we seek for a broader discussion on the factors that determine success and failure of various SDI-related initiatives.

2 Methods

Conceptualization of the national SDI paradigm and its changes is based on:

- a) analysis of structural and semantic changes in the state information systems,
- b) comparative analysis of legal acts, specifications and other documents where the purpose of the SDI and its components are described and
- c) analysis of user surveys and interviews that reveal what are the perceived most important aspects of the SDI.

There are some studies where the concept of maturity of the SDI is used and assessments are made based on various indicators (Hvingel et al., 2014. Kalantari et al., 2016). Still, the assessment methods vary, are either too concrete or too abstract and lack a common scientific basis. Thus, the possibilities of comparison among the countries are quite limited. In this research, we applied original qualitative method based on the criteria that combine the aspects outlined in the INSPIRE directive and those identified during practical use and assessments of the national SDI:

- Data discovery (ranging from availability of references to fully functional system of metadata);
- Data services (clarity and inherent consistency of spatial data services: view, download and transform);
- Specification/Information services (ranging from mere availability of some specifications to consistent methodological guidelines);
- Interactive services (services implementing various spatial data use cases); and
- Popular SDI services (presence and consistency of the supplementary web content and applications).

Each of the criteria was assessed by three aspects:

- Maturity of vision (from a vague idea to full-scale strategy of development, three categories from low to high);
- Coverage (four categories from fragments/'islands' to what could be considered a national optimum; more than just a spatial coverage); and
- Quality (compound indicator describing, where applicable, correctness, comprehensiveness/usability and performance; three categories from low to high).

Analysis of costs and benefits was performed based on quantifiable parameters such as investments, SDI maintenance costs, time and monetary savings due to simplification of procedures of access to data and saved software maintenance costs. Far-reaching but less tangible benefits of better informed decisions in planning and development, better transparency and education are not addressed. For the analysis of impact of the SDI on spatial awareness in the society we used the statistics of organizations and users involved in the SDI, opinions expressed during interviews with different stakeholders, user surveys, requests and feedback received at the LSI portal. Efficiency of co-ordination of the SDI was assessed based on analysis of major issues in the course of development, their causes and effects. This part of the research requires a deeper investigation and is not presented in this paper.

3 Evolution of the paradigm

In the timeline of development of the Lithuanian SDI there are four milestones where particular levels of maturity were reached and principal paradigm was reviewed.

1. **2004–2005.** The first large project of development of the SDI that created organizational framework and the national spatial information portal.

The paradigm: a well-organized network of closely co-operating pro-active public sector data providers oriented to national needs. Spatial data shared in the single national SDI portal. Expectation – massive re-use of data services, increased amount of added value products and results of complex spatial analyses. Commercial data provision is acceptable. The role of the municipal administrations in data sharing is important and growing. The highlights in the European data policy context were the Directive 2003/98/EC on the re-use of public sector information (PSI directive), information society and the knowledge economy (Feasibility..., 2004).

The term ‘geographic’ that had been commonly used in Lithuania before was by default replaced by ‘spatial’ that was transferred from the EU legislation. ‘Spatial’ is more abstract and less associated with geospheres, geographic analysis or geographic knowledge. This may have made indirect impact on shift to technology leaving the geography-oriented goals somewhat aside. Thus, even though the primary purpose of the INSPIRE directive was the harmony in the domain of the environmental data (exactly what we think about in the geographic contexts), the first observable effect was intense promotion of GIS technology in public sector, then followed by spreading GIS skills.

The EU INSPIRE directive came into force in 2007. An extensive in-service training project for 227 specialists of the organizations involved in the SDI was implemented in 2006–2008 (Beconyte at al., 2008). Nine training modules prepared for this project by an international academic team included theoretical parts and are still in use (publicly available at <https://www.geoportal.lt/geoportal/web/geographic-information-training>). The first LSI portal was developed as a national platform for implementation of the directive and launched in 2009 (Beconyte at al., 2010). In 2010, a governmental decree was issued, obliging national spatial data managers and municipalities to share their data that fall under the themes listed by the INSPIRE directive.

The main **lessons learned** between 2002 and 2012 were as follows.

- SDI, at least in its early stage, is not self-organizing. Practical interests of organizations related with their income and disclosure of data quality issues outweigh theoretical understanding of long term benefits that come from data sharing. Motivation to share the data more often arises from the perceived opportunity of external financing of the action than from a genuine interest. Political intent plays crucial role in ensuring the involvement of organizations in the SDI. High level legal acts are necessary in order to make data sharing agreements work in practice.
- Success of SDI-related initiatives is highly dependent on personal attitudes at governmental level. Flexibility and freedom of decisions delegated to the technical team was necessary for the successful start.
- Mere availability of data was not sufficient for a real breakthrough in the market of spatial products. Favourable conditions of data sharing (ease of access and use, free of charge data) are very important for broad re-use.

- Spatial data, services, metadata and specifications are much more important than various popular applications, forums, blogs or community channels. The ‘nice to have’ components should remain in the wishlist until data sharing system starts functioning smoothly.

2. **2012–2015.** Development for INSPIRE implementation (allegedly) and for interactive services (purposefully).

The paradigm: a core system of national spatial data services and several interactive services, closely linked to the master spatial datasets (reference base/topographic data, orthophotographic imagery, various land management databases, DEM). It is complemented by a loose and dynamic network of other spatial data providers, including third parties (businesses, NGOs, research and education organizations). SDI portal provides consolidated services for municipality administrations emerged, including large scale topographic and engineering infrastructure information. Shared data are widely used for decision making.

In 2012, an important stage of the SDI development in Lithuania began.

1. LSI portal was fully legitimized as the single national data sharing system.
2. The most of the national spatial datasets became free of the charge (so far for non-commercial use only; for the commercial use, data sharing policy remained unclear). Lithuania was one of the first countries of the EU who made such decision.
3. A three-year SDI extension project was started, with a goal of developing new interactive services and implementing the first package of the INSPIRE requirements.

A breakthrough in use was observed – compared with 2011, the number of delivered data services grew three times.

INSPIRE served as a good formal pretext for developing full-scale national SDI and spatial data services. It was crucially important for creation of legal base and ensuring the funding necessary for national initiatives (the perspectives of the INSPIRE services as such were still vague and benefits questionable).

In 2016, Regulation (EU) 2016/679 of the European Parliament and of the Council on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation, GDPR) came into force. Existing

national data sharing practices had to be revised with regards to protection of personal data.

The main **lessons learned** between 2015 and 2018:

- The potential of spatial information use is much higher than ever anticipated. The number of registered users of the LSI portal exceeded all expectations and had been growing with the same pace for much longer than it could have been expected. Later, in the end of 2021, the number of registered users will reach 1% per cent of the total population in Lithuania (Figure 1);
- Mobile SDI services are of the same importance as desktop platform. Since introduction in 2017, the geoportal.lt app was intensely used on almost exponentially growing number of devices (Figure 1);
- National SDI portal is not the place for integration of municipal data or other data that have no centralized management (an information system and/or responsible organization). At the early stage, some steps can be made towards integration, but then it must be undertaken by an authorized national body. The same can be said about integration of various thematic data into reference or other compound datasets;
- National SDI portal usually cannot and must not compete with various commercial platforms like *Mapbox*, *Carto* or *Google Maps* when specific popular services are concerned, such as web maps, routing services, business intelligence or GIS cloud services) – it must focus on the administrative services.

SDI is a prerequisite for use of spatial data for national decision making, but it alone is not sufficient. Efficiency in decision making can only be improved by derived spatial data products that are very easy to use. Specific types and contents of such products cannot be reliably predicted.

3. **2018–2019.** Consolidation and linking of data services, refit of the platform.

The paradigm: Integral and well-co-ordinated platform providing semantically associated data services. Consolidated INSPIRE services. National SDI portal provides consultations and services of transformation, updates and optional hosting for the providers of the data used in the INSPIRE themes. More emphasis is laid on usability and efficiency. Municipal data and narrow-purpose datasets available from other sources are only republished when their provision is well justified.

By 2018, after 10 years of functioning of the SDI, the stage of relative stability and certainty was reached. The procedures of data sharing were already well-established and more attention could be paid to efficiency. The potential benefits of the open source technology became evident, while consolidation of necessary competences was still a challenge.

The INSPIRE Directive was the most relevant legal act in the European data policy context. Another three-year SDI extension project was started in 2018 with a goal of maximal coverage of the INSPIRE themes and of the list of the identified priority environmental datasets.

Information system for Topographic and engineering infrastructure information was launched in 2021 with the mission of integration of municipal large scale data. Some other systems integrated local level environmental data into seamless national datasets (noise, habitats and others). Thus, the number of individual data services available in the SDI decreased, though their overall value increased.

Two other information systems emerged, with certain claims for national level co-ordination of data sharing: Governmental data management system (potentially covering all national data including spatial data) and Lithuanian open data portal (covering all open data including spatial data). Weakness of co-ordination of the SDI was clearly understood as a hindrance to efficiency.

The directive of the European Parliament and of The Council on open data and the re-use of public sector information (the recast of the PSI directive) was adopted in 2019. It was expected that opening of the high value national data would become the main focus of the SDI for the next several years. The situation changed with unexpected invasion of Russia into Ukraine. Various security issues became relevant, among them adequate protection of spatial data that previously hadn't been considered sensitive and were made freely available for non-EU citizens. Examples of such data are very high resolution orthophotographic images or detailed road infrastructure data.

The main **lessons learned** after 2019:

- There are high value data and low value data. More data doesn't mean better satisfaction or higher value. On the contrary, the users need reasonable amount of valuable data services of appropriate type. Availability of popular formats for data download, efficient search and good metadata are particularly important;
- Opening of spatial data creates diverse risks may be not immediately evident;
- Stability is not forever. Since 2018, reorganization of several institutions in charge of maintenance of

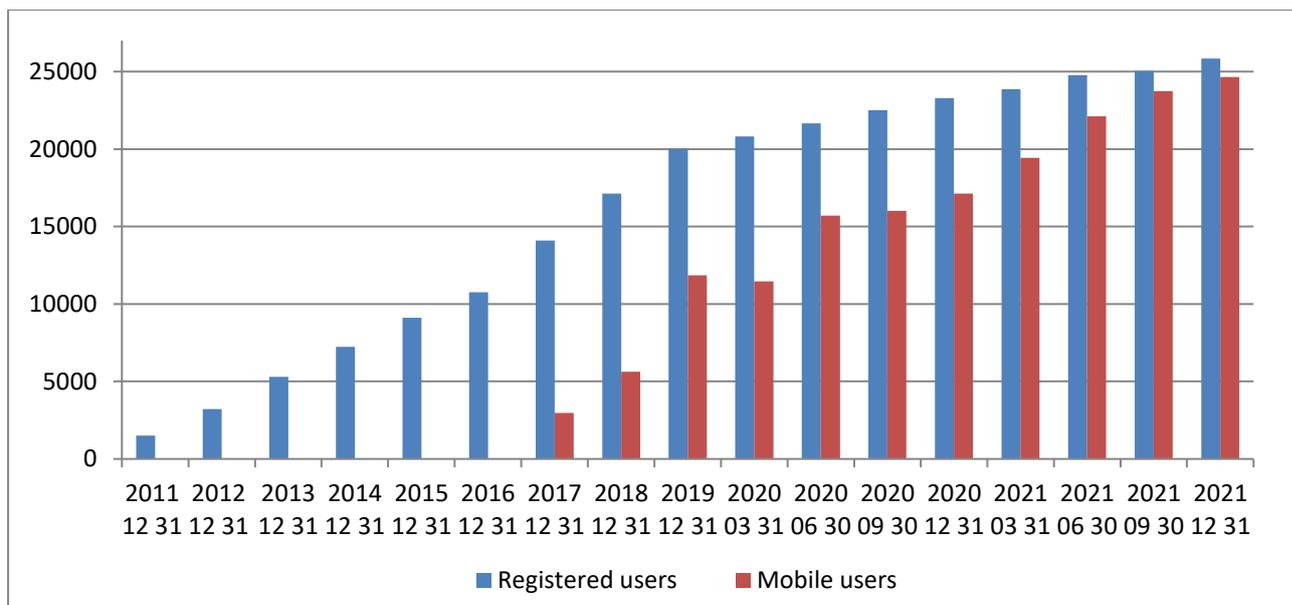


Figure 1. Dynamics of registered users of the LSI portal (www.geoportal.lt) in 2012–2022

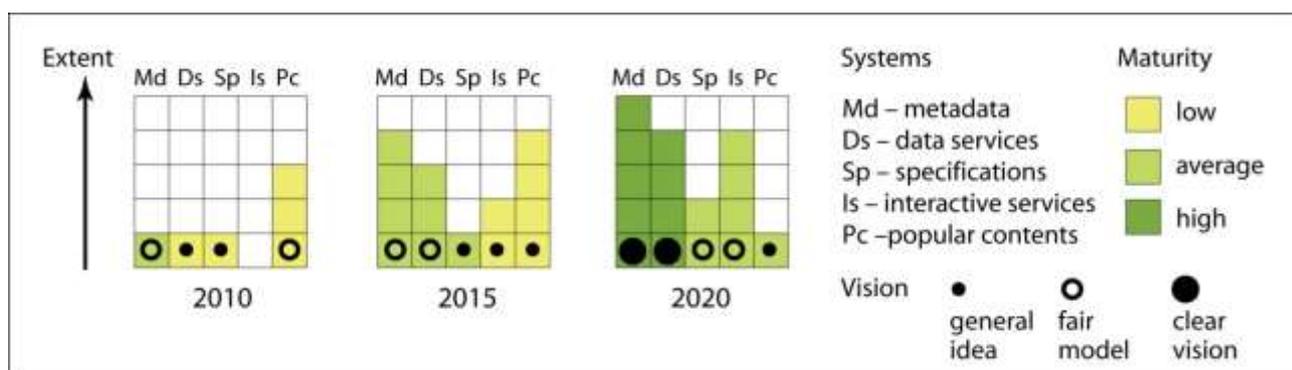


Figure 2. Maturity of Lithuanian SDI

the national SDI is under way. It is not yet clear how it will affect the strategy and the processes of the SDI.

- Even though SDI is in some sense self-organizing, efficiency of organization is dependent on specific persons or bodies. In the time of changes, the need for systematic national coordination is increasing.

4. 2022 – the step into the future.

The paradigm: Optimal amount of valuable data services with well-aligned procedures of data exchange with other state information systems. High quality and up-to-date source data are efficiently shared and widely used for data-driven services and added value products.

Even though the vision of the SDI is now clear and consistent, there’s still a long way to implement it and thi

sway can be interrupted by re-organization of coordinating bodies that is anticipated in 2022. Also, new needs and restrictions emerge related with the Covid-19 pandemic and with the war actions in Ukraine. This is why we cannot expect any intense development in the nearest future.

The tentative assessment of maturity of the Lithuanian SDI in every five years from the beginning of operation of the geoportal is represented on Figure 2. The assessment was performed by the experts involved in the SDI development and must still be validated, however, there is no big dispute about this assessment. The extent of each system was evaluated compared to hypothetic 100% coverage for Lithuania. Maturity of existing system was assessed according to modern vision and maturity of the vision – according to the extent to which it is understood how everything should work.

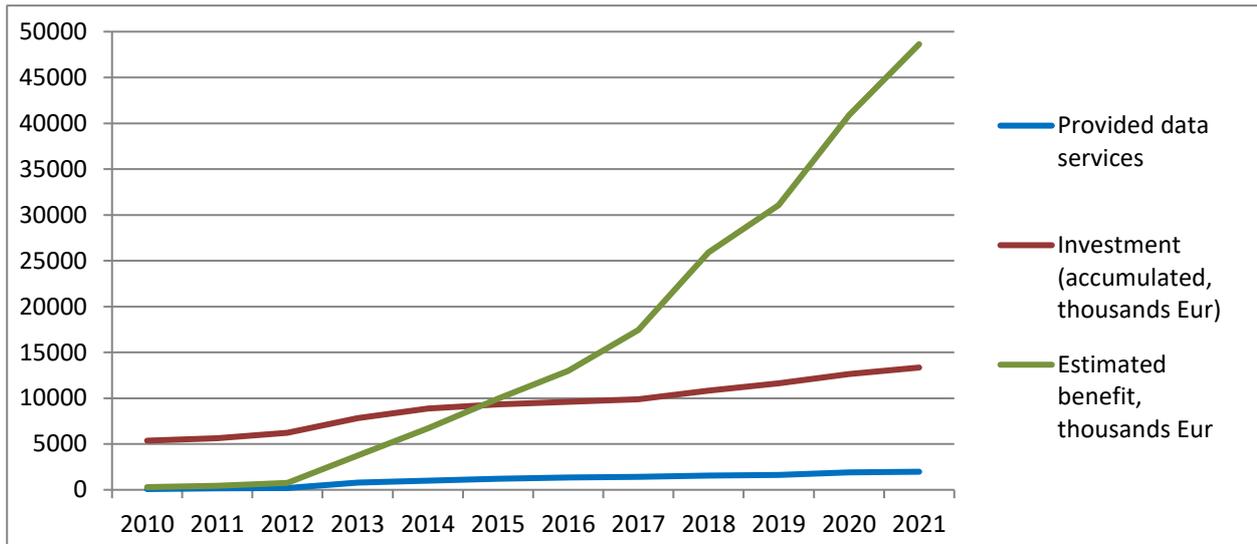


Figure 3. Investment and benefits of Lithuanian SDI

Table 1. Investments, use and benefits of Lithuanian SDI

Year	Investment, thousands Eur	Investment, accumulated, thousands Eur	Registered users	Page visits, thousands	Use of data services, thousands	Number of interactive services	Estimated benefits, thousands Eur
Before 2010	5275	5275	–	–	4	0	
2010	87	5362	728	–	15	0	295
2011	260	5622	1515	47	40	0	454
2012	617	6239	3215	99	98	0	747
2013	1591	7830	5296	414	385	1	3746
2014	1051	8881	7235	665	913	3	6724
2015	449	9330	9116	1072	1312	7	9963
2016	278	9608	10750	1046	1761	8	23192
2017	276	9884	14088	1357	2388	8	17438
2018	940	10824	17124	1843	3208	9	25919
2019	805	11629	20006	2624	4446	13	31073
2020	1014	12643	23286	3011	3684	14	40899
2021	699	13342	25343	3061	3926	15	48632

4 Estimated costs and benefits

In this section we provide figures that illustrate the growth of the use of the SDI portal and the benefits created by spatial data sharing (Figure 3, Table 2). The estimation of economic benefits is the most conservative, based on presumption that each of the registered users with average hourly salary of 7 Eur uses 2% of available different data

services per year, saving 6 hours for data acquisition and transformations per a service. According to a couple of user surveys in 2012 and in 2015, actual figures could have been several times higher. Other components of the overall estimated benefit are:

- a) time and resource savings in public organizations, mainly those responsible for INSPIRE data themes, and.

- b) reduction of total time for administrative procedures that involve spatial data and are made fully electronic.

There are other, indirect economic benefits that were not included in the calculations. Examples of such benefits are:

- reduced duplication of spatial data sets (it is unnecessary to keep copies available online) and no need for repeated efforts to collect similar data sets;
- smaller number of legal proceedings and consequences arising from the incompatibility of spatial data, due to improved availability and transparency of the official spatial data sets;
- decision-makers are better informed, thus financial and time costs are reduced;
- higher number of ongoing projects for the development of spatial information systems, greater demand for professionals, new jobs.
- Social benefits of the SDI cannot be expressed in numbers but already observed. They are primarily linked to improved awareness and motivation at all levels:
- strengthened cooperation between different organisations by using the same spatial data as an instrument for interconnection;
- new possibilities for using spatial information, increasing number of developers of spatial data and added-value services, less investments in hardware and software and more investments in innovative products;
- better awareness of citizens of the living and business environment, ability to use spatial analysis tools and more active participation in decision-making.

Conclusion

The progress of the SDI is not even. In the course of development the processes are reassessed and new understanding may lead to substantial changes in the paradigm. It may take decades before forced involvement of the data providers is replaced by voluntary sharing.

For the Lithuanian SDI, it took five years until the yearly economic benefits certainly exceeded the cumulative investment. Since then, the benefit trend has been rapidly ascending.

Diversity of data services is a driving factor of SDI use, but quality is more important for the real benefits.

Centralized co-ordination of the SDI has proven to be efficient in Lithuania. However, as it was never raised to

the governmental level, the SDI has become oriented to land management. In different sectors, other data sharing platforms emerge and the lack of a national centre for spatial competences has become obvious.

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