Exploring the Emergence of Open Spatial Data Infrastructures
Analysis of Recent Developments and Trends in Europe

Vancauwenberghe, Glenn; van Loenen, Bastiaan

Important note
To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Chapter 2
Exploring the Emergence of Open Spatial Data Infrastructures: Analysis of Recent Developments and Trends in Europe

Glenn Vancauwenberghe and Bastiaan van Loenen

Abstract In the past 20 years, European public authorities have invested considerable resources in the development of spatial data infrastructures. With the European INSPIRE Directive as an important driver, national spatial data infrastructures were developed throughout Europe to facilitate and coordinate the exchange and sharing of geographic data. While the original focus of these spatial data infrastructure was mainly on data sharing among public authorities, it became more and more evident that these data could also be of great value to users outside the public sector. In recent years, several countries and public administrations started to make a shift towards the establishment of an 'open' spatial data infrastructure, in which also businesses, citizens and non-governmental actors were considered as key stakeholders of the infrastructure. This chapter provides an analysis of the measures and solutions implemented in four European countries (the Netherlands, the United Kingdom, Denmark and Finland) to make their spatial data infrastructures open to businesses, citizens and other stakeholders. The analysis shows that in these four countries the move towards more open spatial data infrastructures can mainly be seen in the increased availability of geographic data and spatially enabled services to citizens, businesses and other stakeholders.

Keywords Open data • Geographic data • Open spatial data infrastructures • Citizens • Businesses • Spatially enabled e-services

1 Introduction

Since the 1990s public administrations in Europe and worldwide have invested considerable resources in the development of infrastructures for promoting, facilitating and coordinating the exchange and sharing of geographic data [1]. These so-called spatial data infrastructures have increased the availability and accessibility

---

G. Vancauwenberghe (✉) • B. van Loenen
Knowledge Centre Open Data, Delft University of Technology, Delft, The Netherlands
e-mail: g.vancauwenberghe@tudelft.nl

of geographic data collected and managed by governments. Geographic data, i.e. data that refer to a location on the earth [2], are increasingly important for governments, as most of the societal, environmental and economic challenges that governments are facing, require spatial understanding and insight. Typical examples of geographic data are topographical maps, address data, road data, and hydrographical data [3, 4]. In Europe, an important trigger in the development of spatial data infrastructures was the 2007 INSPIRE Directive establishing an Infrastructure for Spatial Information in the European Community [5]. The Directive had an important impact on the way governments in European countries organized the access to and sharing of their geographic data. Its aim was to develop a European infrastructure based on the creation, operation and maintenance of the national spatial data infrastructures established and operated in the different member states of the European Union.

The original focus of most spatial data infrastructure developments, not only in Europe but also in other parts of the world, was on promoting and stimulating data sharing within the public sector. Also the primary aim of INSPIRE was to create a European Union (EU) spatial data infrastructure for enabling the sharing of environmental geographic information among public sector organizations, within and between member states and especially between member states and the European Commission. In many European countries, data sharing with organizations and individuals outside the public sector for a long time remained limited, as the mechanisms and instruments to support and facilitate this type of sharing were missing [6]. This formed an important barrier to a more effective and efficient use of geographic data throughout society [7]. In recent years, several countries and public administrations in Europe started with the implementation of an open data policy, with the aim of making their government data 'open', i.e. freely available for use and re-use without restrictions. In most countries, also geographic data were under the scope of these open data policies and programmes, and were made available to citizens, businesses and other potential user groups outside the public sector. At the same time also in the development of spatial data infrastructures these private organizations, research institutions and other non-profit institutions were recognized as important stakeholders, and became more actively involved in the governance and implementation of the infrastructures.

The aim of this chapter is to empirically examine the multifaceted and changing role of non-government actors in the development of spatial data infrastructures in Europe. An analysis will be made of how four European countries have been dealing with the challenge of opening their spatial data infrastructures to actors outside the public sector. The chapter will analyse the measures and solutions implemented by European countries in the past 10 years to make their spatial data infrastructures open to businesses, citizens and other stakeholders. In the following section of this chapter, a brief overview is provided of the main concepts, views and research on the role of citizens and businesses in spatial data infrastructures. Next, the EU legal framework on geographic data sharing is described and the four national spatial data infrastructures that will be analysed are introduced. The fourth section presents the main actions and measures taken in these four spatial data infrastructures to make

geographic data available to citizens, businesses and other users. In the fifth section, the analysis is focused on the governance and implementation of the infrastructures, and the involvement of non-government actors in both processes. The chapter ends with a discussion of the main findings and some conclusions.

2 Towards Open Spatial Data Infrastructures

Spatial data infrastructures often are defined and described as a complex and dynamic phenomenon [8, 9]. Giff and Crompvoets [10] see several reasons for the complex character of these infrastructures: the many components a spatial data infrastructure consists of, the diversity of involved stakeholders, and the many different objectives and ambitions of these stakeholders. Technological advancements, such as the emergence of web 2.0 technologies, and societal changes, such as the increasing use of geographic information in everyday life, are often mentioned as important drivers behind the dynamic character of spatial data infrastructures. A key characteristic of spatial data infrastructures is the involvement of a large and diverse group of actors [11]. Governments are often considered as the central actors in the development and implementation of spatial data infrastructure, since they are the major producers and users of geographic information [12]. Governments at different administrative levels and in different thematic domains are involved in the creation, management, use and sharing of geographic data [13]. But also private companies, non-profit organisations, research and education institutions and even citizens can participate in the development and implementation of a spatial data infrastructure [14]. Some authors even argued that the involvement and engagement of each of these stakeholders group is essential to the realization of a successful spatial data infrastructure [2, 14–16]. Also the development of spatial data infrastructures for particular users groups, such as scientists or citizens, is proposed as an alternative approach for addressing the needs of these users [17].

For many years several authors have suggested and explored the introduction of a new generation of more user-driven spatial data infrastructures and the need to redefine or expand the SDI concept [18–21]. In reality most spatial data infrastructures in the world were government initiatives to facilitate and coordinate the exchange of geographic data among producers and users in the public sector. In recent years however, several technological, institutional and societal developments suggested a shift towards more open spatial data infrastructures in which also businesses, citizens and other non-governmental actors were considered as key stakeholders of the infrastructure. The concept of open data spatial data infrastructures entails at least four core but interrelated changes in the role and position of actors outside the public sector in the development and implementation of spatial data infrastructures.

First, open spatial data infrastructures primarily deal with opening geographic data, and making these data freely available to citizens, businesses and other users for re-use without restrictions. Since President Obama's Memorandum on Transparency and Open Government announcing the creation of a transparent

and collaborative government through public participation, the concepts of open government and open data have attracted considerable attention from researchers, practitioners and decision makers. Open government data became a very popular topic in many parts of the world, including Europe, Australia, New Zealand and Azia [22]. Open spatial data infrastructures in essence are about applying the principles of open data to geographic data. This means all geographic data should be made available for free, unless they are subject to legitimate privacy, security or privilege limitations. The data should be license-free, machine processable, and timely available to the widest range of users in an open format [23].

Second, spatial data infrastructures can be considered as a framework supporting the delivery of e-services to citizens, businesses and other stakeholders [24]. Some authors even argue that spatial data infrastructures will only be successful if they are well connected to e-government [13]. The data and other components of a spatial data infrastructure should be used to improve and enhance all types of online services: information services, contact services, transaction services, and participation services. These spatially enabled services, i.e. services built on top of geographic data and other components of a spatial data infrastructure, will ensure that also businesses, citizens and users could optimally take advantage of the benefits of geographic data. In addition to opening up geographic data sets to businesses, citizens and other users, open spatial data infrastructures also include the provision of different types of spatially enabled e-services to these citizens and businesses.

Third, in order to take into account the needs and requirements of different stakeholder groups, also data users and producers outside the public sector should be involved in the governance of the SDI [25]. The governance of spatial data infrastructures deals with the adoption of structures, procedures and instruments for managing the relationships and dependencies between all involved actors, units and organizations. The key challenge of governance is reconciling collective and individual needs and interests of different stakeholders in order to achieve common goals [26]. Therefore, open spatial data infrastructures is also about refining existing governance instruments and adopting new governance instruments to involve organizations and actors outside government in the governance of spatial data infrastructures.

Fourth, spatial data infrastructures only are open in case all stakeholders can contribute to the development of these infrastructure, which means they can also add their own data and components to the infrastructure. The contribution of non-government actors to the development and implementation should go further than the traditional contribution, i.e. working as contractors for public administrations and providing services to these administrations [6]. Open spatial data infrastructures can only be realized by putting in place processes, methods and tools that stimulate and enable non-government actors to add their own data sets and other components to the infrastructure. A particular challenge is to optimally take advantage of voluntary geographic information (VGI), i.e. geographic data provided voluntarily

by individuals [27]. As it was argued by Budhathoki et al. [20], open spatial data infrastructures require a redistribution of data production activities among different types of organizations and users.

3 The European Framework for Geographic Data Sharing

The EU legal framework for the availability and sharing of geographic data is formed by several legal instruments. The two most prominent instruments are the PSI Directive 2003/98/EC on the re-use of public sector information and the INSPIRE Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). Both Directives lay down a set of rules on governing the re-use and availability of government data, and geographic data in particular.

3.1 The European PSI Directive

The European Directive on the re-use of public sector information (Directive 2003/98/EC, known as the 'PSI Directive') entered into force on 31 December 2003. After a review of the Directive and a proposal by the European Commission in 2011 to revise the Directive, the new PSI Directive entered into force in July 2013 [28, 29]. The PSI Directive focuses on the economic aspects of public sector information and encourages the Member States to make as much information available for re-use as possible.

The PSI Directive establishes a minimum set of rules governing the re-use and the practical means of facilitating re-use of existing documents held by public sector bodies of the EU Member States. The Directive rules that all documents held by public sector bodies of the EU Member States are re-usable, unless access is restricted or excluded under national rules on access to documents and subject to the other exceptions laid down in this Directive. The PSI Directive does not contain an obligation concerning access to documents. If information is not accessible also the re-use obligations of the PSI Directive do not apply.

The Directive promotes the use of open licenses, although the use of open licenses is not obliged. The Directive also addresses the use of open and machine-readable formats and the provision of metadata on the documents. Another issue addressed in the Directive are possible charges for public sector information. The Directive supports the re-use of this information by setting marginal cost of reproduction as the rule, although certain exceptions still are possible. In addition, the PSI Directive requires transparency of the amount of, and the calculation basis for all charges.

3.2   The INSPIRE Directive

While an important driving force for public organizations to open their data
came from the revised PSI Directive, also the INSPIRE Directive establishing an
infrastructure for Spatial Information in the European Community of 2007 had an
important impact on the way public administrations in Europe organize the access
to and sharing of their spatial or geographic data [5]. INSPIRE aims to overcome
the major barriers affecting the availability and accessibility of geodata, through
the development of a European spatial information infrastructure. This European
infrastructure will be based on the creation, operation and maintenance of the
national spatial data infrastructures established and operated by the 28 Member
States of the European Union, but also Switzerland, Norway and Iceland.

The INSPIRE Directive requires public authorities to publish all spatial data
related to the environment according to specific technical and non-technical speci-
fications. For each data set, a description of the data should be provided in the form
of metadata and these metadata should be accessible through discovery services
making it possible to search for data sets. In addition, view services should be put
in place making it possible to view the data sets and download services should be
developed enabling to download the data—or parts of it—and access them directly.
Data should be conform to the INSPIRE data specifications, while also the metadata
and network services should be INSPIRE compliant. Moreover, public authorities
should adopt measures for the sharing of spatial data sets and services between its
public authorities enabling these public authorities to gain access to and exchange
and use these spatial data sets and services.

The INSPIRE Directive aimed to tackle many barriers to the—commercial—
re-use of data and services: a central access point is established where users can
discover all available data and services of all member states and also view most
of these data and services free of charge; download services for getting direct
access to spatial dataset need to be put in place, and data providers need to provide
information on the conditions applying to access to, and use of, spatial data sets
and services and on the corresponding fees. Also the need to make data available
harmonized to the INSPIRE specification enables the re-use of this data by other
parties. Analysing the different components and requirements of INSPIRE, it can
be concluded that the Directive makes an important contribution to promoting the
re-use of spatial data, by enhancing the legal and physical attainability of the data
but also the usability [30].

3.3   Open Geographic Data in EU Member States

The European INSPIRE Directive and PSI Directive both have an impact on the
way governments and public authorities in Europe are dealing with the management
and exchange of spatial or geographic data through the establishment of a national

spatial data infrastructure. With the entrance into force of the INSPIRE Directive but also the PSI Directive, countries in Europe started or continued with the development of their national spatial data infrastructure according to the principles, rules and guidelines of INSPIRE and PSI.

It is the aim of this chapter to investigate the role and position of non-government actors, such as citizens, businesses, research institutions and other organizations, in the development of these national spatial data infrastructures. The study focuses on four countries that have been very active in promoting and facilitating the participation of non-government actors in their national spatial data infrastructure and thus can be considered to be at the forefront of the development of open spatial data infrastructures in Europe: the United Kingdom, Finland and Denmark and the Netherlands. The study is based on a document analysis of relevant publicly available documents on the development and implementation of the national spatial data infrastructure and the implementation of INSPIRE in each of these four countries. Key documents are the official country reports on the implementation and use of infrastructures for spatial information that have to be submitted by all EU member states every 3 years.[1] In addition to these official country reports, also other policy documents were analysed, including implementation strategies, legislation and other policy reports.

In the United Kingdom, the UK Location Strategy of 2008 was a crucial step in the development of the UK spatial data infrastructure [31]. Because of the synergies between the Strategy and the European INSPIRE Directive, both were implemented jointly as part of the UK Location Programme. Strategic coordination of the implementation originally was provided by the UK Location Council and the UK Location Programme board, in which all the key stakeholders were represented. In 2013, both were replaced by the UK INSPIRE Compliance Board, which now is the main governance body of the UK spatial data infrastructure. The Board is led by the Department for Environment, Food and Rural Affairs (Defra), the national contact point of the UK spatial data infrastructure.

In Denmark, it was the Danish Act on the infrastructure for spatial information, the so-called SI Act, that provided the legal basis for the development of the infrastructure for spatial information, based on the INSPIRE Directive. In Denmark, the development of the national spatial information infrastructure is strongly connected with the national eGovernment strategy, and with the Basic Data Programme in particular. The Coordination Committee on Infrastructure for Spatial Information was established in 2010, with the aim of facilitating and maintaining an effective spatial data infrastructure. The Danish Geodata Agency, which is part of the Ministry of the Environment, is responsible for the infrastructure and for coordinating and supporting the tasks of different involved parties.

In Finland, a first initiative to coordinate the sharing of geographic data was taken in the beginning of the 80s, with the initiation of the national Land Information System (LIS) project. At that time, around 20 public agencies, ministries, local

---

[1] All reports can be found at http://inspire.ec.europa.eu/INSPIRE-in-your-Country

governments, companies and research units participated in the collaboration on the LIS project. The transposition of the INSPIRE Directive into national legislation in 2009 with a law and a decree on the infrastructure for geographic data provided a new boost to the development of a spatial data infrastructure in Finland. The national coordination of the infrastructure is in hands of the Ministry of Agriculture and Forestry, who is supported by the National Council for Geographic Information.

In the Netherlands the political responsibility for implementing the national spatial data infrastructure but also INSPIRE lies with the Minister of Infrastructure and Environment. While it is the Ministry of Infrastructure and Environment that acts as the principal and budget holder of the SDI, the technical implementation of the infrastructure is delegated to Geonovum. The Ministry of Infrastructure and Environment also chairs the national administrative council for geographic data which incorporates all ministries that are involved in the SDI. INSPIRE is led by a steering committee, in which the main parties concerned in INSPIRE are represented, and which is advised by a consultative group. In addition to INSPIRE, the development of the SDI is strongly related to the key registries of the national e-government policy and the national data facilities, that are based on national legal acts.

4 Open Data and E-Services

The aim of this chapter is to empirically investigate to what extent and in which manner a move was made towards a more open data spatial data infrastructure in the United Kingdom, Finland, Denmark and the Netherlands. This section analyzes the actions and measures taken in these four countries to open the main outputs of these infrastructures, i.e. the data and services on top of these data, to citizens, businesses and other users.

4.1 Open Data

The United Kingdom, Finland, Denmark and the Netherlands all were among the first countries in Europe where the central government decided to release its government data as open data and an open data programme was announced. Although these open data policy programmes and related actions focused on all types of government data, in all four countries they strongly influenced the availability of open geographic data. Important elements in the opening of geographic data were the establishment of single access points and the development of a license framework with standard licenses.

4.1.1 Policy Initiatives

In the United Kingdom, Prime Minister Gordon Brown announced in the summer of 2009 his 'Making Public Data Public' policy programme to increase the availability of government data for re-use by businesses, citizens and other stakeholders. From July 2010, government departments and agencies should ensure that any information published includes the underlying data in an open standardised format. In the following years, similar policies and initiatives were announced and implemented in other European countries.

In March 2011, the Finnish government published its resolution on sharing of government data and increasing the re-use of government data. As a result of this resolution, many government organizations in Finland started opening their data in 2012. In 2013, the Finnish Ministry of Finance launched a 2-year Open Data Program to accelerate the implementation of open data in Finland. The objective was to open all major government database by the year of 2020. From the very beginning, geographic data and maps were considered as one of the pilot target databases.

With the Danish Basic Data Programme "Good Basic Data for Everyone – a driver for growth and efficiency", the Danish government, local governments and regions agreed to make several key data sets in Denmark freely accessible and re-usable for all public authorities, but also for citizens and companies. As 'open and efficient access to geographic data' was one of the seven key priorities of the Basic Data Programme, also geographic data sets were under the scope of the programme.

In the Netherlands, the Ministry of Internal Affairs is the responsible Ministry for access to public sector information. In 2013, the Ministry presented a vision and associated plan of action for an open government. Partly based on the international Open Government Partnership, the Ministry adopted the general policy 'publicly accessible, unless'. Starting point for publicly accessible data is that these should also be available for re-use. Government needs to make the data publicly accessible either on request of a citizen or pro-actively. In anticipation of this vision, action plan and related legislation, the Dutch Ministry of Infrastructure and Environment already adopted an open data policy for the entire Ministry in the Summer of 2012. All the data of the Ministry should be available as open data, unless there was a good reason not to do so (privacy, national security, confidentiality). All departments of the Ministry were provided a single strict deadline to release their data as open data. All government data coming under the Ministry of Infrastructure and Environment by 2015 at the latest.

4.1.2 Availability of Open Geographic Data

Encouraged by these initiatives, and often mandated by a new legal framework, in all four countries many geodatasets became publicly available. However, some organizations already had an open data policy in place before the introduction and implementation of the government-wide open data programme. In Finland,

environmental data had been made available free-of-charge by the Finnish Environment Institute in 2008, several years before the government resolution on open government data. The National Land Survey of Finland opened several small scale data sets in 2011, and all its topographic data, including topographic database and aerial photos, in 2012. Many other data providers opened their data prompted by the resolution on sharing of government data: the Geological Survey of Finland, the Finnish Forest Research Institute, the Statistics of Finland, the National Board of Antiquities and several of the largest municipalities. At the moment, more than half of all data falling under the scope of the INSPIRE Directive are open.

In Denmark, the definition of geographic 'base' data as part of the Basic Data Programme especially focused on data themes recognized by the INSPIRE Directive as reference data. Among the geodata considered as basic data sets, and thus freely available since the beginning of 2013, are the land register, the geographical boundaries (the National Administrative Geographical Classification), Denmark's elevation model, the national geographical names, and the so-called Map Data. Two major geographic data providers are the Danish Geodata Agency and the Ministry of Housing, Urban and Rural Affairs.

In the Netherlands, the Ministry of Infrastructure and Environment, including the different agencies that are part of the Ministry, is the key provider of open geographic data. Almost half of the datasets available on the national open data portal, are geographic data. According to a report of the Dutch Algemene Rekenkamer [32] on the status of open data in the Netherlands, approximately 95% of all map data in the Netherlands are available as open data. Among the open geographic data sets in the Netherlands are several small-scale data sets, but also very detailed data and even 3D data.

In the United Kingdom, the Environment Agency and the Department for Environment, Food & Rural Affairs are among the top providers of open government data, and have also opened several key geographic data sets. Among the most popular and valuable open geographic data are LIDAR data, flood data, geological maps, and land registry data. Also the UK Ordnance Survey has made several geographic data sets openly available, including the road data, river data, terrain data and administrative boundaries.

4.1.3   Single Access Points and Harmonized Licenses

Two key elements in the realization of the open data programmes in the different countries were the establishment of a single access point to data and the development of a license framework. In the UK, the creation of a single online access point for public data, data.gov.uk, was one of the first pillars of the Making Public Data Public programme. Also geographic data sets are made available through data.gov.uk,[2] and form a considerable portion of all government data available on

---

[2]https://data.gov.uk/

this platform. Also in Denmark the creation of a Common Basic Data distribution solution was one of the key priorities of the Basic Data Programme. The common Data Distributor[3] was launched in in 2015, and now is an alternative data distribution channel in addition to Digital Map Supply,[4] the distribution solution of the Danish spatial data infrastructure through which spatial data and services are made available to the public since 2005. In the Netherlands, the National Geo Register[5] is the central access point to spatial data in the Netherlands. Open geodata from the National Geo Register automatically are included in the Dutch Open Data Portal,[6] which was launched as part of the national 'Open Data Programme'. In Finland the national geoportal Paikkatietoikkuna,[7] which was created in 2010, still is the main access point to spatial data.

Also the development and implementation of a licensing framework and standard licenses was an important element in improving the access to and stimulating the re-use of geodata. Since many barriers to sharing and use of geographic data were related to the conditions for use, the Netherlands started with the development of the 'Geo Gedeeld' framework[8] to harmonize conditions for use. The framework was based on the principles of Creative Commons and was built on a set number of standard conditions for use with an individual icon, layperson's wording and a legally binding text [33]. Each data owner had to specify which of the conditions for use (one or more) were applicable to his/her data or services. In 2014, it was decided to bring the Dutch spatial data policy in line with international standards, and to apply where possible the Creative Commons framework. A 'Creative Commons, unless' principle was introduced for INSPIRE data, which means governments now have to apply one of the Creative Commons licenses when making their data available, unless they want to impose specific conditions the Creative Commons framework does not cover. In that case, they have to apply the 'Geo Gedeeld' framework.

In most other European countries, the development of a common license framework from the beginning focused on all government data. In Finland, the Ministry of Finance published an open data license recommendation for public administration in 2014, and the use of the Creative Commons framework now is recommended. In Denmark, several projects dealing with the development of common data licenses across authorities and the private sector were included in the Basic Data Programme. In the United Kingdom, the development of a UK Government Licensing Framework was an important element of the UK Open Data strategy. The UK Government Licensing Framework (UKGLF) provides a policy and legal overview of the arrangements for licensing the use and re-use of

---

[3]http://datafordeler.dk/

[4]http://kortforsyningen.dk/

[5]http://nationaalgeoregister.nl/

[6]https://data.overheid.nl/

[7]http://www.paikkatietoikkuna.fi/

[8]http://geogedeeld.geonovum.nl/

public sector information. The Open Government Licence (OGL) is promoted as the default licence for public sector information. The UKGLF has been endorsed as the licensing framework for the use of spatial datasets covered by the INSPIRE Regulations.

Table 2.1 provides a summary of the main elements of the geographic open data initiatives in the four countries.

4.2 Open E-Services

The realization of an open spatial data policy to make geographic data freely available to citizens, businesses and other stakeholders in many European countries was an important step in the realization of an open spatial data infrastructure. By making geodata accessible and re-usable for actors outside the public sector, also these non-government actors could directly benefit from the large volumes of geographic data collected and managed by public authorities. Opening up geographic data meant the spatial data infrastructure was made more open by making the key output of the infrastructure, i.e. the data, directly available to businesses, citizens and other stakeholders. An alternative way in which European countries opened their spatial data infrastructure was through the provision of spatially enabled services, which were built on top of the geographic data sets. Most European countries strongly focused the implementation of their national spatial data infrastructure on improving the availability and accessibility of geodata, especially in the first years of implementation. An important parallel in the actions and initiatives of the four countries in our analysis is their strong focus on the development of spatially-enabled services to citizens and businesses. These spatially-enabled services have evolved from more simple information services and contact services to more advanced transaction services.

4.2.1 Information Services

The Dutch Atlas Living Environment[9] is a good example of a so-called information service built on top of the national spatial data infrastructure. With the development and provision of these spatially-enabled information services, governments make use of geographic data to make information on their activities, processes and products available to citizens and business, in a user-friendly and accessible manner. The Atlas Living Environment provides citizens and professionals access to up-to-date and correct information on environment and health. The Atlas contains a wide range of digital maps from many different sources, often at a very detailed level, and on several topics: air quality, noise, soil conditions etc. Similar spatially-

---

[9]http://www.atlasleefomgeving.nl/en/

Table 2.1 Key elements of the open geographic data initiatives in the four countries

	United Kingdom	Finland	Denmark	Netherlands
Primary open data policy initiative	Making Public Data Public Programme (2009)	Government resolution to open public data (2011) and Open Data Program (2013)	Danish Basic Data Programme (2013)	Vision and Action Plan on Open Government (2013) and Open Data Policy of the Ministry of Infrastructure and Environment (2012)
Important open geodata providers	Environment Agency; Department for Environment, Food & Rural Affairs	Finnish Environment Institute; National Land Survey of Finland	Danish Geodata Agency; Ministry of Housing, Urban and Rural Affairs	Ministry of Infrastructure and Environment
Access point(s)	data.gov.uk	Paikkatietoikkuna	Data distributor and digital map supply	National Geo Register and the Dutch Open Data Portal
License framework(s)	UK Government Licensing Framework (UKGLF)	Creative Commons	Under the scope of the Danish Basic Data Programme	Creative Commons and Geo Gedeeld

enabled information services can also be found in the United Kingdom, Denmark and Finland, not only in the area of environment, but also in other thematic areas. The Danish MapMyClimate[10] platform informs citizens and other stakeholders about the potential impact of climate change on their life and environment. Also the Finnish Mol.fi[11] website, the national job website where jobseekers can search for vacancies, includes a map interface based on a spatial data service by the national SDI, and can be considered as a spatially enabled information service. The best known example of information services on top of geodata are the multi-modal traffic planners (e.g. Rejseplanen[12] in Denmark or Reittiopas[13] in Finland) providing citizens information on all types of public transport and allowing them to plan their journey.

4.2.2 Contact Services

One of the first spatially enabled contact services was developed and implemented in the United Kingdom. With the online FixMyStreet[14] service citizens could report potholes, broken street lights and other problems with streets and roads. FixMyStreet services now exist in many different European countries and are a good example of spatially enabled contact services, i.e. online services based on geographic data that allow citizens or other stakeholders to contact public administrations and provide them with relevant information. Similar applications exist to allow citizens to report on illegal dumping, other garbage related complaints or cases of pollution. But contact services also include services that can be used by specific stakeholders or professionals to submit an application. One example of this is the Finnish Vipu[15] service, an electronic service farmer can use to submit their application for agricultural subsidies. The service contains a map interface supported by the national spatial data infrastructure, where farmers can submit cultivation plans.

4.2.3 Transaction Services

Also in Denmark farmers can use an online e-service to submit their applications for EU agricultural subsidies. As the entire process has been digitized and also the processing of the application and the final payment of the subsidy is integrated into the system, the service has developed towards a spatially enabled transaction ser-

---

[10]http://mapmyclimate.dk/

[11]http://mol.fi

[12]http://www.rejseplanen.dk/

[13]https://www.reittiopas.fi/

[14]https://www.fixmystreet.com/

[15]https://vipu.mavi.fi/

vice. These transaction services, which refers to the electronic intake and handling of requests and applications of rights, benefits and obligations, can be considered as a third type of spatially enabled e-services. Because these transaction services demand two-way interactions between government and citizens/businesses, they are more complex and more difficult to realise than information services and contact services, which are mostly one-way services. In Denmark, Finland, the Netherlands and the United Kingdom several examples of spatially enabled transaction services can be found. A typical example is the online application and processing of building permits. Under the Finnish Action Programme on eServices and eDemocracry, several services to support the process of building permits were developed based on the national spatial data infrastructure.

5 Open Infrastructure

In the previous section it was shown how several European countries have opened their national spatial data infrastructure to citizens, businesses and other actors outside public administration by making geographic data and e-services on top of these data available to these parties. The provision of data and services to non-government actors can be seen as opening the main outputs of the infrastructure to other parties. Another way of opening the infrastructure is by allowing other stakeholders to contribute to and participate in building up the infrastructure. A distinction can be made between two main types of active participation: participation in the governance of the infrastructure and participation in the implementation of the infrastructure.

5.1 Open Governance

Open governance of spatial data infrastructures implies that also non-government actors and bodies are actively involved in the governance of the infrastructure, and particular effort is done to respect and reconcile the needs and interests of different parties. Two main ways to do this are through the establishment of appropriate governance structures and through the development of a shared vision and strategy on the spatial data infrastructure.

5.1.1 Governance Structures

A common instrument for the governance of national spatial data infrastructures is the creation of a coordination or governance structure through which stakeholders can participate in decision making on the development and implementation of the infrastructure. SDI governance bodies are in place in all European countries,

although they come in many different sizes and shapes. Originally, the United Kingdom had a UK Location Council and a UK Location Programme board, which in 2013 were replaced by the UK INSPIRE Compliance Board. The Netherlands still has two main governance bodies for INSPIRE, with the steering committee and the consultative group. The national SDI has an informal governance structure in the top team and strategic platform with representatives of the 'golden helix' (government, business, and academia) in both teams. National government governs the government part in the SDI through the national administrative body for SDI (GI Council). In Finland, the governance structure of the national SDI consists of the National Council for Geographic Information, while in Denmark this role is fulfilled by the Coordination Committee on the Infrastructure for Spatial Information. Although similar structures and bodies are in place in other European countries, the governance of the SDI in the United Kingdom, Finland, Denmark and the Netherlands is characterized by a relatively strong involvement of non-government actors.

In the Netherlands, the involvement of the non-government actors in the decision making process on SDI takes place in the INSPIRE Consultative Group, in which besides INSPIRE data providers also users, universities and the business community are represented. The Consultative group provides advise to the central Steering Committee of INSPIRE, and the chair of the consultative group is also member of the Steering Group. The Consultative Group is considered to be an important factor in the quality assurance procedure of the INSPIRE programme in the Netherlands, as the group examines the main results delivered by the INSPIRE programme and advises the steering committee on the implementation of the programme. For the general geodata policy, a 'top team' and strategic platform have been established in which the private sector is represented to align supply and demand, consisting out of leaders and representatives from the public, private and academic sector. Together they determine the priorities and direction of the geo-sector.

The SDI governance structures of Finland and Denmark formally consist of one single body, i.e. the Coordination Committee in Denmark and the National Council in Finland. In both countries, non-government actors are directly involved in the governance body. The National Council for Geographic Information in Finland consists of representatives of eight central ministries, but also of several members representing several producers and users, the municipalities, collaboration networks and the research community. In Denmark, the Danish universities are directly involved in the Coordination Committee, in which also Geoforum is represented. Geoforum is the Danish forum for spatial information, with members from both public authorities and the private sector. A similar role is fulfilled by the National INSPIRE network of Finland, which is a voluntary network of 350 experts from around 120 organisations, including government institutions, companies and research and education institutions.

In the United Kingdom, representatives from the wider GI sector, including the private, research and non-profit sector, participated in the original UK Location Council, the executive group that provided strategic direction to the UK Location Programme, but also in the UK User Group, an advisory board that monitored

the UK Location Programme and ensured that wider end user needs and priorities were met. Experts from private, academic and third sectors are also involved in different working groups of the INSPIRE governance structure. The Association for Geographic Information (AGI), the association representing the UK GI industry, is seen as a key partner in the implementation of the infrastructure. Especially in the starting phase of SDI implementation, many individual experts contributed to the definition of the overall architecture and strategy. However, in the new governance structure the GI industry and wider GI community are not formally part of the new structure, but still remain involved in the implementation.

5.1.2 Strategic Planning and Management

Besides in the governance structure the ambition to develop an Open SDI is also reflected in the strategic planning and management of the implementation of the SDI. All four countries in our analysis have developed an SDI strategic plan in recent years, and each of these plans clearly expressed a move towards an open spatial data infrastructure. In Denmark the development of the strategic document on 'Location – A gateway to eGovernment' mainly was in hands of the Danish National Survey and Cadastre. The document contained a presentation of the National Survey and Cadastre, but also provided a broader view on the national spatial data infrastructure and a detailed discussion of the importance of geographic data.

In the United Kingdom, Finland and Netherlands, the process of developing the strategic plan was a more open process, as actors outside the public sector were involved in the planning process. In Finland, the National INSPIRE network prepared the national spatial data strategy for 2010–2015 entitled 'Location: the Unifying Factor' [34], and actively contributed to the implementation of the strategy. The network was also involved in updating the strategy in 2013 and 2014, which resulted in the Finnish national spatial data strategy 2016 'Position for spatial data'. In the Netherlands, the implementation approach and strategy for the development of national spatial data infrastructure between 2008 and 2011 was described in the GIDEON policy document [35]. Besides several public authorities, also the association for Geo-ICT companies (GeoBusiness Nederland) and several academic institutions contributed to the creation of this strategic document. Also the 2014 policy document, the 'Partners in GEO' vision, is a shared vision of both the private, academic and public sector on the geo-information infrastructure in the Netherlands [36]. The Location Strategy for the United Kingdom was launched by the UK Geographic Information Panel, a high-level advisory board providing advice on location information issues of national importance [31]. Also the members of this panel represent key interest groups in government, business and the wider location information community in the UK.

The idea of an open spatial data infrastructure is not only expressed in the way these strategies were developed, but also in the content of the strategies. All strategies explicitly emphasize the significance of geodata for businesses, citizens and the society in general. The original Dutch GIDEON strategy made a

distinction between government-provided products and services for the public and businesses, and products and services that are developed by businesses. Location information provides governments at different levels the opportunities to improve their interactions with citizens and businesses. Moreover, if businesses but also citizens are able to work with location information and create new products and services, economic value is added to governmental location information. The more recent 'Partners in GEO' vision document strongly focuses on the importance of geographic data to address key societal challenges and the need for improved cooperation between government, the private sector and the academic sector.

The UK Location Strategy highlights the significance of location information for realizing innovation, as existing information is used in new and innovative ways, and added value is generated at no additional costs [31]. According to the original Finish 'Location: the Unifying Factor' strategy, geographic data can serve as a basis for new companies to develop their ideas into new products and services for a growing market [34]. The Finish strategy also mentions the role of geo-information in support of participation of citizens. Making available forecasts, plans and decisions as interoperable and easy accessible maps allows citizens to assess them easily and to provide their feedback and proposals. The strategy of Denmark states that geographic data and information will make it easier for citizens and businesses to find information from governments [37]. Presenting administrative information together with location information will make it easier to communicate and understand public sector activities and decisions. Moreover, geodata increase the opportunities of citizens and business to participate in the public debate and secure their individual rights.

Table 2.2 summarizes the key elements of the governance structures and strategic plans of the four national spatial data infrastructures.

5.2   Open Implementation

Besides their involvement in the governance and decision making on the SDI, non-government actors could also actively contribute to the implementation of the spatial data infrastructure through the provision of data, products and services. Businesses but also other institutions such as research institutions often play a significant role in the development of national spatial data infrastructure by collecting data on behalf of public authorities or by handling the data collection and processing at the request of a public authority. Geo-ICT companies also provide tools and services for supporting the distribution of geodata. In many cases, public authorities especially rely on local companies within their own country to support them with the processes of creation metadata, setting up catalogues, setting up view and download services, harmonizing data sets and monitoring the performance of the infrastructure. However, some Geo-ICT companies and SMEs in particular are also active outside their own country and provide support to the implementation of spatial data infrastructures worldwide. Two examples of such internationally

Table 2.2 Key elements of open governance of the national SDI in the four countries

	United Kingdom	Finland	Denmark	Netherlands
Governance structures	UK Location Council, UK User Group and INSPIRE working groups	National Council for Geographic Information	Coordination Committee on the Infrastructure for Spatial Information	INSPIRE Consultative Group 'Partners in GEO' top team and strategic platform
Key associations and networks	Association for Geographic Information (AGI)	National INSPIRE network of Finland	Geoforum	GeoBusiness Nederland
Strategic documents	Place matters—the Location Strategy for the United Kingdom (2008)	Location: the Unifying Factor (2010) and Position for spatial data (2014)	Location—A gateway to eGovernment (2011)	GIDEON—Key geo-information facility for the Netherlands (2008) and Partners in GEO (2014)

recognized companies can be found in the Netherlands and in Finland. While the Dutch company GeoCat has contributed to the development of many national metadata catalogues based on the opensource software GeoNetwork, many national spatial data infrastructures rely on the products and services of the Finnish company Spatineo for monitoring and evaluating the performance of their spatial web services.

Interesting to notice is also how some of the associations and networks connecting different stakeholders have contributed to the development of the national spatial data infrastructure. In the United Kingdom for instance, the Association for Geographic Information (AGI) played a major role in the development of the UK GEMINI standard for describing metadata. In Denmark, the Geoforum association developed a WMS cookbook that focused on how international standards are linked and how they can be used in practice. Besides these examples of concrete products delivered by associations, the different associations in Denmark, the United Kingdom but also in Finland and the Netherlands contributed to the implementation of the national spatial data infrastructure through the organization of meetings, workshops and conferences for exchanging knowledge and experiences. The organization of competitions and the provision of prices and awards is a way of promoting the development of new and innovative solutions, and raise awareness on the possibilities of using open geodata. For instance, in Finland a Maps4Finland competition was organized and an award was given to the best application using spatial data. In Denmark, the Geodataprisen hands out awards to the best solutions, innovations and ideas dealing with spatial data.

The Netherlands have a strong tradition of joint testing and development activities among public sector parties and other stakeholders in the GI domain. Through the organization of pilot projects and testbeds, different stakeholders are involved in knowledge exchange and experimenting with new technological developments we are considered to be relevant for the future SDI. In 2010, a pilot project was organized on 3D GI to promote and facilitate the development of 3D applications. The pilot led to the development of a 3D toolkit to guide and assists organizations in starting with 3D developments, but also the definition of a 3D standards for the Netherlands. A similar initiative was the pilot project on linked data, which was launched in 2012. Again, the aim of this pilot project was to bring together different actors and organizations to explore the possibilities of linked data for publishing spatial data, define potential use cases and exchange knowledge and expertise related to this topic. In 2015, a testbed on 'Spatial data on the web' was launched in which academic and private organizations were invited to explore the possibilities for publishing spatial data as a usable and integrated component of the web. The testbed consisted of four smaller research projects, focusing on particular research questions. An interesting rather recent evolution is the opportunity given to non-government actors to add their own geographic data to the national SDI and make their geographic data sets available to the central access point. In the Netherlands, for example, several businesses have added their data to the National Geo Register.

6 Discussion and Conclusion

The goal of this chapter was to analyse the role and position of non-government actors in the development of national spatial data infrastructures in Europe and investigate to what extent the current spatial data infrastructures can be considered as open spatial data infrastructures. The analysis focused on four European countries that have taken several measures to facilitate and stimulate the involvement of non-government actors in the development of their spatial data infrastructure: the Netherlands, the United Kingdom, Finland and Denmark, all have taken. The analysis showed that in these four countries the move towards more open spatial data infrastructures can mainly be observed in the increased availability of spatial data and spatially enabled services to citizens, businesses and other stakeholders. Despite their efforts to also increase the involvement of these non-government actors in the governance and implementation of the infrastructure, government still remains the major player in the development and implementation of spatial data infrastructures in Europe.

In other words, it can be argued that the development of spatial data infrastructures in Europe so far has been successful in opening the data but less in opening the infrastructure. Driven by recent open data initiatives and EU legislation, the four countries in the analysis have opened most of their geographic data sets to the public, and allowed the re-use of these data sets for many purposes. Access to these data is provided through the national geoportals and more recently established open data portals, and the conditions for access to and use of the data have been simplified and harmonized through the use of common licenses. In addition to making the data available and accessible, the four countries also have been very active in the development of spatially enabled e-services to citizens and businesses. The development and online provision of different types of services on top of geographic data is about making the data valuable for different stakeholder groups. Citizens but also businesses and professionals outside the geographic data domain will especially benefit from the development of services on top of the data and customized to their needs, rather than from the data themselves. Making data available will be an important enabler for the development of such services and applications, as it allows businesses and other organizations to take control of the development of these services and products. The key challenge for public authorities will be to decide on which services should be provided by the government and which services should be left to the market. In some cases, even the co-design of location enabled services should be considered.

While European countries have been successful in opening their spatial data to citizens, businesses and other stakeholders in society, still a lot of progress can be made in also opening the infrastructure. The analysis of the four national spatial data infrastructures revealed some interesting approaches and practices of involving businesses, research institutions and other organizations in the governance of these infrastructures, especially through the design of an appropriate governance structure and the development of strategic plans. However, even in the most advanced spatial

data infrastructures in Europe, public sector bodies still remain dominant in the decision making process and in the implementation of the infrastructure. Based on this observation it can be argued that spatial data infrastructures in Europe still are far away from being truly open infrastructures. A truly open spatial data infrastructure would not only contain and make available government data, but would provide an access point to all geographic data in society, including government data, private sector data and citizen data. The fundamental challenge in realizing such an open spatial data infrastructure will be to consider and treat all involved parties, i.e. public sector organizations, businesses, research institutions but also citizens, as equals and to look for the most effective approaches, methods and technologies for embedding non-government actors in the development and implementation of the spatial data infrastructure. Only then the SDI will be able to arrive at its full potential.

References

1. Dessers E, Crompvoets J, Janssen K, Vancauwenberghe G, Vandenbroucke D, Vanhaverbeke L (2011) SDI at work—the spatial zoning plans case. Spatialist, Leuven
2. Van Loenen B (2006) Developing geographic information infrastructures: the role of information policies. DUP Science, Delft
3. Groot R, McLaughlin J (2000) Introduction. In: Groot R, McLaughlin J (eds) Geospatial data infrastructure: concepts, cases, and good practice. Oxford University Press, New York, pp 1–12
4. Nedović-Budić Z, Crompvoets J, Georgiadou Y (eds) (2011) Spatial data infrastructures in context: North and South. CRC-Press—Taylor & Francis Group, Boca Raton
5. European Commission (2007) 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), OJ L 108/1
6. Vancauwenberghe G, Dessers E, Crompvoets J, Vandenbroucke D (2014) Realizing data sharing: the role of spatial data infrastructures. In: Gascó-Hernández M (ed) Open government. Opportunities and challenges for public governance. Springer, New York, pp 155–169
7. McDougall K (2009) The potential of citizen volunteered spatial information for building SDI. In: GSDI 11 world conference: spatial data infrastructure convergence: building SDI bridges to address global challenges, Rotterdam
8. Groot R (1997) Spatial data infrastructure (SDI) for sustainable land management. ITC J 3(4):287–294
9. Grus L, Crompvoets J, Bregt A (2010) Spatial data infrastructures as complex adaptive systems. Int J Geogr Inf Sci 24(3):439–463
10. Giff G, Crompvoets J (2008) Performance indicators a tool to support spatial data infrastructures assessment. Comput Environ Urban Syst 32(5):365–376
11. Rhind D (2000) Funding an NGDI. In: Groot R, McLaughlin J (eds) Geospatial data infrastructure: concepts, cases and good practice. Oxford University Press, New York, pp 39–55
12. Janssen K (2010) The availability of spatial and environmental data in the EU at the crossroads between public and economic interests. Kluwer, Dordrecht
13. Warnest M (2005) A collaboration model for national spatial data infrastructure in federated countries. University of Melbourne, Department of Geomatics, Melbourne
14. Craglia M (2006) Introduction to the international journal of spatial data infrastructures research. Int J Spat Data Infrastruct Res 1(1):1–13

15. Wehn de Montalvo U (2001) Strategies for SDI implementation: a survey of national experiences. In: 5th global spatial data infrastructure conference, Cartagena de Indias, 21–25 May 2001
16. McLaughlin J, Nichols S (1994) Developing a national spatial data infrastructure. J Surv Eng 120(2):62–76
17. Bernard L, Mäs S, Müller M, Henzen C, Brauner J (2013) Scientific geodata infrastructures: challenges, approaches and directions. Int J Digital Earth 7(7):613–633
18. Hendriks P, Dessers E, Van Hootegem G (2012) Reconsidering the definition of a spatial data infrastructure. Int J Geogr Inf Sci 26(8):1479–1494
19. Masser I (2009) Changing notions of a spatial data infrastructure. In: Loenen B, Besemer JWJ, Zevenbergen JA (eds) SDI convergence. Netherlands Geodetic Commission, Delft, pp 219–228
20. Budhathoki NR, Bruce BC, Nedovic-Budic Z (2008) Reconceptualizing the role of the user of spatial data infrastructure. GeoJournal 72(3):149–160
21. Coleman DJ, Rajabifard A, Kolodziej KW (2016) Expanding the SDI environment: comparing current spatial data infrastructure with emerging indoor location-based services. Int J Digital Earth 9(6):1–19
22. Wirtz BW, Birkmeyer S (2015) Open government: origin, development, and conceptual perspectives. Int J Public Adm 38(5):381–396
23. OpenGovData (2016) Eight principles of open government data. http://www.opengovdata.org
24. Latre MA, Lopez-Pellicer FJ, Nogueras-Iso J, Bejar R, Zarazaga-Soria FJ, Muro-Medrano PR (2013) Spatial Data Infrastructures for environmental e-government services: the case of water abstractions authorisations. Environ Model Softw 48:81–92
25. De Kleijn M, van Manen N, Kolen JCA, Scholten HJ (2014) Towards a user-centric SDI framework for historical and heritage European landscape research. Int J Spat Data Infrastruct Res 9:1–35
26. Box P (2013) The governance of spatial data infrastructure: a registry based model. University of Melbourne, Department of Infrastructure Engineering, Melbourne
27. Goodchild M (2007) Citizens as voluntary sensors: spatial data infrastructure in the world of Web 2.0. Int J Spat Data Infrastruct Res 2:24–32
28. European Commission (2003) Directive 2003/98/EC of the European Parliament and of the council of 17 November 2003 on the re-use of public sector information, OJ L 345/90
29. European Commission (2013) Directive 2013/37/EU of the European Parliament and of the council of 26 June 2013 amending Directive 2003/98/EC on the reuse of public sector information, OJ L 175/1
30. Van Loenen B, Grothe M (2014) INSPIRE empowers re-use of public sector information. Int J Spat Data Infrastruct Res 9:86–106
31. UK Geographic Information Panel (2008) Place matters: the location strategy for the United Kingdom. Communities and Local Government, London
32. Rekenkamer A (2014) Trendrapport open data. Algemene Rekenkamer, Den Haag
33. Van Loenen B, van Barneveld DW (2010) Implementing INSPIRE: the process towards the harmonization of licenses for public sector geographic information in the Netherlands. In: The 4th INSPIRE conference, Krakow, 22–25 June 2010
34. Finnish Ministry of Agriculture and Forestry (2010) Location: the unifying factor. Finnish national spatial data strategy 2010–2015. Ministry of Agriculture and Forestry, Helsinki
35. Netherlands Ministry of Housing, Spatial Planning and the Environment (2008) GIDEON—key geo-information facility for the Netherlands. Approach and implementation strategy (2008–2011). Ministry of Housing, Spatial Planning and the Environment, The Hague
36. Bregt A, Nijpels E, Tijl H (2014) Partners in GEO: shared vision of government, private sector and scientific community on the future of the geo-information sector. http://geosamen.nl
37. Danish National Survey and Cadastre (2011) Location—a gateway to eGovernment. Strategic basis for the National survey and cadaster 2011–2015. Danish Ministry of the Environment, Copenhagen