

Public Geospatial Platforms in Europe

Report based on a survey and benchmarking visits

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Contents

Introduction	1
Materials	1
Results of the questionnaire	1
Classification of platforms.....	2
User needs and novelties of the platform solutions.....	3
Specifications and services for data providers	3
Services for data users	4
Datasets	5
Legal aspects	6
Future development	6
Selected platforms	7
The Netherlands.....	7
Norway.....	7
The United Kingdom	8
National Geospatial Platform of Finland.....	8
Discussion.....	9

Introduction

Digital platforms and platform economy has become as one of the central topics in information technology and economy. One definition of platform is *a plug-and-play business model that allows multiple participants (producers and consumers) to connect to it, interact with each other and create and exchange value*¹. Also collections of services used for hosting, processing and distributing geospatial data are called platforms. In this report, we call such platforms as geospatial platforms. Geospatial platforms have been established by as well companies as public authorities. One example is the Geospatial Platform in the United States, opened in 2010. The Finnish Ministry of Agriculture and Forestry as part of the government digitalisation programme started a project to build a national geospatial platform in March 2017. The project partners include the National Land Survey of Finland, the Ministry of Environment and the Finnish Environment Institute. Platform will host key geospatial features and imagery collected in municipalities, regions and government. As part of the project there was a need to benchmark the best practices in the other European countries. The results of the investigation are summarized in this report.

Materials

First, a web-based questionnaire concerning geospatial platforms was sent by the National Land Survey of Finland to 28 recipients from 18 national mapping authorities in March 2017. The questionnaire consisted of 20 questions or groups of shorter questions. The recipients were asked to answer on the basis of existing or planned geospatial platforms in their country. If there was no geospatial platform in the recipients' country, they were instructed to answer based on a national geoportal. In the questionnaire, the geospatial platform was described as a collection of geographic data, services and applications that are hosted in a shared infrastructure.

Based on the results of the questionnaire, we selected the two most comprehensive platforms, in Norway and the Netherlands and one planned platform solution, in the UK, for more closely investigation. We visited Kadaster in the Netherlands on 12 June – 13 June 2017 when Dorus Kruse, Raymond Kroon, Cees Bos, Kasper Groen, Jeroen Hogeboom, Nicolien Jongerius, Erwin Folmer and Jasper Roes presented the PDOK platform. The Geonorge platform we examined during the visit at Kartverket in Norway at 7 September 2017 when Roy Mellum, Olaf Østensen, Arvid Lillethun, Erlend Klokkervold and Thomas Ellett von Brasch gave us presentations about the platform. Tamsyn Dollery, Steve Campbell, Dave Stow and Michael Gordon presented their services and upcoming digital platform at Ordnance Survey in the UK on 14 June 2017. We would like to thank all people who answered the questionnaire and those hosting and responding our questions during the benchmarking visits.

Results of the questionnaire

In total 11 answers from 10 countries were received for the web-based questionnaire. The geoportals and geospatial platforms were in the United Kingdom (UK), Iceland (IS), Ireland (IE), the Netherlands (NL), Norway (NO), Sweden (SE), Poland (PL) and Spain (ES). Two answers concerned German geoportal and platform: geoportal.de (DE¹) and Dienstleistungszentrum des Bundes für Geoinformation und Geodäsie in Germany (DE²). The platforms and geoportals are listed in table 1. The planned Finnish Geospatial platform (FI) has been added to the answers as well.

¹ S. P. Choudary (2015) The Platform Stack: For everyone building a platform... and for everyone else. <http://platformed.info/platform-stack/>. Retrieved 25th Oct 2017

Table 1 Geoportals and platforms covered by the questionnaire

Country	Name of the platform:	Link to the existing platform or portal:
The Netherlands	PDOK (Public Services on the Map)	www.pdok.nl
Norway	Geonorge (SDI is Norway digital)	www.geonorge.no
Ireland	GeoPortal.ie	www.geoportal.ie/
Iceland	Oskari	kort.lmi.is
Spain	Spanish Spatial Data Infrastructure	www.idee.es
Sweden	Geodataportalen	www.geodata.se/GeodataExplorer/
Germany	Geoportal.de	www.geoportal.de
Germany	Dienstleistungszentrum des Bundes für Geoinformation und Geodäsie (DLZ)	www.geodatenzentrum.de
Poland	Geoportal	www.geoportal.gov.pl/
Great Britain	data.gov.uk (existing portal)	data.gov.uk/location
Finland	Paikkatietoalusta	www.paikkatietoalusta.fi (development site) www.geoportal.fi (existing portal)

Classification of platforms

The first questions in the questionnaire concerned the classification of the platforms. Four countries responded that there is a geospatial platform in their country (Table 2). In Great Britain there were plans to open a new platform and in the rest of cases there is only a geoportal. One respondent from Germany answered that there is a geospatial platform and other answered that there is only a geoportal. This was possibly due to the fact that the answers concerned different services. We considered the Icelandic platform rather restricted and suggest that it could be classified as a geoportal which includes also view service.

Table 2 Geoportals and geospatial platforms in European countries

Type of the platform	Countries
Geospatial platform	DE ² , IS, NL, NO
Plans to create a platform	UK, FI
A geoportal	SE, IE, ES, PL, DE ¹

The level of centralisation varies between the platforms and portals (Table 3). In geoportals the content is mainly accessed via interfaces from external sources but in the Irish geoportal the data hosting is centralised, as in the Dutch platform. In the UK, Germany, Iceland and Norway the mixed model of centralised and decentralised data hosting is in the use.

Table 3 Level of centralisation in geospatial platforms

Level of centralisation	Countries
Totally decentralised	ES, SE
Decentralised with some caching of data	DE ¹ , PL
Centralised data hosting in the platform	NL, IE
Mixed model of centralised and decentralised	UK, DE ² , IS, NO, FI

User needs and novelties of the platform solutions

One access point to geospatial data was mentioned as main user benefit of geospatial platforms and portals by the majority of services (8/10). Other mentioned subjects were e.g. improved access to harmonised and quality checked data and INSPIRE compliant services. One aim is also to support the exploitation of geospatial data.

The novelties of present or upcoming platform solutions differed among the answers. The platforms improve the access to spatial data and offer more standardised data. Also automated quality checks and new application programming interfaces are mentioned as novel components. The new platform solutions support the analyses and visualisations of datasets from different sources in the cloud. Usage of open source software is mentioned in two answers.

Specifications and services for data providers

Dutch and Norwegian platforms have common specifications for data models and schemas, for quality and for process descriptions. German has common specifications platform for data models, schemas and quality. Irish and Swedish geoportals have common specifications for data models and schemas. Finland is planning to introduce common specifications.

Availability of different services for data providers was studied by multiple choice questions (Table 4). Metadata upload and validation were implemented in most of the platforms and portals. All of the listed services have already been implemented or planned in Dutch PDOK and Norwegian Geonorge platforms. All the services except discussion forum are planned to be included also in the upcoming geospatial platform by the UK. Data quality validation has been implemented only in one platform but planned in four other platforms.

Table 4 Services for data providers. Dark green colour (1) indicates freely available, light green (2) indicates available for restricted group of user/by charge, yellow (3) indicates planned but not implemented, red (4) indicates not available and grey (0) indicates no answer.

	UK	DE ¹	DE ²	IS	IE	NL	NO	PL	ES	SE	FI
Schema validation	3	0	4	4	4	2	1	0	4	1	3
Data quality validation	3	3	2	4	4	3	3	0	4	4	3
Data transformation services	3	4	2	0	4	2	1	0	4	4	3
Data storage	3	4	2	3	4	2	2	0	4	4	3
Data upload service	3	4	2	3	4	2	1	0	4	4	3
Uploading change only update	3	4	2	4	4	2	2	0	4	4	3
Metadata upload	3	1	4	1	2	1	1	1	2	1	1
Metadata validation	3	1	4	1	2	1	1	1	4	1	1
Persistent ID management services	3	4	4	0	2	3	3	0	4	4	3
Data administration interface	3	4	4	4	4	1	2	0	2	1	3
Discussion forum	0	2	4	3	4	1	1	1	1	0	4
Other services	3	1	4	0	4	1	1	0	0	1	4

UK stands for United Kingdom, DE¹ for geoportal.de in Germany, DE² Dienstleistungszentrum des Bundes für Geoinformation und Geodäsie in Germany, IS for Iceland, IE for Ireland, NL for the Netherlands, NO for Norway, PL for Poland, ES for Spain and SE for Sweden.

The data providers are mainly in charge of providing their own INSPIRE service. However, Ireland, Iceland and the Netherlands have common services for the data providers. In the Netherlands platform provided INSPIRE services on behalf of the partners of PDOK platform.

Services for data users

Also availability of different services for data users was inquired by multiple choice questions (Table 5). The view services are part of all platforms and portals except the present data.go.uk portal by the UK. One of the German respondents did not answer this question. Also the user support and download services are part of or are planned to be included in all portals and platforms. All of the listed services have been implemented in some of the platforms and portals. Norwegian Geonorge and Dutch PDOK platform also provide additional APIs. For example, JSON, GML and CityGML formats are supported in PDOK.

Table 5. Services for data users. Dark green colour (1) indicates freely available, light green (2) indicates available for restricted group of user/by charge, yellow (3) indicates planned but not implemented, red (4) indicates not available and grey (0) indicates no answer.

	UK	DE ¹	DE ²	IS	IE	NL	NO	PL	ES	SE	FI
View services	3	1	0	1	1	1	1	1	1	1	1
Data analysing services	3	3	4	3	4	4	2	3	1	4	1
Publishing of web maps	0	1	0	3	4	1	4	1	4	4	1
Download service for pre-defined data sets	3	3	0	1	1	1	2	2	1	1	1
Direct access download	3	3	0	1	2	1	2	2	1	1	1
Other APIs	0	0	0	1	4	1	1	0	4	0	3
Downloading change only update	3	3	2	4	4	1	3	0	4	4	3
Linked Data	3	4	4	3	4	1	3	1	3	4	3
Geocoding	3	2	2	1	4	1	4	1	1	4	3
Discussion forum	0	2	0	3	4	1	1	1	1	4	4
User support	3	1	0	1	1	1	1	1	1	1	3
Other services	3	0	0	0	4	1	4	0	1	0	4

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Datasets

Digital elevation model, land cover, place names and metadata are part of or planned to be in every platform or geoportal (Table 6). German and Polish respondents did not answer these questions. Satellite images are only implemented in Spain and Iceland. In the Netherlands all of the data themes are implemented or planned. Also in the Norwegian Georange platform all data themes are available except satellite images. In the Netherlands, Iceland, Norway and Spain, most of the datasets are available freely while in Ireland and Sweden most of the data is available only for the restricted group of users or by charge.

Table 6. Data sets available on geospatial platforms. Dark green colour (1) indicates freely available, light green (2) indicates available for restricted group of users/by charge, yellow (3) indicates planned but not implemented, red (4) indicates not available and grey (0) indicates no answer.

	UK	DE ¹	DE ²	IS	IE	NL	NO	PL	ES	SE	FI
Aerialimagery or orthoimagery	3	0	0	4	2	1	1	0	1	2	1
Satellite imagery	3	0	0	2	4	3	4	0	2	4	3
Point clouds	3	0	0	4	4	3	1	0	1	4	1
Digital elevation model	3	0	0	1	2	1	1	0	1	2	1
Buildings	3	0	0	4	2	1	1	0	1	2	3
Traffic networks	3	0	0	4	4	1	1	0	1	1	1
Hydrography	0	0	0	4	2	1	1	0	1	2	1
Land cover	3	0	0	1	2	1	1	0	1	2	1
Land use	3	0	0	1	2	1	1	0	1	1	1
Addresses	3	0	0	1	4	1	1	0	1	2	1
Place names	3	0	0	1	2	1	1	0	1	2	1
Metadata	3	1	0	1	2	1	1	0	1	1	1
Other datasets	0	0	0	1	2	1	1	0	1	0	1

UK stands for United Kingdom, DE¹ for geoportal.de in Germany, DE² Dienstleistungszentrum des Bundes für Geoinformation und Geodäsie in Germany, IS for Iceland, IE for Ireland, NL for the Netherlands, NO for Norway, PL for Poland, ES for Spain and SE for Sweden.

Investigated platforms and portals provide also numerous additional datasets including soil data, cadastral parcels, points of interest etc.

Legal aspects

The questionnaire contained also questions on the legal basis of the platforms and issues of the privacy of individuals in relations the geospatial platforms. The INSPIRE directive and its national implementations are the main legislation steering the data providers to provide information on the platforms. In the Netherlands, there is legislation on the key geographic registers and the PDOK platform is based on the agreement between the core partners. Germany have agreement between the federal government and the federal states on the provision of digital topographic reference data to users in need of data across state borders.

The problems with the protection of privacy of individuals and open geospatial data in not widely seen as a big issue. National privacy protection laws are followed but there are only a few special legislation or practices related to geospatial platforms. The impact of the new General Data Protection regulation (GDPR) was not raised in the responses.

Future development

The future development of geospatial platforms was also inquired in the questionnaire. The answers to this question vary considerably between the respondents. There are many differences in development of spatial data infrastructure and data policies between European countries which is likely to affect the future visions of the respondents. It was mentioned that sensor data (IoT) and 3D data are types of data which will be added to the repertoire. Inclusion of Linked Data and semantics are mentioned in two answers. Crowdsourcing is seen as one possible method for updating the data.

The geospatial platforms are seen to become more customer-centric and user defined. There will be a move from pre-defined data products to content-as-a-service model. In several answers, cloud computing

and data analyses between different spatial and non-spatial data is mentioned becoming part of the platforms. It is also envisioned that the platforms will develop towards collaborative and federated solutions in which data producers can host, manage and share their own data services and the platforms have a mediating role. The data quality and validation of the data are also seen important in the future.

Selected platforms

The Netherlands

The PDOK platform in the Netherlands has the most comprehensive set of services and spatial data of the platforms examined in this survey. The PDOK-platform was formed by five core partners: Kadaster, Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zake, Rijkswaterstaat and Geonovum. The technical and business activities are part of the geoinformation section in Kadaster.

The basis of data on the platform is the national key registers by the core partners. The partners also provide their INSPIRE services on the platform. The other public organizations can provide their data on the platform for a fee but there is no commercial data available. The datasets are owned by the data producers and are only hosted and distributed as web services on the PDOK platform. PDOK administration does not make any changes to the data. In total platform provides circa 150 data sets which includes all the data themes mentioned in the questionnaire excluding point clouds and satellite imagery. In addition also e.g. soil data and cadastral parcels are available. There are plans to add point clouds, satellite imagery, land cover data, 3D-data and sensory data in the future. The data is free and open with the exception of orthophotos with 10cm resolution. There are plans to implement API keys to get more information about the users and to be able to track inappropriate use.

The PDOK platform contains a large variety of services for both data providers and users. The user services are open for all users. In addition to the OGC interfaces there are services for JSON, GML and CityGML formats. The platform provides only a simple view services and the idea is that the partner organizations and private companies can build their own applications and services on top of the standard web services. The most fundamental benefit of the platform solution is that it provides 99% availability of standardized web services as the platform is fully INSPIRE, OGC and ISO compliant. Also the INSPIRE discovery service is part of the platform.

Kadaster is developing new PDOK Data Platform which provides Linked Data and novel interfaces. The aim is to offer the same data sets through WFS and REST interfaces and as Linked Data in RDF format. Linked Data makes possible to link geospatial datasets also with other types of data. The new solutions are directed by the new environmental legislation in which the aim is to provide all data associated to properties is available at one source. In the future map data is planned to be distributed using vector tiles. Raster tiles will be rendered in the fly if they are still needed. This makes it easier to offer fully up-to-date information.

Norway

Georange geoportal in Norway distributes spatial data provided by the Norge digitalt coalition. Even though Georange is called geoportal it contains large variety of services for both data producers and users and thus can be classified as a platform. It is maintained and developed by Kartverket. Based on the questionnaire Georange platform has the second most comprehensive set of services and datasets of the platforms covered by this survey.

In Geonorge, data is available from more than 400 data producers in total. The data is available via WMS and WFS interfaces and in GML, Esri shapefile, Esri file geodatabase and postGIS file formats. Also vector tiles have been tested and there are plans to take them in the production in the future. Documentation and other nonspatial information is distributed via REST interfaces.

In Norway, long efforts have been made towards decentralized architecture in the national spatial data infrastructure. However, it has recently been recognized that some services need to be implemented centrally. In all cases, the decentralized system has not worked as intended, for example, all data providers have not followed all the common standards which have caused issues with interoperability. It is intended that data producers can focus more on producing high-quality data when Kartverket is centrally responsible for providing the infrastructure. Kartverket guarantees the service of Geonorge 24 hours a day, 7 days a week. As part of the Geonorge, a common data storage for data produced by municipalities has been opened. Data upload into the storage is arranged through WFS-T service. The system verifies that the data follows the common data model. After the validation, the data can be downloaded back to the data producer. There are common data models for municipalities' data and the Kartverket controls that the common data models are followed. Data models are defined formally in Unified Modelling Language which is important for the interoperability.

The United Kingdom

There is no actual geospatial platform in the United Kingdom. The data.gov.uk portal provides access to public data, including spatial data. In addition, Ordnance Survey is hosting numerous digital geospatial services. At the moment, Ordnance Survey is developing a new geospatial platform that will collect a large set of services and datasets. The plan is that digital platform is consisted of set of well-defined services which are also offered commercially to other users. These services are mainly related to the production of geographic information, real estate management and the management of infrastructure assets.

Ordnance Survey considers that in the future with data gathered has an increasingly important role. Their aim is to collect all the data into one Data Lake where all kinds of data from unstructured raw data to structured data can be stored. The problem has been that pervious product-centric thinking has led to the situation where information is in the separate silos and the combining of the information is complicated. The aim is to move from a product-centric model to a customer-centric content-as-a-service model. The new model let them respond to rapidly changing information needs of administration and other users.

In the future, the roles of data producers and users can get mixed. The same actors can both produce and use geographic information. The goal is that that the platform will compile information also from external data producers. For example, sensor data is planned to be joined in the platform. At the moment, external data to the services by Ordnance Survey is mainly provided by the local authorities. The gap between spatial data and nonspatial data has decreased and future spatial data is intended to be provided for other users than spatial GIS professionals. The strategy is that the new digital platform will primarily serve application developers who can develop products for end users.

National Geospatial Platform of Finland

The Finnish Ministry of Agriculture and Forestry as part of the government digitalisation programme started a project to build a national geospatial platform in March 2017. The project partners include the National Land Survey of Finland, the Ministry of Environment and the Finnish Environment Institute. The objective of the platform is to provide shared services and datasets for the users and common data specifications and services for provision of interoperability to data providers. The aim is to open the first version of the platform in the end of 2019. The platform project is divided into eight subprojects: the National

Topographic Database, INSPIRE-services, the spatial data infrastructure for regions, land use planning, addresses, support and training services, the distribution of satellite imagery and the technical infrastructure.

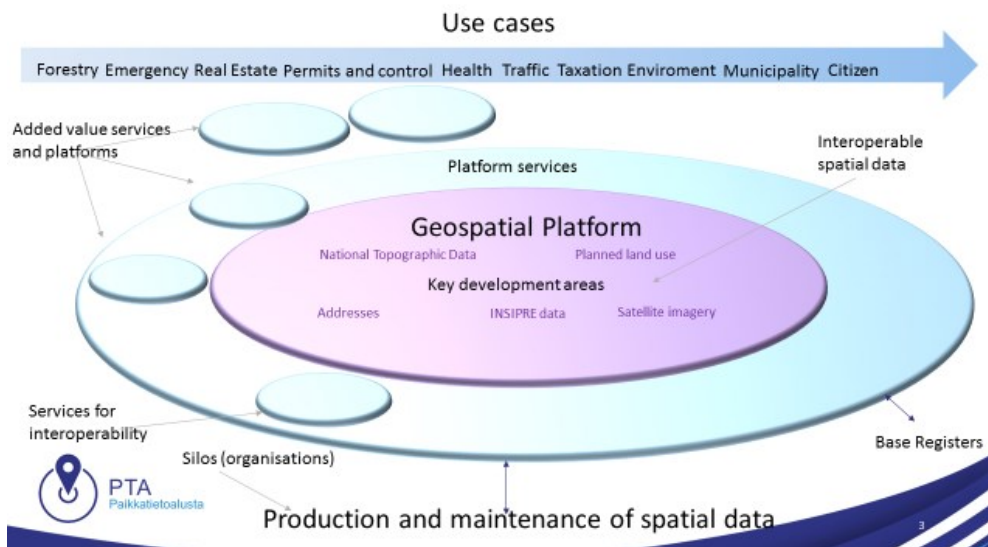


Figure 1. Structure of the Geospatial Platform

The main reasons for introducing the geospatial platform are: 1) Spatial data production is decentralized and currently it is not easy to get data for national use cases, 2) society needs spatial data for government use and for new business cases, 3) more efficient use will create savings and new innovations.

Discussion

Geospatial platforms have been opened or they are planned by public authorities in several European countries. However, most of the European countries covered by this survey have a geoportal or fairly restricted geospatial platforms. Many countries are planning to develop their service towards platform-like solutions in which multiple participants can host, process and distribute spatial data. Based on our results, there are geospatial platforms in the Netherlands, Germany and Norway that are integrating services for data providers, services for data users and hosting of data. In Great Britain and in Finland, the platform is planned. The Dutch PDOK platform is the most comprehensive of the platforms and geoportals covered by this survey.

As a concept, geospatial platform is not well established which was likely to affect how the respondents categorized their platform or portals in their answers. However, the classification was not very important because the platforms and portals were described more closely in the other questions. The questionnaire did not reach all of the European countries but we think that the results still give valuable information about the geospatial platforms and portals in Europe.

The respondents thought that the **significance of the data** will increase in the future. The border between the spatial and non-spatial information is diminishing. In response to this development, for example Ordnance Survey is planning to collect different kinds of data into a Data Lake. Spatial data is more and more produced by external producers, crowd sourced or coming from sensors in addition to the authoritative sources. New data collection methods have emerged like laser scanning which provide possibilities to do recollection of data. All of us as individuals are more and more collecting data with our mobile phones. These new data sources increase the volume of data but also give new possibilities for data analyses. In the future, **artificial intelligence** can be used to analyse and process the data.

The effective use of information often requires combining data and services from different sources which can be facilitated by geospatial platforms. **Linked Data** was mentioned frequently in the answers of this

questionnaire as a technique to interlink data. It is also crucial to ensure the sufficient **quality** of the data in order to allow the effective collaborative use of data. **Common specifications** for data models, interfaces and processes are needed to enable the development of a spatial data ecosystem.

Spatial data infrastructures have been widely developed towards a decentralized system. However, in some cases centralized solutions can provide some benefits. In the Netherlands it has been seen that the central benefit of the PDOK platform is its ability to provide the web services with over 99% **reliability**. Also in Norway, it has been realised that centrally operated web services and data storage allows data producers to focus on producing high quality spatial data. One responsible organisation can also ensure that the common standards and data models are followed which improves the sharing of the data. Key success factor in Norway has been support to the municipalities that create and maintain spatial data.

The platforms must be integrated into a wider ecosystems to get the maximum benefit. The problem in the national platforms can be that they do not reach the critical mass. They might not reach the large enough group of data providers and users and thus do not attract new users and external developers. Therefore European or international co-operation is needed. The European geospatial platforms widely follow e.g. INSPIRE and OGC specifications providing a possibility to create a European geospatial ecosystem. European Location Framework project, OpenELS and ELISE projects are examples how national data may be utilised for European use cases. We believe that **interoperable national platforms** may provide the model for reaching this critical mass. The survey also showed that many platforms are built on **open source software** which makes possible to share the tools between European authorities.

Generally, a platform is a very powerful business model which will surely also be used in the distribution of public spatial data and services. Finland has now set a national goal to exploit platform economy and artificial intelligence and become one of the leading countries in this fieldⁱ.

ⁱ A national interim report was published 23rd Oct 2017 https://tekoalyaika.fi/ai_will_be_the_new_normal/
(Report only available in Finnish)