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Executive Summary

The study, prepared for the European Commission's Joint Research Centre (JRC), aims to analyse and identify the economic opportunities and barriers associated with the use of the geospatial data in the context of the Digital Single Market. More specifically, the study explores the context in which geospatial data is used for service and product creation across Europe and identifies the main actors associated with the sharing and reuse of geospatial data, while also analysing the barriers faced by them when working with geospatial data and identifying the key opportunities associated with the sharing and reuse of geospatial data.

For the research purposes of this study, a case study approach was adopted. Together with JRC, five different case studies were selected, all exhibiting different contexts of the use of geospatial data for service and product creation. The case studies analysed in the study are: Public Services on Map (PDOK) in the Netherlands, Smart Open Data Portugal-Spain Pilot, FOODIE project, Innovate UK programme, Danish Basic Data programme. The case studies exhibit variations in terms of stakeholder interactions, geographical coverage, ownership of geospatial data (public or private), and domain coverage (transportation, agriculture, agroforestry management, etc.). For each case study, a list of stakeholders was identified and interviews scheduled. A total of 16 interviews were held, with stakeholders ranging from owners of governmental data portals, private sector re-users of open geospatial data, and third sector organisations.

The case study analysis, coupled with in-depth desk research revealed the following main findings:

- **Context of geospatial data usage:** there are three main ways in which geospatial data can be shared: 1) through governmental (geo)portals and open data portals, 2) through digital platforms and 3) in combination with other types of data;
- **Main actors involved in the geospatial data ecosystem:** actors from both private and public sector can be identified in all stages of the geospatial data ecosystem. In most cases, public sector bodies, such as national cadastres or responsible agencies collect geospatial data and are often in charge of its standardisation and publication. Nevertheless, some private sector actors tend to collect their own geospatial data as well as reuse some of the geospatial data collected by the public sector actors, and process it themselves in order to create unique geospatial data products and services. Geospatial data products and services are reused by both the public and private sector, as well as citizens, universities and other research bodies;
- **Value created from geospatial data:** the standardisation and sharing of geospatial data for product and service creation generates significant value primarily for the public sector itself, as they incur significant efficiency gains from standardising and sharing the data. Secondly, private sector actors generate significant additional revenue due to the larger availability of open data for their businesses – they create geospatial data products that are either reused by public administrations or by private sector actors. Finally, citizens, while not explicitly targeted by the study, benefit from the positive spill-over effects of using geospatial data for product and service creation. They benefit from more efficient public service and cheaper, improved private sector-generated goods;
- **Identified barriers to the reuse of geospatial data:** several barriers related to the use of geospatial data can be identified. Most importantly, access to reliable and sustainable data in the right format is a barrier faced by most private sector actors trying to work with open geospatial data. Similarly, it is currently challenging to integrate and link geospatial data with other data types. On the project

implementation side, the most cited barriers were financial constraints, organisational constraints, workers working in 'silos' within public sector bodies and a lack of legal clarity.

- **Opportunities associated with the wider reuse of the geospatial data:** numerous opportunities can be identified, relating to both private and public sector. Firstly, geospatial data can be used to drive the creation of better, more efficient public services through evidence-based methods. The public sector can also significantly benefit from the shared geospatial data infrastructures, in order to improve administrative cooperation. Emerging technologies generate vast amounts of new (geospatial) data, which serves as an opportunity for governments to discover new ways to collect, process, and most importantly, use geospatial data. It is also important to identify and scale up successful national and cross-border pilots to ensure that the good outcomes of pilot projects are adopted. In addition to this, if the extended domain specific data models are reused, then the application of geospatial data can be expanded to new domains.

Given the main findings of the study, in the recommendations section, this study presents the actions that policy makers at the European and Member States' level should take to improve the use of geospatial data and the delivery of geospatial data based products and services. These recommendations complement or reinforce the importance of the work being conducted by the Commission, notably by the DG JRC. The main recommendations of the study are the following:

- **Recommendation 1 - Continue promoting the implementation of the INSPIRE Directive:** the European Commission and responsible national bodies should invest in efforts to promote the implementation of the INSPIRE Directive, promoting its associated benefits to specific stakeholder groups. Moreover, the European Commission, national and sub-national public organisations should also make efforts to highlight the benefits obtained by the implementation of the INSPIRE Directive.
- **Recommendation 2 - Continue promoting the use of interoperable INSPIRE based specifications:** given the difficulties to standardise data and, in some cases, applying INSPIRE data specifications to specific domains, especially those not covered by the 34 INSPIRE themes, the Commission should continue promote the development of INSPIRE based specifications, including INSPIRE data models and their extensions. The Commission should also support the reuse of the already developed data models built from INSPIRE. Additionally, the Commission should also promote the use of INSPIRE based specifications whenever a new European initiative requires the use of geospatial data or integrating and linking any other kind of data with geospatial data.
- **Recommendation 3 - Facilitate access to funding of initiatives aiming to use or increase interoperability of geospatial data, products and services:** given geospatial data's high production, procurement and update costs, the European Commission should offer funding for initiatives that focus on data management more broadly (including geospatial data) and those that aim to increase the interoperability of geospatial data, its products and services. Where funding is already available, the Commission can support business by providing information and user friendly guidelines on how to access the correct funding opportunities.
- **Recommendation 4 - Ensure transparency regarding the reuse of geospatial data across the EU:** the Commission should take the opportunity of the revision[1] of the PSI Directive to ensure

[1] https://ec.europa.eu/digital-single-market/en/news/revision-psi-directive

transparency regarding equal and easy access to geospatial and other open data across the EU. More specifically, the EU should encourage: Member States to open up their public data in a user friendly way by making use of APIs and platforms; the standardisation of reporting practices across the EU; the availability for reuse of data generated in the context of the provision of a public task by publicly owned companies or by independent economic operators.

- **Recommendation 5 - Support the creation of a harmonised licensing framework for geospatial data:** the European Commission, in close cooperation with the Member States, should facilitate the creation of and promote a clear and harmonised licensing framework for geospatial data in the EU.
- **Recommendation 6 - Support the adoption of new technologies into the geospatial data ecosystem:** given the rapidly changing technological landscape, new ways to collect, process and reuse geospatial data are emerging, thanks to the abundance of Internet of Things devices, and the application of machine learning, among others. The European Commission and national governments, in close cooperation with the private sector, should work together to prepare for the smooth integration of these technologies into the geospatial data ecosystem.
- **Recommendation 7 - Ensure a user centric approach when opening up geospatial data:** it is crucial that national governments and other responsible public sector agencies, when standardising and opening up geospatial data, consult with the users of the data. This would help the public sector to better understand users' needs in terms of data products and services, hence overcoming the lack of 'geospatial data literacy' among users (namely, the private sector companies working with geospatial data) and helping them to better plan ahead.
- **Recommendation 8 - Perform an assessment of the value created by (open) geospatial data:** in order to overcome political barriers and silos, ex-ante, interim and ex-post cost-benefit assessments of the value of geospatial date could be performed. This could serve as a tool for responsible public sector agencies to supporting the use of geospatial data and raising the awareness of its expected benefits.

Introduction

In 2010 the European Commission launched an ambitious digital agenda[2], aiming at, among other things, establishing a fully functional and unconstrained digital single market. This laid the groundwork for the Commission's Digital Single Market Strategy[3] in 2015, focused on improving online access for consumers and businesses, ameliorating competition conditions for advanced digital networks and innovative services and maximising the growth potential of the digital economy in Europe while creating a digital single market. The strategy's chief objective is to generate new streams of growth in the European economy, creating sustainable jobs for the young, and a vibrant knowledge-based society. The implementation of the digital single market strategy will require the elimination of the main obstacles and barriers to the creation of a connected single market. To this end it is necessary to fully understand the barriers and obstacles, both technical and legal, to the construction and implementation of a truly digital single market and especially the place of data in this strategy.

It is currently inconceivable to look at a future digital single market without considering the increasing importance of data in the digital world[4]. These data types will increasingly be transferred, consumed and manipulated across borders and sectors. Consequently, it is important to understand the current obstacles to the data economy, and in particular, how the benefits of the 'data economy'[5], such as productivity and GDP growth, can be unleashed across Europe. Building a data economy in the EU will require **better access, transfer, availability and interoperability in relation to geospatial data**. These are the central issues being addressed in the Commission Communication on building a data driven economy adopted in January 2017[6]. These can relate, although not directly, to the concept of the 'free flow of data' as defined by this Commission Communication and concerning location limits to the exchange of data from one country to another. Accordingly, geospatial data is a type of data that may benefit from the 'free flow of data', however a location barrier to the exchange of geospatial data is only one factor among others that would affect its application and the opportunities arising from its use[7].

In this context, Wavestone was mandated by the Joint Research Centre (JRC) to conduct a study identifying, the barriers to the application of geospatial data for the creation of goods and services in the public and private sector, and the opportunities arising from their removal. The study had two main parts: first, a **market analysis** identifying opportunities and barriers related to the use of geospatial data and the delivery of geospatial data based products and services by public and private organisations, and second, **the provision**

[2] COM/2010/0245 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Agenda for Europe.
[3] COM/2015/0192 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Single Market Strategy for Europe.
[4] 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).
[5] We refer to ''data economy'' as the economy characterised by an ecosystem of different types of market players – such as manufacturers, researchers and infrastructure providers – collaborating to ensure that data is accessible and usable. It involves the generation, collection, storage, processing, distribution, analysis, elaboration, delivery, and exploitation of data enabled by digital technologies (European Data Market study, SMART 2013/0063, IDC, 2016).
[6] COM/2017/09 final, Communication from the Commission to European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "Building a European Data Economy".
[7] Kick-off Meeting of the ISA Action 2016.10 – ELISE "European Location Interoperability Solutions for eGovernment" project held on the 23rd of January 2017 at the JRC in Ispra.

of recommendations to policy makers to improve the use of geospatial data and the delivery of geospatial data based products and services and improve the geospatial legal framework in the EU.

As part of the **market analysis**, the study focused on the new developments in the usage of geospatial data by the public sector for an enhanced public service delivery and the use of geospatial data by private sector organisations, looking specifically at three types of geospatial data application; a) public services and products using publicly-held geospatial data; b) public services and products using geospatial data held by the private sector; c) private sector services and products using publicly-held geospatial data. The study assessed **the existing landscape for the application of these types of geospatial data use** for the delivery of services and products and **profiled the key players** involved.

To achieve this, the study undertook a literature review on the current European data legal and governance landscape, together with a review of existing projects, policies, and other studies published by European institutions on geospatial data. In a second stage, the study analysed five case studies and conducted a series of interviews with key experts and market players to help identify specific barriers and opportunities they associate with the geospatial data market in the EU. The barriers and opportunities to geospatial data are explained through the case studies, and the analysis also considers specific applications of geospatial in public or private services and product delivery.

The recommendations of the study took into account the current political and legal landscape affecting the data economy and geospatial data in particular, and reflect upon existing best practices from specific initiatives, sectors, policy domains and geographies which are replicable by policy makers and market players in Europe. The recommendations include direct recommendations to key stakeholders, such as the Commission and national regulators, on how to better facilitate and promote the development and use of geospatial data.

The study comprises the following chapters:

- **Section 1: Context and background,** this section provides an overview of the policy background and the role of the study in terms of the wider context in which it takes place.
- **Section 2: Methodological approach,** this section describes the overall methodology applied to this study, including the definition of research questions, the phases of the study and the approach used for the selection of case studies.
- **Section 3: Case studies: geospatial data market in Europe,** this section presents the assessment of selected case studies, highlighting the main actors involved as well as the opportunities and barriers faced by them in the use of geospatial data and the delivery of geospatial data based products and services.
- **Section 4: Conclusions**, this section provides a synthesis of our key findings, as well as a set of recommended actions for regulators and market players.
- **Section 5: Recommendations**, this section puts forward recommendations to policy makers based on the main findings of the study.

1. Context and background

This section presents the wider context of the study, outlining the role of data in the European digital economy and the digital single market. The section first defines the key components of a digital economy and later moves on to explain the features of the European digital economy and the role of geospatial data in it. The study proposes a glossary in Table 1 explaining the terms that are most commonly referred to in the context of geospatial data and its application, as referred to in the INSPIRE Directive[8].

Table 1 Glossary of common referred concepts

Terms	Definition
Geospatial data	'Geospatial data' means any data with a direct or indirect reference to a specific location or geographical area.
Geospatial data set	'Geospatial data set' means an identifiable collection of Geospatial data.
Geospatial data services	'Geospatial data services' are services which may be performed, by invoking a computer application, on the data contained in Geospatial data sets or on the related metadata.
Metadata	'Metadata' means information describing Geospatial data sets and Geospatial data services or products, making it possible to discover, inventory and use them.
Geospatial Object	'Geospatial object' is an abstract representation of a real world phenomenon related to a specific location or geographical area.
Interoperability[9]	'Interoperability' means the possibility for Geospatial data sets to be combined, and for services to interact, without repetitive manual intervention, enhancing the value of the data sets and services.

The Digital Economy

The current economic paradigm is being challenged on many fronts, but nothing can quite compare with the current revolution in the digital economy, which is bound to disrupt how companies and other organisations create value and interact with consumers. Whereas, it is quite common to perceive the digital economy as a threat, one must not shy away from the challenges it represents and ultimately the opportunities it might yield, especially for the European economy.

Indeed, whilst Europe is at a risk from losing jobs to automation[10], it has not yet embraced the digital economy to the extent that other OECD countries have and is currently losing out in competitiveness, productivity and ultimately digital literacy[11], with severe consequences on the future of European youth and the region's positioning in the world.

[8] 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).
[9] https://ec.europa.eu/isa2/eif
[10] http://bruegel.org/2014/07/chart-of-the-week-54-of-eu-jobs-at-risk-of-computerisation/
[11] The Information Technology and Innovation Foundation - Raising European Productivity Growth Through ICT (2014) available at: http://www.lisboncouncil.net/component/downloads/?id=1058. Last accessed on: 29/09/2017.

What constitutes the digital economy?

The digital economy initiated before the dawn of the third millennium has been recognised as a major economic transition in its own right, with transformational levels similar to those of the 1st and 2nd industrial revolutions, but this time with its impacts affecting the livelihoods of billions in a matter of a few decades and not generations[12]. The current digital revolution is underpinned by the following trends: the **development of knowledge**, which fuels the new economy; **digitisation**, facilitated by greater micro-processing technologies; **molecularisation**, or the rise of more flexible organisations; **convergence**, or the convergence of computing, communications and content; **innovation**, the basis behind the development of new products and services; and **globalisation**, reducing the barriers to knowledge[13].

These developments will be greatly facilitated by the use and application of **open data** and **big data** in the public sector, and by making this data available for the use and benefit of businesses and citizens through enhanced digital services. These types of data should not be treated as independent data types, and indeed when they are linked together their potential is unveiled, especially for their application in the public sector. The availability and access to open government data can provide a large source of diverse data, such a demographic and health data that can then be exploited to generate research and economic opportunities. In the scope of this study, particular attention is paid to geospatial data, as it can significantly benefit organisations in the private and public sector, and ultimately EU citizens.

Geospatial data is a particular type of data that provides geographic and location information of different data objects that are connected with a specific place or location, which can then be mapped. The Inspire Directive in particular defines Spatial Data as any data with a direct or indirect reference to a specific location or geographical area*[14]*.

Additionally, it is estimated that **geospatial data accounts for an estimated 80% of governmental data** and is considered the most significant category of open government data due to its high production, procurement and costs of updating, as well as its relevance to multiple thematic areas and domains[15]. It is thus of prime interest to understand the economic impact that this particular data can have on the European economy and how enabling the free movement of this data can contribute to creating a real digital single market.

However, there currently are multiple barriers to effective the transfer and usage of geospatial data, which result in the regulatory fragmentation of the single market, reduced consumption options, lack of new market development and new business models, constraints to growth and continued control of strategic datasets by

[12] United States. Economics and Statistics Administration – The Emerging Digital Economy (1998) available at: http://www.esa.doc.gov/sites/default/files/emergingdig_0.pdf. Last accessed on 29/09/2017.
[13] Tapscott – The digital economy: promise and peril in the age of networked intelligence (1995) available at: http://http-server.carleton.ca/~aramirez/5401/BookReviews/Babu.pdf. Last accessed on 29/09/2017.
[14] 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)
[15] EU Project Publica Mundi – Publishable Summary, (2014) available at: http://cordis.europa.eu/docs/projects/cnect/8/609608/080/publishing/readmore/PublicaMundi-Periodic-Publishable-summary-2014Y1.pdf. Last accessed on 29/09/2017.

large corporate players. It is therefore an imperative for the EU to develop a strategy promoting the sharing and usage of geospatial data. The following section describes the current initiatives and laws from the EU that can support and facilitate not only the establishment of a digital single market, but also the exploitation of big data, open data, geospatial data and their free transfer and exchange.

The digital economy in Europe

It is estimated that more than 4%[16] of European GDP comes from the continuously expanding ICT sector, which is the main source of productivity growth in the continent (accounting for up to 50% of productivity increases). There is a meaningful potential for the European Economy to increase through the application of big data, by up to 1.9% of GDP[17]. In 2015, the European Commission launched a vision for making Europe a digitally innovative region and one of the engines of digital growth, through the Digital Single Market Strategy[18]. In order to achieve the true digital potential of Europe and the cascading economic benefits this would bring about, the Strategy aims to create a **Digital Single Market**. The digital single market is seen as the manifest destiny of the European economy as it is poised to continue in its integration. Such integration is unforeseeable without integrating the digital space, as our economies and transactions are increasingly being digitised. The economic ramifications of a common digital European market, could herald a new age of European growth.

The European Digital Single Market Strategy is made up of three key policy areas: improving access to digital goods and services, creating an environment where digital networks and services can prosper and promoting digital tools as drivers for growth. The latter involved addressing barriers in the European data economy.

A European digital single market requires the following elements to ensure its functioning: a common telecommunication regulatory framework, a pan-European market for digital commerce and a single market for digital content[19]. To achieve this, the EU needs a common regulatory framework for electronic communications, **pan-European licensing**, together with **harmonised consumer legislation** and **copyright laws**. These will be key to creating a seamless online consumer market, with increased **digital transactions** and **reduced barriers** to the consumption of **European digital content**.

More recently, in January 2017, the European Commission produced a new Communication on Building a European Data Economy, which addresses issues concerning the free flow of data and data localisation. Among the main issues hindering the existence of a fully functioning European data economy are: data **availability**, **accessibility**, and **interoperability**. The identification of these issues serves as a first stepping stone of the analysis of our study. Our study should be seen in the context of the creation of a European data-

[16] European Commission – The ICT sector and its R&D performance in the EU (2016) available at: https://ec.europa.eu/jrc/sites/jrcsh/files/ICT%20Sector%20and%20R&D%20performance%20in%20the%20EU%202016.pdf. Last accessed on 29/09/2017.
[17] Demos Europa – Big and open data in Europe - A growth engine or a missed opportunity (2014) available at: https://www.microsoft.com/global/eu/RenderingAssets/pdf/2014%20Jan%2028%20EMEA%20Big%20and%20Open%20Data%20Report%20-%20Final%20Report.pdf. Last accessed on 29/09/2017.
[18] COM/2010/2020 final, EUROPE 2020 a strategy for smart, sustainable and inclusive growth.
[19] Marion Monti – A new strategy for the single market (2010) available at: http://www.frank-cs.org/cms/pdfs/EC/EC_Monti_Report_9.5.10.pdf. Last accessed on 29/09/2017.

driven economy, which is essential to ensuring a digital single market. This study, by conducting in depth case study analysis to identify the main actors involved in the creation of value using geospatial data, will assess the existing barriers and potential opportunities in the European data economy.

To establish a fully functioning digital single market, the EU has introduced a series of initiatives and communications aiming to consolidate the framework that will give life to the European digital single market and create a data driven economy. In order to understand the complexity involved in establishing a data economy, and indirectly supporting the use of geospatial data, it is important to understand the initiatives at EU level that support this. The main European measures that touch the realm of data are presented below:

- **European Interoperability Framework[20] and the Interoperability Action Plan[21]:** the two documents promote and support the delivery of European public services by fostering cross-border and cross-sectoral interoperability, eGovernment services and increased interoperability reduce administrative burden on businesses and citizens by making their interactions with public administrations faster, cheaper and more efficient. Furthermore, achieving interoperability across EU will significantly contribute to the European data economy.
- **Building a European Data Economy[22]:** the Communication looks at proven or potential blockages to the free movement of data and presents options to remove unjustified and or disproportionate data location restrictions in the EU.
- **Free flow of data initiative[23]:** the initiative aims to promote the flow of data across Europe and to tackle restrictions on data location in order to foster innovation in the EU.
- **NIS Directive**[24]**:** the Directive aims to bring cyber-security capabilities to the same level of development in EU Member States and ensure that exchanges of information and cooperation are secure, as there cannot be a single digital single market if there is no trust in the exchange of data and its security.
- **General Data Protection Regulation[25]:** the new Directive aims to give citizens back control over their personal data and to also simplify the regulatory environment for business who handle customer data. This Regulation is heralded as one of the key enablers of the digital single market as it will allow European citizens and business to fully benefit from the digital economy. It is believed that the new Regulation will help to reinforce trust and security in digital services.

[20] COM(2017) 134 final Annex to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Region – European Interoperability Framework – Implementation, 2017

[21] COM(2017) 134 final Annex to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Region – European Interoperability Framework – Implementation Strategy, Interoperability Action Plan, 2017

22 COM(2017) 9 final, Communication from the Commission to the European parliament, the Council, the European economic and social committee and the committee of the regions "Building a European Data Economy", 2017,

[23] DSM Strategy - The Free Flow of Data Initiative

[24] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union

[25] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)

- **Digital Single Market Strategy[26]:** the Digital Single Market constitutes the most ambitious initiative to date aiming at the establishment of a seamless digital market and reducing the key legislative and technical barriers to a truly digital single market. Open data is seen as one of the key enablers of the digital single market. The openness of data in the EU is being ensured through the Directive of the reuse of public sector information. Furthermore, the European Data Portal[27] serves as a gateway for open data, EU and national.
- **Communication on data driven economy[28]:** the communication sets out features of the data driven economy the EU hopes will move towards in the future and want tools and objectives the EU should set to achieve this.
- **eIDAS Regulation**[29]**:** the Regulation aims to provide a predictable regulatory environment to enable secure and seamless electronic interactions between businesses, citizens and public authorities. The digital single market would be facilitated by the introduction of a common electronic identification.
- **Directive on the reuse of public sector information (PSI)[30]:** the Directive stipulates that public sector bodies should make documents, when possible, available in open and machine readable formats together with their metadata. The Member States had to transpose the Directive into national law by July 2015. Following the review of the Digital Single Market Strategy, the review of the Directive is foreseen in spring 2018.
- **European Cloud Strategy**[31]**:** the strategy aims to speed up and increase the use of cloud computing across all sectors of the economy across EU. Cloud computing facilitates the necessary infrastructure that facilitates and eases the access to government open data.
- **INSPIRE Directive**[32]**:** the Directive aims to establish an infrastructure for spatial information in Europe that is geared towards making spatial or geographical information across Europe more accessible and interoperable. It aims to establish common standards across the EU to describe data for 34 different geospatial data themes[33]. The Directive requires common Implemented Rules to be adopted in a total of six specific areas: metadata, data specifications, network services, data and service sharing, spatial data services, and monitoring and reporting.

The list of the initiatives illustrates the importance of data to the EU. In order to better understand to what extent geospatial data is used in the EU, it is of crucial importance to analyse the geospatial data market and the main stakeholders involved in it. Geospatial data has many uses and is potentially one of the main contributors to the European data economy. However, the extent to which this potential is being realised needs to be better understood. To do this, our study identifies the barriers faced by the actors involved in the delivery of products of services using geospatial data, as well as opportunities that would arise from facilitating the use of geospatial data, and how value can be created from this.

[26] COM/2015/0192 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Single Market Strategy for Europe, 2015
[27] https://www.europeandataportal.eu/
[28] COM(2014) 442 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Towards a Thriving Data-Driven Economy, 2014
[29] Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC (eIDAS Regulation)
[30] 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 Text with EEA relevance
[31] European Cloud Computing Strategy, 2012
[32] 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)
[33] http://inspire.ec.europa.eu/data-specifications/2892

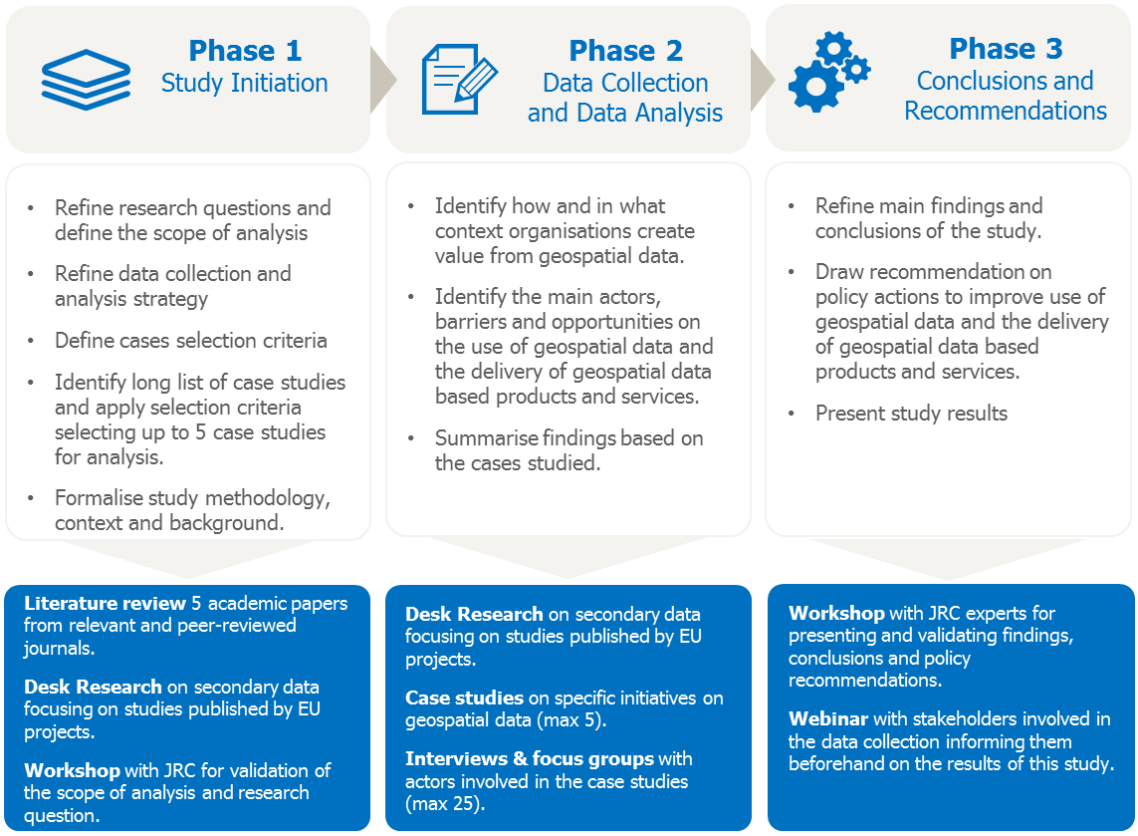
2. Methodological approach

This section describes our methodological approach to conducting the study. Section 2.2 provides the scope of the study through the main research questions. Section 2.1 sets out the overall methodological framework that were employed to address the research questions, providing a detailed step-by-step description of the research methods employed and how conclusions and recommendations were drawn. Section 2.3 describes the selection criteria that were employed to select the case studies presented in this study, and the geospatial domains this study focused on in its assessment of the barriers and opportunities in the application of geospatial data in Europe.

2.1 Overall framework

The methodological approach taken to conduct this study was designed to provide answers to the research questions in a structured way. It comprised three phases, shown in Figure 1.

Figure 1 Methodological Approach



Phase 1 – Study initiation

The aim of the first phase was to set the groundwork for the study by refining and agreeing upon the scope and methodological approach to be followed. During this phase we performed desk research and literature review in order to propose the *case study selection criteria* and identify a long list of case studies that could be potentially analysed within the framework of the study. More than 50 relevant case studies were identified to which the selection criteria were applied in order to select five cases studies to be analysed in this study.

Phase 2 – Identify barriers and opportunities to the geospatial market

The second phase of the study analysed the selected case studies in order to identify the key actors and the barriers faced by them in delivering products and services using geospatial data, but also the economic opportunities that arise from the application of geospatial data in these case studies.

Once the key actors related to case studies selected were identified, extensive desk research as well as targeted interviews were used to get a complete view of the existing barriers faced by them in the delivery of geospatial data based products and services. Building on the list of identified key actors, interviews were conducted not only with key experts and representatives of organisations supporting the geospatial data ecosystem within a case study, but also with organisations responsible for overseeing the consumption of geospatial data or consuming it themselves. All data collected from desk research and target interviews was analysed in order to identify the key barriers and opportunities to the data driven economy in Europe. A summary of the insights for each case study is presented in Section 3.

Phase 3 – Provide conclusions and recommendations

In this phase, all the insights from the analysis of the case studies were consolidated in order to enable the project team to draw sound conclusions on the existing opportunities and barriers within the geospatial data market in Europe. Based on these conclusions, the study put forward policy recommendations and actions that would facilitate the transfer and exchange of geospatial data in the EU.

The conclusions and recommendations were presented during a workshop with JRC, which took place in November 2017. During the workshop the team validated the findings of the study and collected additional information and feedback relevant to the conclusions and recommendations of the study.

The main result of phase 3 is the final report of the study containing recommendations and specific actions that would boost the geospatial market in Europe. A webinar, presenting the key findings of the study to all involved and otherwise interested parties was organised in February 2018.

2.2 Research questions

The objectives of the study are made operational through the following six research questions. These questions are included in the list below, which also contains the corresponding section or chapter in which each Research Question is answered.

- **RQ1.** How and in what context do public and private organisations create value from geospatial data and the delivery of geospatial data based products and services?
- **RQ2.** Who are the main actors involved in the processes of creating value from geospatial data and the delivery of geospatial data based products and services?
- **RQ3.** What are the main opportunities that can be found through a more extensive use of geospatial data and the delivery of geospatial data based products and services?
- **RQ4.** What are the main barriers that limit the access and the reuse of geospatial information, held either by a public or private organisation, by potential users?
- **RQ5.** What are the most important actions that the policy makers on European and Member States' level should take to improve use of geospatial data and the delivery of geospatial data based products and services?

Questions (RQ1, RQ2, RQ3 and RQ4) will be addressed in section ***3 Case studies: geospatial data market in Europe*** and section ***0 Conclusions*** and RQ5 will be addresses in section ***5 Recommendations.***

2.3 Case study selection criteria

In order to achieve the studies' objective and answer the main research of the study, the study performed an in-depth analysis of a list of five case studies that illustrate the variety of different stakeholders that can be involved in the application of geospatial data, the barriers these actors may find and the individual impact produced in each case study. Five criteria have been put together in order to select the final list of case studies. Initially, together with JRC, a list of 53 preliminary case studies had been compiled, with each case study carefully described along the selection criteria. The selection criteria was then used to select the five most appropriate case studies from the long list, available in Annex 2.

The following criteria were used to make the selection of case studies representative and comprehensive.

Criterion 1. Relevance to the conceptual framework

Case studies must fall within the scope of analysis of the study, the following types of geospatial data shall be considered, and be categorised appropriately:

- **G-G:** Use of public sector held geospatial data by public sector organisations for the delivery of public services;
- **G-B:** Use of public sector held geospatial data by the private sector for commercial and non-commercial purposes;
- **B-G:** Use of private sector held geospatial data by public sector for the delivery of public services; and
- **Mixed:** two way data exchange between the public and private sector supporting their respective interests.

Case studies involving the reuse of privately held geospatial by other private entities (B-B) was outside the scope of this study. At least one case out of the five were selected from each of the aforementioned categories.

Criterion 2. Diversity of stakeholder interaction

The case studies must present the full spectrum of the interactions between the main identified stakeholders, between the different types of geospatial data uses and within the delivery of geospatial data based products and services. Geographical diversity and coverage as well as cross border exchanges, were considered for this criterion. Where possible, case studies were chosen to reflect the diversity of stakeholder types (e.g. EU, national, regional and local governments, large enterprises, SMEs) in order to study the use and reuse of geospatial data, services and products in general rather than focus on a specific type of stakeholder, geography or business model. In the selection of case studies, the study attempted to include as many initiatives as possible that are funded or partly-funded by the European Union or its agencies, such as the Copernicus[34] and Galileo[35] programmes.

[34] http://www.copernicus.eu/
[35] https://ec.europa.eu/growth/sectors/space/galileo_en

More specifically, the five selected case studies should together cover the following stakeholder types:

- Different countries;
- Established and new European Member States;
- Location, national, and multi-national examples;
- Involvement of small, medium and large private sector companies;
- At least one pan-European example.

Criterion 3. Diversity of domains covered

The case studies selected should not only reflect the use and reuse of geospatial data by the private or public sector but should also demonstrate the usability of geospatial data in different domains (e.g. addresses, transport networks, mining, land use, natural risk zones, etc.).

Criterion 4. Value created from geospatial data and the delivery of geospatial data based products and services

Cases must present observable successes and/or failures related to the use and reuse of geospatial data and geospatial data based products and services. More specifically, they should highlight both areas of economic opportunities and areas where the actors involved in the case study faced difficulties and barriers when applying geospatial data and developing geospatial data based products and services.

Criterion 5. Feasibility

Case studies must be accessible, general, reproducible and feasible in order to investigate and research from an external perspective. The availability of data, the proximity and availability key stakeholders, and the relevance to the work conducted by JRC are all factors to be considered for this criterion. However, the case studies should not only present what is currently happening in the realm of geospatial application, but provide also a blueprint for practitioners on how to combine different functionalities and uses, enabling in turn new ways of thinking and generating opportunities involving geospatial data.

Out of scope:

Research projects, including any Horizon 2020 projects as well as already finished and closed projects have been indicated to be out of the scope of this study by JRC.

2.4 Data Collection Process

Once the five case studies that will be analysed have been selected together with JRC, data collection activities took place. Within each case study, the main stakeholders along with their contacts were identified. Desk research as well as JRC's contact database were used to reach out to the stakeholders identified. For each case study, telephone interviews were held to collect stakeholder's motivations for using geospatial data to create their products and services, their experience with product or service delivery and any barriers they might have faced or are still facing. A tailored interview guide was prepared to guide the interview with stakeholders within each case study. The interview guide template, which will was used as a basis for tailored interview guide within each case study is presented in Annex I. The interview guide is accompanied by a specific privacy statement.

The data collection activities took place in parallel for all case studies. Within the case study, project coordinators were contacted first and, in addition to the questions contained in the interview guide, they were

also asked for their opinion on which other stakeholders within the case study they would recommend to interview.

Results of the interviews were complemented by desk research and conclusions were drawn for each case study individually as well as in more generally, for all case studies together. Section 3 presents the analysis and findings for each individual case study.

3. Case studies: geospatial data market in Europe

Using the selection criteria, a long list of case studies, comprising a total of 53 European case studies involving the use of geospatial data for product and service creation has been compiled. The long list of identified case studies is available in Annex II. Following the application of the case study selection criteria, five cases have been selected and analysed under the scope of this study. These are:

- Public Services on the Map (PDOK) [36];
- Smart Open Data Portugal-Spain Pilot[37];
- FOODIE Project[38];
- Danish Basic Data programme[39];
- Innovate UK[40] geospatial data related initiatives.

Table 10 below details the assessment of the five case studies against the selection criteria. The five case studies cover a total of 10 countries: Netherlands, Spain, Portugal, Italy, Poland, Czech Republic, Latvia, Germany, Denmark and UK.

Table 2 Mapping of chosen case studies against the selection criteria

Case Study	Conceptual Framework	Stakeholders Involved	Domains Covered	Value Created	Feasibility
Public Services on the Map	Data owned by the public sector and used by both private and public actors.	Government organisations and agencies, Dutch citizens, research organisations and private companies.	Digital mapping, open data.	The Data is now standardised in an INSPIRE compliant way, is held in one place and is open for anyone to use.	Feasible, contacts through JRC.
Smart Open Data Portugal-Spain Pilot	Data owned by the public sector and used by both private and public actors.	EU institutions and agencies, national public bodies, SMEs and research organisations involved in forest management and land use planning.	Agroforestry management.	The pilot created a linked open data infrastructure and created a common platform for the Portuguese and Spanish authorities to use.	Feasible, contacts available through desk research.
The FOODIE Project	Data owned by both the public and private sector and used by both private and public actors.	EU institutions and agencies, farmers, advisory bodies, retail businesses, public sector bodies working in the agriculture domain, researchers for large scale experimentation, SMEs, technology providers.	Precision agriculture.	Creation of a common platform for farmers to store and access their data as well as a marketplace for data products exchange and scale up.	Feasible, contacts available through desk research.

[36] https://www.pdok.nl/en/about-pdok
[37] http://www.smartopendata.eu/pilots/portugal-spain-pilot
[38] http://www.foodie-project.eu/
[39] https://www.digst.dk/Servicemenu/English/Digitisation/Basic-Data/Basic-Data-in-brief
[40] https://www.gov.uk/government/organisations/innovate-uk

Case Study	Conceptual Framework	Stakeholders Involved	Domains Covered	Value Created	Feasibility
Danish Basic Data programme	Data owned by the public sector and used by both private and public actors.	Government organisations and agencies, Dutch citizens, research organisations and private companies.	Digital mapping, open data.	Data is now standardised in an INSPIRE compliant way, is held in one place and is open for anyone to use.	Feasible, contacts through JRC.
Innovate UK initiatives	Data owned by both the public and private sector and used by both private and public actors.	Government organisations, experts from various geospatial related domains experts, digital innovators, designer, entrepreneurs, research bodies, British citizens.	Future Cities, building performance data, satellite data applications.	Through making large grants available to various initiatives, the British government fosters innovation.	Feasible, contacts available through desk research.

In addition to the five case studies, the EULF Transportation Pilot[41] has been chosen as a trial case study to test the data collection approach. Given JRC's good knowledge of the case study, a practice interview has been held with the Project Officers at JRC and the case study has been included in the scope of analysis of this study.

Within each case study, desk research was performed to identify the main stakeholders involved. Telephone interviews (i.e. primary data collection) were held with the identified stakeholders and the findings were then complemented with secondary data, collected through desk research activities. The remainder of the section presents the analysis of each case study based on the primary and secondary data collected. For each case study, the following are presented:

- **Case study introduction**, which briefly summarises the project and presents its main actors and objectives;
- **Geospatial data ecosystem**, which carefully details the context in which geospatial data is collected, processed and reused, as well as the actors involved in each step of the geospatial data ecosystem. The section answers to RQ1 and RQ2;
- **Value crated,** which presents the main value created to different stakeholders involved in the project, hence answering to RQ1;
- **Barriers**, which details the identified barriers to the wider reuse of geospatial data in the case study, hence answering to RQ4;
- **Opportunities,** which presents the identified opportunities associated with wider reuse of geospatial data in the project, hence answering to RQ3.

[41] https://joinup.ec.europa.eu/community/eulf/og_page/eulf-transportation-pilot

3.1 Case study 1 – Public Service on the Map (PDOK)

The Dutch National SDI (PDOK) is a central platform for storing and sharing open geospatial data from the Netherlands in a single repository. It provides up-to-date and reliable information for both the public and private sectors. PDOK makes digital geospatial data available through both web services and data files. Most PDOK services are based on open data and are therefore public and free to use. The PDOK services meet national and international standards, including the European INSPIRE related standards and the Dutch eGovernment standards. In 2016, there were 104 datasets available through PDOK.[42] The data sets cover topography, topographical background maps, background aerial photos, height data, addresses, buildings, geospatial referencing codes, data on administrative units and statistical information. PDOK also manages the National PDOK Georegister, an online catalogue, which contains more than 8300 links to Dutch spatial datasets, including about 500 web services from different providers.

PDOK was created by a collaboration between the Dutch Cadastre[43], the Ministries of Infrastructure and Environment[44], Economic Affairs[45], Department of waterways and public works (*Rijkswaterstaat*)[46] and Geonovum[47], a government agency responsible for the national spatial data infrastructure in the Netherlands and the main standardisation body in the country. The creation of PDOK began in 2007, with the platform officially launched in January 2013. The four partners recognised the challenge faced by national agencies in adopting the INSPIRE standards. This encouraged them to create a central platform on which all national agencies could supply their data and where it would be standardised in an INSPIRE compliant way. Furthermore, the creation of a central platform for reusing geospatial data was also motivated by the fact that the Dutch law requires data from the national registries to be reused by national agencies and bodies. PDOK helps to facilitate this reuse. Finally, the four cooperating bodies recognised that creating the platform cooperatively would result in greater efficiencies, more reliability for all partners but also make it more sustainable.

The organisation of PDOK consists of two parts. The Cadastre is responsible for delivering PDOK services and supporting its users. The Steering Board monitors the service quality and is responsible for the long term development of PDOK. The Steering Board is supported by Geonovum with a small team consisting of representatives of all partner organisations. The Customer Panel represents the users of PDOK and serves as a sounding board for customer satisfaction.[48]

The PDOK platform provides up-to-date data for its users and also allows for easier data management, as it is all stored in one place. Users coming from universities and public administrations have access to slightly more capabilities on the platform, such as the possibility to download more data and access more datasets. PDOK has plans to expand its functionalities and is currently developing the PDOK extension for ArcGIS, an

[42] https://www.pdok.nl/en/products/pdok-services
[43] https://www.kadaster.com/about-kadaster
[44] https://www.government.nl/ministries/ministry-of-infrastructure-and-the-environment
[45] https://www.government.nl/ministries/ministry-of-economic-affairs
[46] https://www.pdok.nl/en/about-pdok/partners/department-waterways-and-public-works
[47] https://www.geonovum.nl/
[48] https://www.pdok.nl/en/about-pdok/organisation

online mapping tool developed by the private company, ESRI[49]. This tool will facilitate the search process and the usability of PDOK services in ArcGIS. This section will present the PDOK platform in more detail.

Geospatial data ecosystem

PDOK publishes geospatial data supplied to it by national agencies, which pay a small fee for the data to be published. PDOK does not own any of the data that it publishes, it makes a copy of every dataset. Data can be supplied to PDOK in different standards, it is then processed by an internal team who transforms the data into Geographic Mark-up Language (GML)[50] developed by Open Geospatial Consortium (OGC)[51]. PDOK is not responsible for any of the data that is published on its platform; if a user makes a complaint about the quality of the data, it is then forwarded directly to the original data provider.

PDOK provides four different types of qualified products to its end users:

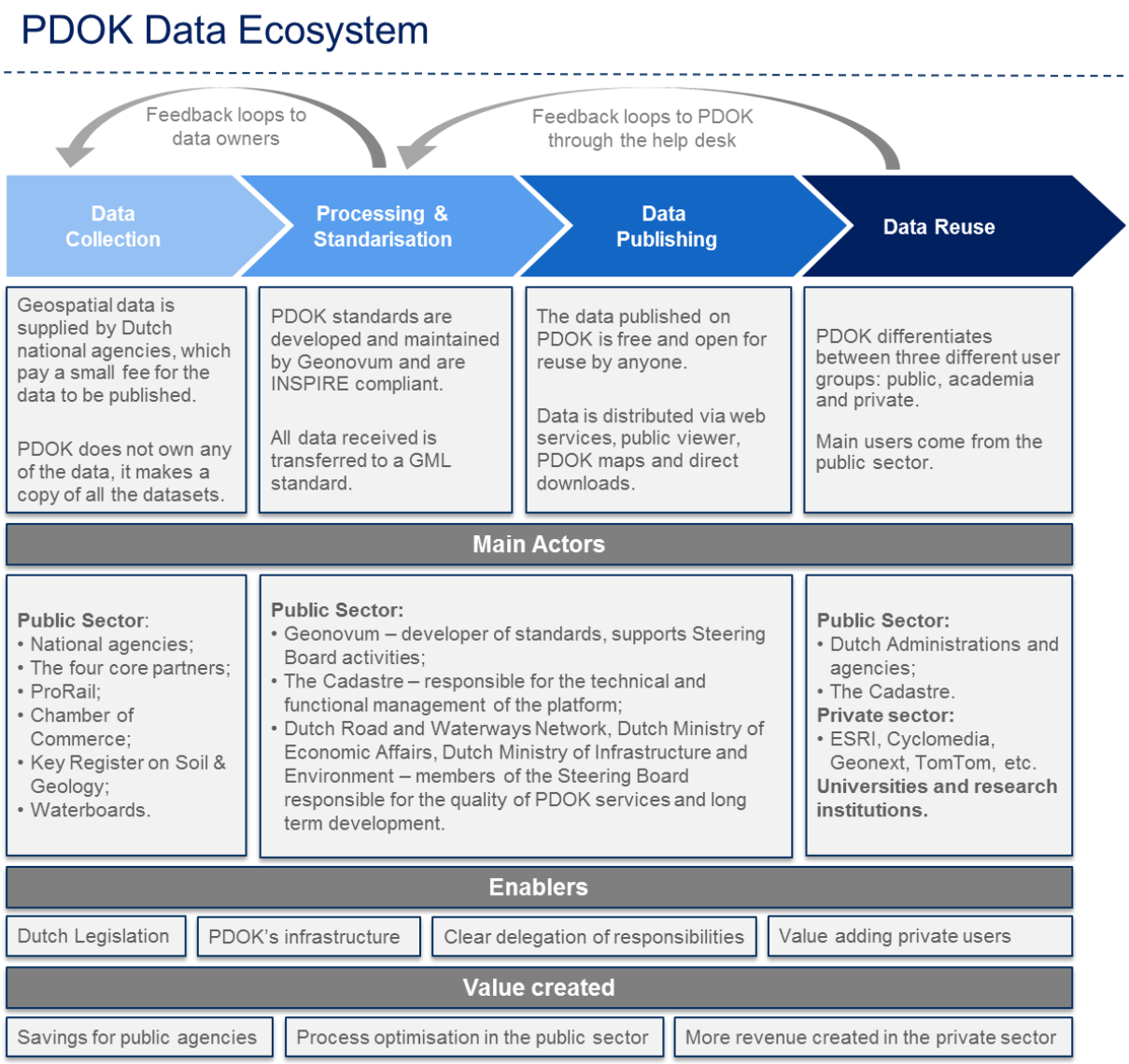
- **Web services**[52] – the platform provides data mapping services. The data used is sourced directly from the data owner, which helps ensure that users access the most timely and reliable data through PDOK. The web services meet the OGC international standards, including Web Map Tile Services (WMTS), Web Map Services (WMS), Web Feature Services (WFS), and Web Coverage Services (WCS).[53]
- **Direct Downloads**[54] – PDOK allows its users to also access and download numerous data sets. The data sets usually contain geographic data from the Netherlands. By downloading the data, the user obtains direct access to the files in their original source format. In comparison to the web services provided by PDOK, data downloads require the transfer of a large amount of data.
- **PDOK Public Viewer**[55] – PDOK users can access a standard and fully open viewer, which allows them to visualise some of the data sets that they might download into their own Geographic Information System (GIS) application. The public viewer also allows for the layering of different data types, hence allowing users to explore different data sets at once.
- **PDOK *Kaart* (PDOK Map)**[56] – the PDOK team has developed the PDOK *Kaart* capability, containing APIs, in order to allow users to integrate the capability in their own applications and websites. PDOK *Kaart* can be used by everyone, both for public websites and commercial websites and blogs. PDOK *Kaart* also does not require any geospatial knowledge to be used. Users can simply pinpoint locations on the maps using the PDOK *Kaart* Wizard to customise it.

PDOK relies on the principles of free and fair use. Hence, all of the data published on the PDOK services is free for reuse. PDOK has three different service level agreements. Users coming from universities and public sector have more access rights than other users, as they have no restriction of how much data they can download and reuse, while public sector representatives can also benefit from the help desk services. Private sector users, whilst having access to most of the same datasets, have less capacity to download and reuse

[49] http://www.esri.com/arcgis/about-arcgis
[50] http://www.opengeospatial.org/standards/gml
[51] http://www.opengeospatial.org/
[52] https://www.pdok.nl/en/products/pdok
[53] http://www.opengeospatial.org/standards/owc
[54] https://www.pdok.nl/en/products/downloading-data-pdok
[55] http://pdokviewer.pdok.nl/
[56] http://kaart.pdok.nl/

the data, especially large datasets. This is done in order to ensure that as many private users can access the platform at the same time. Users from the private sector also do not have access to the help desk facilities. The main user group of PDOK remains those coming from the public sector. Figure 2 below presents a summary of the PDOK's geospatial data ecosystem.

Figure 2 PDOK's data Ecosystem



An analysis of the PDOK case study reveals different types of stakeholders involved in the provision, processing, publishing and reuse[57] of the data. The Dutch Cadastre is the main public body benefiting significantly from PDOK's services, as it both provides the data to the platform and a major user of the data from other national agencies that has been made available through PDOK. Several municipalities in the

[57] https://www.pdok.nl/nl/voor-wie/overheid-pdok-basis/wie-gebruiken-pdok-basis-educatief

Netherlands, such as Zeeland[58], Nijmegen[59] and Zuid-Holand[60], use PDOK's *Kaart* functionality to illustrate cadastre information, green spaces, buildings and other geospatial data on the map.

PDOK's services are also widely used by several private companies, with ESRI being one of them. ESRI is an international company that builds ArcGIS, a mapping and spatial mapping software.[61] The role of ESRI's office in the Netherlands in relation to PDOK, can be seen as that of an enabling organisation, which works with the same data as PDOK to make it more accessible to a wider array of users. Whilst ESRI initially used PDOK's platform to develop its products and services for users in Netherlands, it has now developed its own platform and tools to work with data supplied to PDOK. This is due to the fact that the data structure and the pace of data analysis of PDOK was not suitable for the organisation's style of working. ESRI required faster data analytics and different data models. Whilst ESRI does not have a formal agreement with PDOK, it now has an agreement with the underlying data providers, who now simultaneously provide data to both PDOK and ESRI. Representatives of ESRI and PDOK meet twice per year to coordinate the data distribution strategy. ESRI works together with numerous organisations across the Netherlands, supporting them in the application development and hence generating time to market gains, as well as time savings.

Finally, given the number of different actors involved in the PDOK's data ecosystem and the importance of the service that PDOK delivers, several enablers have been identified that help to simplify and foster the process of data supply and exchange.

- **Legislative enablers** – Dutch legislation, such as the Law on Reuse of Government Information[62], together with the INSPIRE Directive, have significantly contributed to the creation of PDOK, whose creators point to the legislative environment in the Netherlands as the main motivation to create the platform. National agencies are required by law to supply and use the data in the national basic registries and to report any mistakes that occur in this data[63]. PDOK facilitates this exchange and use of data by providing a central place where the data from the 13 registries is stored and made easily available. Hence, the Dutch legal environment facilitates PDOK's services.
- **Technological enabler** – PDOK's infrastructure allows data providers to provide their data in any format, which is then transferred to a GML format.
- **Clear division of roles and responsibilities** – Another enabler, from the point of view of PDOK's creators, is the clear division of roles and responsibilities within the platform. The smooth cooperation and functioning of PDOK was enabled, once the four founding agencies delegated roles and tasks related to the data collection, maintenance of the platform and further strategy development.
- **Value adding private users** – some private reuses of PDOK's services act as further enablers for wider data reuse. Given that users who are not geospatial specialists may find it difficult to work with PDOK's web services, ESRI adds value to the same data by formatting the data in more user friendly way, this is then published by PDOK and enables more users to reuse it. ESRI publishes data from

[58] https://zldgwb.zeeland.nl/geoloket/?Viewer=Natura2000
[59] http://kaart.nijmegen.nl/milieu/
[60] https://www.zuid-holland.nl/overons/feiten-cijfers/interactieve/
[61] https://www.esri.com/en-us/home
[62] http://wetten.overheid.nl/BWBR0036795/2016-10-01
[63] http://ggim.un.org/knowledgebase/KnowledgebaseArticle51515.aspx

PDOK in different web formats and with various characteristics, which is then harvested and provided to the final end users using different web services.

Value Created

Savings for public

One of the key motivations for the creation of PDOK was to provide a service without which national agencies would incur significant costs when implementing the INSPIRE Directive. According to the creators of PDOK, the existence of PDOK saves a significant amount of resources for public agencies, especially for smaller ones, who would incur costs if they had to set up the infrastructures and find geospatial data experts themselves to share their data in an INSPIRE compliant way.

Process optimisation

Furthermore, given that PDOK serves as a one-stop-shop for data providers and data users, it helps to optimise the processes of the reuse of data from the national registry. The sharing and reuse of national registry data is demanded by Dutch law. Data sharing and reuse in the public sector has now become more efficient.

Value for the private sector

The existence of PDOK also creates value for users from the private sector. PDOK's map viewer has no advertisements and users can also refer to the help desk when working with large datasets. The usefulness of PDOK for users both from the private and public sectors is demonstrated by the popularity of the platform. In the year of its inception, the platform had a total of 500 million hits[64]. In 2016, the number increased tenfold, the platform reaching a total of 6 billion hits, with 4 billion being recorded on its topographical map alone. Furthermore, according to a survey conducted by PDOK in 2016, 56% of business users indicated that the data provided by PDOK had a positive effect on their turnover. For example, an SME specialising in the production of point clouds and 3D models increased its revenue up to 100k per year, thanks to the open data of PDOK.

Value added by users

According to private users of PDOK, such as ESRI or Cyclomedia[65], a geospatial imagery and software developer, further value could be added to PDOK provided data by standardising it and presenting it in other formats, allowing it to be reused not only by geospatial specialists.

Barriers

The developers of PDOK have faced several organisational and financial barriers when initiating the creation of the platform. The main barriers were linked to the division of responsibilities and coordination activities. PDOK also identified some barriers that are linked to the future development of the platform. The key barrier relates to further reuse of the data available on the platform. Data on PDOK is published through web services, which are not always easy to use for less skilled users. Web services used by PDOK have been labelled as particularly difficult to work with for web developers. Web developers prefer to use Google Maps, for example, due to the simple APIs offered by them. Hence, if the data published through PDOK becomes more easily reused, a wider audience can be reached. Table 3 presents an overview of the barriers for wider reuse of the data made available through the platform identified by PDOK.

[64] A 'hit' is defined as any data related activity on the platform – accessing the map, zooming in or out on the map, opening a dataset, modifying or downloading the data, etc.
[65] https://www.cyclomedia.com/en/imagery/nederland-obliek

Table 3 Barriers perceived by PDOK

Barriers to the project implementation	
Category	**Description**
Organisational constraints	The creation of PDOK was facilitated by the coordination of four agencies. However, the early stages of cooperation were not smooth as each agency had a different view of what role it should play. Yet, as soon as the project implementation phase ended and the production of PDOK began, the process of collaboration was much smoother as the roles and responsibilities for each organisation became clear.
Financial constraints	Each agency had a different view of how the PDOK maintenance costs were to be shared, which led to conflicts in the development and implementation phases of the PDOK platform. It was agreed that the four partners will share the maintenance costs of the platform equally. This allocation of costs was also approved through an external benchmarking exercise.
Barriers to future growth	
Category	**Description**
Platform visibility	The platform is currently not widely reused by users from domains other than geospatial data experts. This might be because of its low visibility on Google. PDOK is difficult to find online and the team of PDOK does not have specific resources allocated for further visibility enhancement.
Awareness	PDOK could publish data from even more data providers in the Netherlands. Many national agencies, who would benefit from PDOK's services, open calls for tenders when they want their data to be processed and standardised. A greater awareness amongst national agencies about the services provided by PDOK would be desirable.
Data accessibility	PDOK's data is made primarily available through web services, which are not always easy to work with for users who are not experts in geospatial data. Web developers, especially, would benefit from web services that facilitate the integration and linking of geospatial data with other data types. To achieve this, PDOK is planning work on the creation of linked data sets and simpler APIs. According to ESRI, PDOK should put less emphasis on GIS-heavy language, but communicate with its users in more accessible terms.
Adaptability to rapidly changing geospatial data environment	According to ESRI, PDOK would benefit significantly from learning to adapt more rapidly to its environment, as it currently takes PDOK some time to market the existing solutions and also to expand its commercial functionalities. This ability to adapt to changing users' needs and capabilities would help PDOK's data become more usable.
Slow responsiveness	According to ESRI, PDOK's help desk takes up to five days to respond, which sometimes can significantly hinder the reuse of its data.
Competitor sensitivity	One of the barriers to the expansion of PDOK's services, is the resistance from private firms. As PDOK plans to add functionalities to their core services, it would offer a value-added service for free, which could damage the user base of companies such as ESRI.
Sustainability of the business model	As the PDOK platform matures, it is becoming more evident that private companies often require a service level agreement in order to reuse the data. Such an agreement is in place with public organisations but not yet with private ones. The principles of free and fair use, under which PDOK operates, are not always enough for private enterprises.

Opportunities

The developers of PDOK are currently working on expanding functionalities for users. Soon, users will be able to access data in 3D (through a 3D viewer and 3D web services), and the platform will also provide table joining services (TJS). The TJS will allow users to combine tabular statistical and geospatial data to be integrated into the web services. Additionally, PDOK will work towards encouraging better feedback loops to ensure the constant updating of data. In addition to the help desk, specific user forums and communities will be created.

PDOK's team aims to expand its user database by attracting data users involved in other domains such as the environment, traffic management and road safety. In order to encourage the reuse of their data, Geonovum, the body responsible for standard development in PDOK, is working on the creation of linked

datasets and simpler mapping APIs, which would make PDOK's datasets easier to reuse. Hence PDOK would provide APIs, Linked Data and OGC compliant web services.

Finally, to optimise its data collection activities, the Dutch Cadastre will incorporate data collected through sensors and will move towards hosting real time data in the PDOK platform.

3.2 Case study 2 – Smart Open Data Portugal-Spain Pilot

The Portuguese and Spanish pilot is part of a wider Smart Open Data project[66], which aimed at creating a set of linked open data infrastructure.

The goal of the pilot was to help understand the relationship between river basin management by integrating potable water reserves and the management of land use and occupation, based on the associated national and European normative framework. A prototype Map Viewer was built based on data from the public domain, such as the results of the TER-WATER project[67], and also through the integration of constant information updates with a special emphasis on open data integration (e.g. CORINE Land Cover). The results and outcomes of the pilot are now open, standardised and publicly accessible, including web services and information management applications. The technological approach was based on open data (environmental monitoring data, cartographic services and remote sensing products) linked through INSPIRE compliant semantic services. This strategy based on open data was chosen in order to optimise the use of public information, improve management issues and involve stakeholders in the decision making processes.

The prototype Map Viewer created during the pilot enables its users (forest managers and forest owners, both public and private, and policy makers) to better understand agroforestry related resource management and to build consensus aligned with local and regional economic growth. For the development of the Map Viewer, open data from environmental INSPIRE compliant databases, cartographic services and remote sensing data was used.

The pilot was led by TRAGSA[68], who was the main project coordinator and the geospatial domain expert, and carried out in cooperation with the *Direção Geral do Território* (DG Território)[69] in Portugal, who supplied necessary geospatial data for Portugal. One of the technical aspects of the project, namely the development of a linked data model, was executed by SpazioDati[70], a technical partner based in Italy, and Sintef[71], a Norwegian research organisation with expertise in publishing linked open data. ERCIM[72], the European Research Consortium for Informatics and Mathematics and World Wide Web Consortium (W3C), the main international standards organisation for the World Wide Web, were also among the participating organisations[73].

The pilot is located in a transboundary region which includes the Ourense province in the Northwest of Spain, and the region surrounding the Castelo De Bode dam, in the centre of Portugal. A dual approach has been adopted: (i) regional, focused in the province of Ourense and the region of the Castelo De Bode dam (sustainable forest management), and (ii) local, focused in the village of Maceda in Ourense-Spain (sustainable exploitation of forest resources).

The project hopes not only to enhance the cross border cooperation between the municipalities in Spain and Portugal, but also to facilitate access to agroforestry information through collaborative spatial data

[66] http://www.smartopendata.eu/
[67] https://itea3.org/project/water-m.html
[68] http://www.tragsa.es/es/Paginas/default.aspx
[69] http://www.dgterritorio.pt/
[70] https://spaziodati.eu/en/
[71] http://www.sintef.no/
[72] https://www.ercim.eu/
[73] http://www.smartopendata.eu/partners%20

infrastructure. The main target audience of the pilot, hence, is mainly composed of SMEs as well as other private actors and policy-makers.

Geospatial data ecosystem

Within the Smart Open Data project, the objective of the Portugal-Spain pilot was the creation of linked open data infrastructure, supporting the publication of agroforestry data provided by the national administrations of Portugal and Spain in one map viewer. The geospatial data for the project was supplied by TRAGSA and DG Território. Geospatial data related to administrative boundaries, cadastre information, excavation data, temperature geomorphology, climatology, land cover, forestry maps, etc. was supplied by the national authorities of the two countries[74]. The data supplied by the national authorities was complemented by data from OpenStreetMap. All data used in the project was open data.

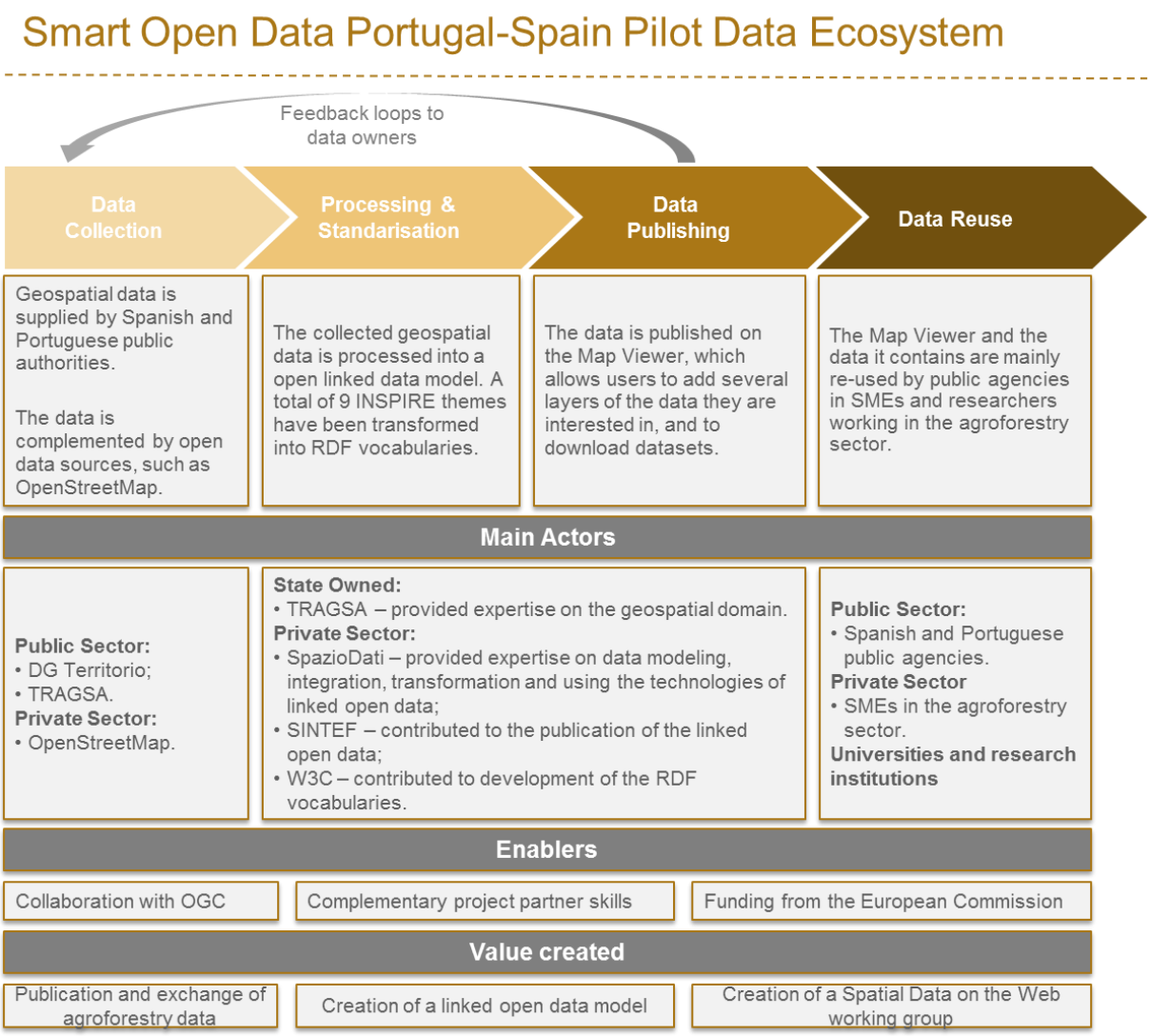
Data processing was the most challenging part of the Portugal-Spain pilot. The purpose of the pilot was to promote sustainable agroforestry management, through the building of linked open data infrastructure. The INSPIRE data model was not fully available in terms of linked open data standards, as it was defined using the more conventional standards of the geospatial community, such as XML and GML. Hence, the main objective of the data harmonisation task was to transform the conceptual model of INSPIRE into RDF, a widely used standard for linked open data models. According to SpazioDati, the following INSPIRE themes were transformed into RDF vocabularies: cadastral parcels, land-use, protected sites, species distribution and marine land cover. There were two main iterations of the Smart Open Data model. The initial approach of the technical team was to transform the classes and relations of the conceptual model of INSPIRE, into classes of RDF. Unfortunately, as indicated by both SpazioDati and W3C, the approach turned out to be too verbose and not fit for the pilots' needs. The technical team realised that there was no need for direct translation and mapping of INSPIRE into RDF, and the team worked closely with TRAGSA and DG Território, as well as participants of the other Smart Open Data pilots to create a variation of the model. In the end, it was apparent that many of the attributes and relations translated to RDF in the first model, were not necessary for the final users and were only making it more difficult for them to use the model. Hence, the technical team decided to take a more bottom-up approach – only the main classes were selected and transformed into RDF vocabularies, which are now available on W3C.[75] The nine vocabularies correspond to nine INSPIRE themes used across the Smart Open Data pilots. However, in the case of the Portugal and Spain pilot, the technical team went beyond INSPIRE, when creating the data model. SpazioDati was in charge of evaluating the data model in the context of individual pilots. In the case of the Portugal and Spain pilot, the level of granularity of the data required by the pilot users was not found within INSPIRE. Hence, the technical team developed an extension of the INSPIRE – the 'Smart Open Data Custom Vocabulary'.[76]

The resulting data model was published on the Map Viewer of the Portugal-Spain pilot. The Map Viewer not only allows its users to visualise the necessary data from the two countries but also gives them full access to

[74] http://map.tragsatec.es:8081/SMODViewer/
[75] https://www.w3.org/2015/03/inspire/
[76] https://www.w3.org/2015/03/inspire/smod

read and download the datasets. The data is mainly used by public administrations themselves, but also by SMEs working in the agroforestry sector and in the environmental domain, more broadly. It is hoped that the SMEs will use the linked open data models to add value to their existing services and products and to also create new ones.[77] During a workshop presenting the value of agroforestry data in Spain[78], several SMEs working in this domain were present, such as CeseFor[79] and FORA[80]. Figure 3 below presents the geospatial data ecosystem of the Portugal-Spain pilot in more detail.

Figure 3 Portugal-Spain Pilot Data Ecosystem



The Portugal-Spain pilot succeeded in achieving its objective to develop a linked open data infrastructure for agroforestry management. There were several factors that enabled the success of the project:

- **Complementary project partner skills** – according to pilot participants, the collaboration between project partners was smooth from the very beginning of the project, thanks to complementary project

[77] http://www.smartopendata.eu/public-deliverables/final-report
[78] http://www.smartopendata.eu/content/ponencia-informacion-forestal-y-activacion-socioeconomica
[79] http://www.cesefor.com/
[80] http://fora.es/en/

partner skills. The pilot brought together experts of the semantic web, geospatial data experts and public authorities providing the necessary open data.

- **Collaboration with OGC** – thanks to the workshop organised by W3C in the context of the Smart Open Data project, collaboration with OGC began in the form of the Spatial Data on the Web working group, which helped to identify best practices for publishing geospatial data online.[81]
- **Funding from the European Commission** – the project and involvement of numerous partners would not have been possible without the funding and support of the European Commission.

Value created

The Smart Open Data Portugal and Spain pilot has created significant value in three different areas: making data collected by public agencies publicly available, developing linked open data model, which is INSPIRE compliant and the creation of a web-based W3C-OGC working group on Spatial Data. Each type of value added is described in more detail below.

Publication of geospatial data

One the biggest benefits of the Portugal-Spain pilot is the publication of geospatial data. Whilst some of the data was already open to a wider range of users, a significant amount of the data made available through the Map Viewer was only available for internal use by the agencies of Portugal and Spain. Hence, the project has created value for end users of the data as the data is now available online for free. While it is mandatory for all public administrations in Spain and Portugal to provide datasets as open data, more often than not, they are not standardised, not interoperable and not easy to find by potential end users.

Creation of the linked open data model

Another benefit of the Portugal-Spain pilot, which lies at the core of its objective, is the creation of the linked open data model for geospatial data, which thanks to the work done by the technical partners of the pilot, is simple to understand and use, and is INSPIRE compliant. Some of the benefits of publishing geospatial data as linked open data include the possibility for users to discover new data of interest while consuming other information, allowing users to access the data schema and allowing users to discover geospatial data more easily. This means that any organisation working with geospatial data can adapt and reuse the model. The model can be used as a guide by other users to create RDF vocabularies for other geospatial domains.

Spatial Data On the Web working group

Another positive and long term outcome of the Portugal-Spain pilot, was the creation of the W3C-OGC working group on Spatial Data online[82]. The group emerged out of the discussions that took place between participating partners in the Smart Open Data project. According to W3C, early in the project, it became evident that geospatial data experts and web developers were speaking 'two different' languages, which required easier ways of publishing geospatial data on the web. The working group has published a list of best practices for sharing geospatial data on the web[83] and are continuing to develop easy-to-use APIs, working on ways to make geospatial data indexable by search engines and developing guidance for INSPIRE data providers.

[81] https://www.w3.org/2015/spatial/wiki/Main_Page
[82] Ibid.
[83] https://www.w3.org/TR/dwbp/

Barriers

Whilst the Smart Open Data Portugal and Spain pilot involved 17 partners, the project did not face many barriers related to project organisation, funding or legal issues. According to pilot participants, all partners harnessed their complementary areas of expertise to ensure smooth collaboration in the pilot. The main barriers that arose during the project are presented in Table 4 below.

Table 4 Barriers identified in the Portugal-Spain Pilot

Barriers to the project implementation	
Category	**Description**
Data accessibility	Pilot coordinators initially faced some issues obtaining access to all the data required to develop the Map Viewer as the agencies were initially concerned about the ultimate usage of the open data. However, the barrier was overcome when it was explained that the agencies will have no responsibility over what happens to the data once it is published, as the responsibility lies with the user.
Complexity of INSPIRE	The initial approach taken by the technical team when developing the linked open data model, showed how the complexity of the INSPIRE standards makes the ultimate RDF vocabularies too verbose and difficult for web developers to use. Ultimately, the complexity and level of detail of the INSPIRE data model sometimes means that it has to be less useful than other data models. When it comes to transposing geospatial data to RDF, transforming geometries into RDF is a complex process. It is not easy to query the data. According to SpazioDati, the best approach would be to add an RDF layer to geospatial metadata.
Barriers to future growth	
Category	**Description**
Geospatial data linkage	According to W3C, the main barrier preventing further access and reuse of geospatial data is the complexity of working with it. The moment one can easily link geospatial data with other types of data, many of the opportunities of working with geospatial data to create products and services will become available.

According to W3C, during the Smart Open Data project it became apparent that there is a big gap between the way that geospatial data is produced, processed and manipulated, and the way data on the web is processed and used on the web. There is an enormous amount of useful geospatial data, yet at present it is mainly used by those working in the world of geospatial data. One take away from the project was that it is important to make geospatial data usable by those working in the web domain, so as to encourage web developers to harness this data.

Opportunities

The executing team behind the Smart Open Data project hopes that the linked open data infrastructure and model will serve as a useful tool for SMEs and will help to foster innovation within the environment sector. More specifically, the technical team of the Portugal-Spain pilot hopes that the creation of the linked open data model will serve as a step towards the easier linking of geospatial data with other types of data on the web and will help to facilitate the creation of new services and products. The team is convinced that geospatial data can help complement many other datasets in different domains. But before this can be done, one has to ensure that different domain experts use the same language and similar standards. Some of the elements and lessons learnt from the creation of the linked open data model are now being used in a new project called

DataBio, focusing on big data applications in the bioeconomy sectors.[84] The project brings together some of the organisations that participated in the Smart Open Data project and the FOODIE project, which is detailed in the next section.[85]

[84] https://www.databio.eu/en/
[85] https://www.databio.eu/en/consortium/

3.3 Case study 3 – FOODIE Project

The Farm Oriented Open Data in Europe (FOODIE) project aims at building an open and interoperable agricultural specialised platform hub on the cloud for the management of geospatial and non-geospatial data. The platform aims to store relevant data for farming production; allow users to discover geospatial and non-geospatial agriculture related data from heterogeneous sources; and integrate existing valuable European open datasets related to agriculture[86]. Furthermore, the platform enables the data publication and data linking of external agriculture data sources provided by different public and private stakeholders. The platform facilitates data sharing and knowledge creation, hence providing specific and high-value applications and services for the support of the planning and decision-making processes for different stakeholders groups involved in the agricultural and environmental domains. The potential of the FOODIE platform was demonstrated through three different pilot scenarios across Europe, providing within each a specific set of common and specific requirements:

1. Precision Viticulture in Spain – the pilot focused on the management of crop variability, in order to achieve greater economic benefits and reduce the environmental impact.
2. Open Data for Strategic and Tactical Planning (Czech Republic) – the pilot focused on improving the management of farms by introducing new tools and management methods, by following a cost optimisation path and allowing the reduction of the environment burden.
3. Technology led integration of logistics through service providers and farm management, including traceability (Germany) – the pilot focused on integrating German machinery cooperative systems with existing farm management and logistic systems as well as developing and enlarging the present cooperation and business models with different partners along the supply chain.

Other smaller pilots were implemented within the project for the further validation of the platform services, taking place in Latvia, Italy, Poland and Turkey.

The FOODIE project is relevant for four different groups of users: stakeholders from the agriculture sector as end users of final applications (farmers, advisory services, service organisations, retail businesses); public sector stakeholders involved in the taxation, subsidies, regulation matters of farmers, among others; researchers; ICT companies developing new applications for the agriculture and food sector, using the implemented tools (SME developers of ICT for agriculture platform, technology producers).

The FOODIE Consortium consists of a multinational team encompassing research institutions, large companies and SMEs, public bodies and organisations from seven different countries (Austria, Czech Republic, Italy, Latvia, Poland, Spain and Turkey)[87]. Its multidisciplinary profile ensures the correct synergies as regards skills and industrial expertise, which are essential to the implementation of the three different pilots and the FOODIE platform. The Successful cooperation in the FOODIE project was ensured through several bilateral agreements between the main partners. Whilst some partners cooperated on the development of the FOODIE platform itself, others were working together to collect and process data from the pilots. The FOODIE project was partially financed by the European Commission under the ICT Policy Support Programme[88].

[86] http://www.foodie-project.eu/
[87] http://www.foodie-project.eu/partners.php
[88] https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/fp7/calls/cip-ict-psp-2013-7.html

The implementation of the FOODIE project officially ended in February 2017. However, given the success of the FOODIE pilots and of the FOODIE platform, the consortium partners are planning to expand the scope of FOODIE. They are now preparing a commercial agreement to ensure that their cooperation continues into the future and to help the maintenance of the platform. The FOODIE team is currently evaluating options that would help ensure the sustainability of the platform, such as charging users for some of the data.

Geospatial data ecosystem

The FOODIE project was an initiative involving numerous partners in Europe. Different organisations were involved in the creation of the FOODIE data model, the development of the FOODIE platform, and the collection and processing of the necessary data. Atos Spain, a large technology company, was the main project coordinator of the project. The company was assisted significantly by Wirelessinfo[89], an SME located in Czech Republic, in the development of the FOODIE data model and the FOODIE platform, as well as by the Poznan Supercomputing and Networking Centre (PSNC)[90] in Poland.

The data necessary for the implementation of the FOODIE pilots was collected from several sources. The main open data sources to build the FOODIE platform were:

- Satellite information from Landsat-8[91] and Sentinel-2[92] repositories. The data was available for the Spanish, Czech Republic, Latvian, Polish and Turkish pilot areas. Netcad[93], Wirelessinfo and Seresco[94], brought their expertise together to extract the necessary data from the satellite images;
- Land Parcel Identification System (LPIS)[95] data was used for the Spanish, Czech and German pilots;
- OpenStreetMap, a user powered open license map of the world[96], was used by Wirelessinfo to develop an Open Transport Map[97] for all Europe. The model created is INSPIRE compliant[98].
- Meteorological data was used for the Spanish and Czech pilot;
- Open cadastre data was used for the Spanish and Czech pilot.

Furthermore, farmers in each of the pilots gave the FOODIE project participants access to their own data systems. Finally, a significant amount of data was collected during the pilots themselves through the deployment of sensors on farming machinery.

Regarding data processing, as indicated by PSNC, there was no single value chain. For example, in both the Czech and Polish pilots, the collected satellite imagery was used by Wirelessinfo and Netcad to create vegetation indexes. In order to create the vegetation indexes, satellite data was combined with data from pilot

[89] http://www.wirelessinfo.cz/en
[90] http://www.man.poznan.pl/online/en/
[91] https://landsat.usgs.gov/
[92] http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-2
[93] http://www.netcad.com/
[94] https://www.seresco.es/
[95] https://www.europeandataportal.eu/data/nl/dataset/8c8072f5-2075-49c3-b3e5-56ee58f8db8d
[96] https://www.openstreetmap.org/#map=6/46.449/2.210
[97] http://opentransportmap.info/
[98] https://inspire-reference.jrc.ec.europa.eu/apps/open-transport-map-otm

participants' information systems. The vegetation indexes were then used to calculate farmer's crop yield potential.

All the data collected or connected to the FOODIE systems was processed and transformed in the FOODIE data model, which built on the INSPIRE Agricultural and aquaculture facilities model[99]. The FOODIE data model was developed in cooperation between PSNC and Wirelessinfo. The resulting conceptual data model of FOODIE relies upon the following basic pillars:

- Data and service modelling in the geospatial domain rely upon a series of ISO/OGC geospatial standards and best-practices,
- Specific agriculture standards and best-practices, such as the INSPIRE data model for Agricultural and Aquaculture Facilities or for Transport and Monitoring Facilities.

Furthermore, the FOODIE data model ensures a unified understanding and concept of agricultural data and interoperability with other similar (sub)systems when using open data in a standardised, while also being compliant with existing legislative requirements within (and beyond) Europe (especially INSPIRE and the Land Parcel Information System[100]). FOODIE's data model was also transformed into an RDF linked open data model, hence linking the data in the platform together with ontologies and RDF vocabularies.

The resulting data product was different for each of the FOODIE pilots. Whilst vegetation indexes were used to calculate yield potential in the Czech Republic and Spain, sensor data was used for pest detection in potatoes and vineyards, while sensor data installed onto trucks was used for route optimisation in the German pilot. Most of the data collected through the FOODIE project was stored in the cloud infrastructure provided by PSNC. PSNC was in charge of the storage of the semantic data and its publication according to the linked data principles on the FOODIE platform. The data products were available to pilot participants through FOODIE's platform hub.

The creation of the FOODIE platform hub[101] for the data collection, management, integration and analysis in the agri-food sector was a product in itself. The platform offers several services to its users. Users can access a virtual marketplace developed by PSNC, where they can download reports, datasets and upload their own data products. The platform is also linked to a geoportal where users can find the necessary geospatial data.[102] Registered users whose data is available through the platform (such as participants of the FOODIE pilots) can access the dashboard to view and use their data. Finally, the platform has a dedicated developers' corner where the APIs of the FOODIE platform can be accessed and it also offers training materials on how to use the platform and reap the benefits of precision agriculture.

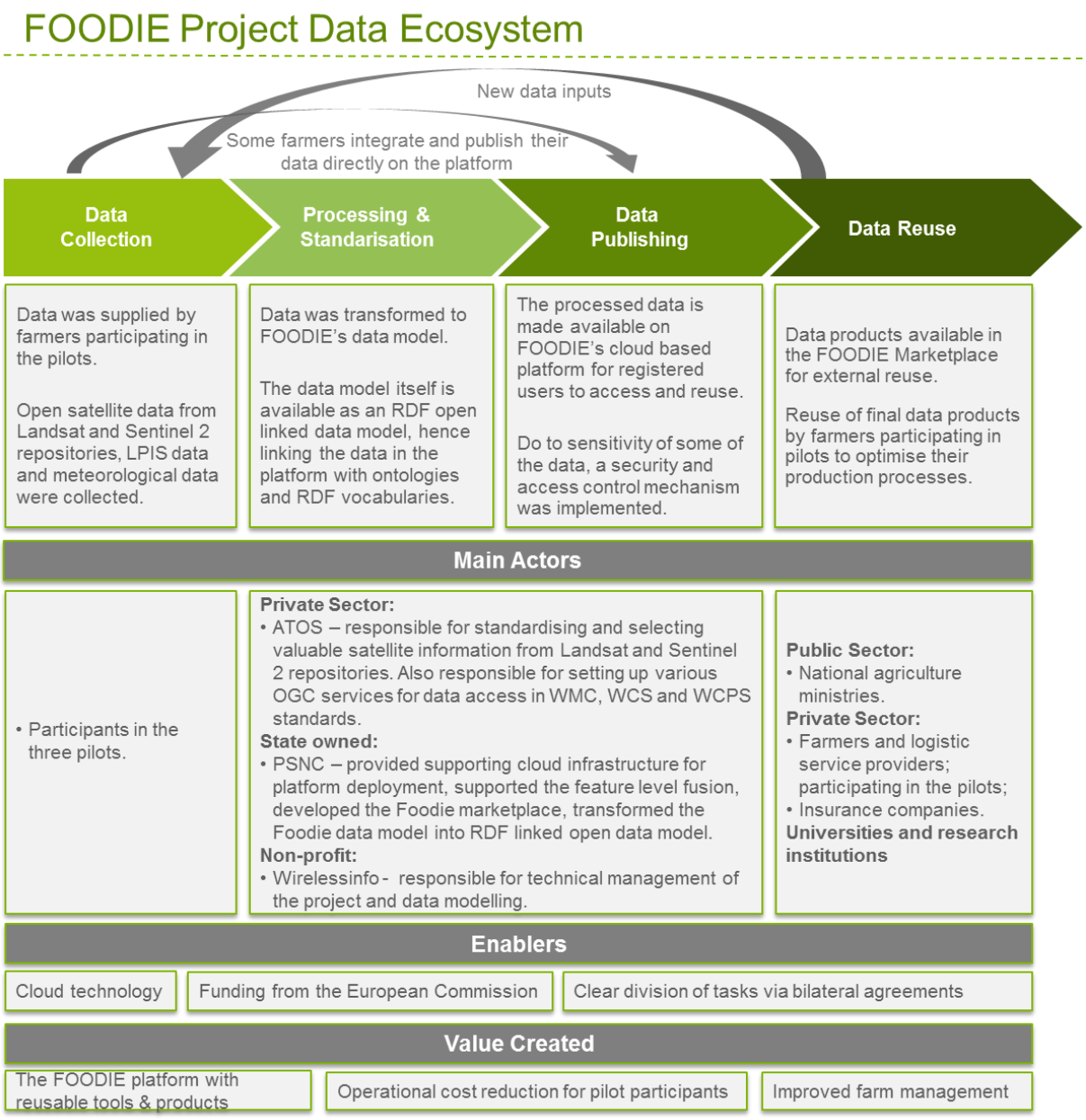
[99] https://inspire.ec.europa.eu/Themes/137/2892

[100] https://www.researchgate.net/profile/Karel_Charvat2/publication/305851288_FOODIE_DATA_MODELS_FOR_PRECISION_AGRICULTURE/links/57a3af9d08ae3f4529247b39/FOODIE-DATA-MODELS-FOR-PRECISION-AGRICULTURE.pdf

[101] https://www.foodie-cloud.org/#open-data-platform

[102] http://portal.foodie-cloud.org/

Figure 4 FOODIE Project data Ecosystem



There were several different enablers contributing to the success of the FOODIE project:

- **Cloud storage:** the solution offered by PSNC helped to simplify the storage and processing of the large amount of data collected for the implementation of the three pilots. Without the cloud solutions, significant investment in the infrastructure to store the data would have been needed;
- **Funding from the European Commission:** European Commission financing was instrumental in realising the goals of the project and brought the entire Consortium team together;
- **Close cooperation with the final end users:** constant communication with the end users of the project contributed significantly to the successful implementation of the FOODIE platform. The Consortium partners could obtain real time feedback on the data they were collecting as well as the data products that they were offering back to the end users in the three pilots.

- **Clear division of roles and responsibilities:** given the fact that the FOODIE Consortium was made up of nearly 20 partners, an effective cooperation was a crucial component to its success. In addition to the project agreement, the collaboration in the project was ensured through bilateral agreements between different individual companies working together to implement specific aspects of the FOODIE project, such as the FOODIE data model, data collection and processing and the development of the FOODIE marketplace.

Value Created

The FOODIE project generated significant value to its direct end users and its creators also expect to deliver value to a wider audience that might benefit from the cloud based platform in the future.

The main beneficiaries of the FOODIE platform remain the end users of the three main pilots. As the data supplied from the pilots to the platform is processed and linked with other datasets, farmers are able to optimise their production methods. More particularly:

- The end users of the Spanish pilot, namely the Bodegas Terras Gauda winery, reduced its operational costs (mainly due to irrigation reduction) through the data supplied by FOODIE. The winery also successfully optimised their production thanks to a recommendation, based on the data collected by FOODIE, to implement a targeted phytosanitary treatment significantly reducing crop loss. By early estimates, there is an expected 2-5% increase in crop yields.

Operational cost reduction

- The end users in the Czech pilot significantly improved their farm management activities thanks to a more efficient use of fertilisers and pesticides, thanks to the developed fertilisation planning maps and an improved use of fuels. The Geospatial data collected from sensors installed on trucks helped optimise their paths across farms, leading to fewer CO2 emissions. Furthermore, analyses made by FOODIE helped reveal which specific areas were in need of or had an abundance of fertilisers, leading to additional productivity optimisation.

Improved farm management

- Finally, thanks to the integration of German machinery cooperatives systems with existing farm management and logistics systems, the logistics companies' transportation costs were reduced by 5-10%.

Reduced transportation costs

Overall, logistics service experts participating in the FOODIE project significantly benefited from having detailed information on roads connecting different farms and distribution sights, allowing them to plan their routes and deliver goods to the food industry on time.

According to Lesprojekt, the ability to produce fertilisation planning maps[103] is one of the main reusable outcomes of the project. The FOODIE team created fertilisation planning maps for the farms involved in the Czech pilot. The maps help farmers to predict the yield potential of their crops and hence, optimise the use of fertilisers. To test the applicability of the maps beyond the farms in the three pilots, the FOODIE team developed a fertilisation map for the country of Luxembourg. The country was chosen due to its small size. Nevertheless, it took the developers two weeks to compile the right algorithms to cover the entire country. Hence, while the expansion of the map to other countries is foreseen, this will be a lengthy procedure.

Fertilisation planning map creation

[103] http://foodie-data.wirelessinfo.cz/php/foodie_luc/

Another innovative solution developed by the FOODIE project team in a smaller pilot in Italy was the development of livestock management tools to help track and analyse the current location of cows. The developed tracking tool is aimed at SME farmers due to its low costs. The FOODIE team developed tailor made solar powered sensors for all cows in the farm with a GNSS receiver and RFID chips. The developed tracking application was based on INSPIRE standards and hence demonstrated that INSPIRE based standardisation can be used successfully in commercial applications. The tracking tool is currently only available for farmers participating in the pilots.

Livestock management tool creation

Furthermore, while the FOODIE platform is mainly intended for the end users of the three pilots and smaller case studies, creators of FOODIE hope to expand it for a wider audience, and there are many benefits that would stem from its usage. Firstly, national agriculture ministries could use the platform to support some organisational activities, such as subsidy distribution. The platform already contains most of the data that would be used by national agriculture ministries for the execution of certain tasks. Usage of the FOODIE platform would help avoid the duplication of data collection efforts. The FOODIE platform could help in the elaboration and delivery of optimised policies. The FOODIE platform could support more evidence-based regulation for the agriculture sector. The platform can also be used to see how different companies are contributing to the environment and hence better assess land taxes.

Platform scale up

The creators of the platform hope that fund managers will be able to use the information available to develop detailed business plans allowing them to finance farmers and foresters (by obtaining the information on the growth period, costs and expected returns). Insurance companies will also be able to use the detailed information to obtain information to make accurate insurance packages for farmers' crops.

The main output of the FOODIE project was the FOODIE cloud based platform for data exchange. Equally important was the creation of the FOODIE data model[104]. The FOODIE data model is INSPIRE compliant and is available for anyone to reuse. It is published as a XML package with an open licence, as well as PDF descriptions and SQL scripts for setting up the database schema. The model has been presented at several events and workshops[105] and its creators hope that it will soon become the main data model used in precision agriculture. The FOODIE model is also being used as input for the earlier DataBio project, focusing on big data applications in the bioeconomy sector.[106] Also the APIs of FOODIE are now available for free. The process of semantic linking and the technology produced by FOODIE are also of interest for R&D purposes.

Applicability of the FOODIE data model

Furthermore, an added value to the FOODIE project, compared to other similar projects in the agriculture domain, is the linking of the final users in the pilots to the developed platform. Indeed, there was close coordination with the farmers from the very start of the FOODIE project. The pilot successfully brought together farmers, data scientists, and users in one platform to achieve something operational.

Proximity to the end user

The FOODIE project also accurately calculated and offered a tangible return on investment to the farmers. Technology companies and researchers often make the mistake of not thinking about the return on investment for farmers when developing new applications and products. Indeed, developers themselves need to step up

[104] https://github.com/Wirelessinfo/FOODIE-data-model

[105] https://www.researchgate.net/profile/Karel_Charvat2/publication/305851288_FOODIE_DATA_MODELS_FOR_PRECISION_AGRICULTURE/links/57a3af9d08ae3f4529247b39/FOODIE-DATA-MODELS-FOR-PRECISION-AGRICULTURE.pdf

[106] https://www.databio.eu/en/

and work to bridge this gap by creating products that offer them tangible benefits. This would encourage farmers to invest in the new farming technology and hence lead to a larger scale implementation of research.

Barriers

The implementers of the FOODIE project, containing a total of three pilots and aiming to create a cloud based data sharing infrastructure, faced several barriers in realising the project's objectives. Additionally, given the hopes to expand the FOODIE project beyond the three pilots, there are several barriers that have been identified to the growth of the FOODIE platform. Table 5 summarises the barriers that occurred and were overcome by the development of the FOODIE project, as well as barriers to future expansion of the platform.

Table 5 Barriers identified in the FOODIE project

Barriers to the project implementation	
Category	**Description**
Data accessibility	The FOODIE team faced a significant barrier when attempting to access data in Europe. It was significantly more difficult to access the necessary geospatial data in certain pilots. For example, whilst data access was not an issue per se in Spain, in Germany as well as in Latvia, the process was more complicated. As there was no clear policy regarding access to data at national or regional levels, the FOODIE team had to contact each concerned farmer individually to agree on the access to their data.
Data privacy	Another barrier that complicated the project in terms of data collection and processing, was the privacy and commercial concerns of farmers participating in the pilots. Several farmers demanded that their data, which is to be used for analysis, remains in their own existing systems. This was motivated both by privacy concerns and the fact that most farmers endured significant costs in developing their data storage systems and were hence unwilling to replace them with the FOODIE system. In order to ensure that third parties did not access private farmers' data, a security and access control mechanism was put in place in the FOODIE platform. Regarding the wish of farmers to keep their data, their systems were simply connected to that of FOODIE. This was a smooth process as most farmers were using OGC standards already to describe their data.
Infrastructure needs	Given the scale of the FOODIE project, significant resources to store and process data were needed. The barrier was overcome with the provision of cloud infrastructure for data storage by PSNC.
Barriers to future growth	
Category	**Description**
Data accessibility	One significant barrier to further expansion of the FOODIE platform is the lack of homogeneity of standards and rules regarding data access across Europe. Legal and regulatory frameworks differ at local, national and EU level in terms of content, licensing framework, the implementation status and also the availability of service capabilities. There is currently no level playing field in relation to the access and availability of geospatial data in Europe. Furthermore, the data available is often poorly described.
Sustainability of the business model	Some of the companies involved in the FOODIE project were concerned about the sustainability of the concept of open data as a public good. In most cases, the organisations or private entities who provide geospatial data incur costs associated with data collection and processing, whilst government organisations expect to have access to this data for free. Difficulty in obtaining free open data could become a potential barrier in the future.
Complexity of INSPIRE	The complexity of the technical specification of the INSPIRE standards as opposed to other commercial or open source geospatial services (e.g. publicly available WMS, WFS standards) is another barrier to expanding the usage of the FOODIE platform. Users of the geospatial data described in an INSPIRE compliant way, would need to have good INSPIRE expertise. Applications like OpenStreetMap or Google Maps are much easier to use in combination with other standards.
Geospatial data integration	The ease of integration of geospatial data can be a barrier. To transform data from one model to another, one needs many resources and expertise about geographical information. These resources are not always at hand, especially for smaller organisations. FOODIE acts as a place to test some things in practice and the team now shares an ambition to continue the development and extensions of the data model developed by FOODIE. The standardisation of data remains the main issue in the transferability and expansion of the FOODIE project.

Scale up	A significant part of FOODIE is related to offering products through the created marketplace, which also helps to facilitate data exchanges. Yet, it is currently challenging to obtain necessary inputs to bootstrap this marketplace and make it of value to the general agroforestry community. There is a need to identify and involve the right stakeholders (farmers, data experts, IT experts) in the marketplace.

The creators of the FOODIE platform see the different data access rules and procedures in Europe as a significant obstacle to the expansion of the FOODIE platform. Furthermore, the lack of a single policy or legal framework in the field of precision agriculture means that it is much less likely that EU Member States will be interested in having a single agroforestry platform for all of Europe. This, however, is the ultimate aim to the creators of the FOODIE platform. The creators of the FOODIE platform believe that a push from either the European Union or national legislators is needed.

Opportunities

Given the recognition of the FOODIE data model, its creators hope that it will ultimately become the main data model used in agroforestry management, while a wider reuse of the FOODIE data model is foreseen. Furthermore, the creators of the FOODIE platform hope that, if some of the abovementioned barriers to growth are overcome, the platform can expand further and become the main access point for agroforestry data exchange in Europe.

According to the creators of FOODIE, what is currently needed in the agriculture sector is stronger cooperation between research and practitioners to overcome existing barriers regarding geospatial access and standardisation. Whilst there is a lot of research being done on geospatial data and its applications, the work is usually done in silos. There is very little communication and, more importantly, collaboration with final end users. Closer collaboration with end users in the domain of smart farming would help unlock the potential of 'geospatial' data more quickly.

The FOODIE team also expects that, given that the FOODIE platform is sustained in the future, the vast amount of data collected through the platform could also serve as an input to policy makers working in the agriculture domain. This would avoid the unnecessary duplication of data collection activities and would also foster evidence based policy making.

The FOODIE project team believes that, in order to ensure the wide-spread adoption of precision agriculture approaches, comprehensive EU policies are needed. The current standards required by INSPIRE, while relatively broad and complex, are not detailed enough when it comes to the domain of agriculture. In the case of the FOODIE data model, whilst it relied on the INSPIRE data model for Agricultural and Aquaculture Facilities, a more detailed feature than that of 'Site' was necessary for the FOODIE project. Hence, the team developed one level lower features for the FOODIE data model.[107]

[107] https://www.researchgate.net/publication/305851288_FOODIE_DATA_MODELS_FOR_PRECISION_AGRICULTURE

3.4 Case study 4 – Innovate UK programme

Innovate UK is the UK's Innovation agency, which funds science and technology developments that will drive future economic growth. The agency also works with UK innovators to help them connect, launch and grow into successful businesses. The organisation has been operational since 2007 and has allocated over £1.8 billion (EUR 2 billion) to foster innovation in the UK.[108] Three different projects involving the use of geospatial data and funded by Innovate UK were analysed for the purpose of this study. Namely, the Building Data Exchange programme[109], Future City Glasgow[110] and CityVerve Manchester.[111]

The Building Data Exchange platform was developed by Innovate UK's Building Information Modelling (BIM) team to unlock one of the largest unexplored datasets in the built environment. Innovate UK's Building Performance Evaluation (BPE) programme spent four years analysing how real buildings perform in comparison to their performance expectations at the outset of construction[112]. The BPE programme has supported and analysed over 100 projects, half of which were domestic houses and homes and the rest were non-domestic buildings (such as offices, schools, restaurants, bars, etc.). The resulting data became what is now known as the Building Data Exchange programme. The initial idea of the Building Data Exchange was to store the data of the BPE programme in an easily accessible way to make it useful for different stakeholders in the construction industry. Yet, Building Data Exchange expanded the scope of BPE and has worked towards developing new datasets and analysing new buildings. It is hoped that the platform will become a single source for building performance information across UK, with lessons, advice and datasets.

In 2013, Innovate UK awarded the city of Glasgow with £24 million (EUR 27 million) to explore innovative ways to use technology and open data to make the city more efficient, sustainable and safe. Future City Glasgow made use not only of the data made available by the public sector, but the programme also actively encouraged private organisations across Glasgow to make non-sensitive and non-personal data available online for the reuse by others. To date, the Future City Glasgow open data catalogue contains over 370 open datasets from 60 different organisations. It acts as a one-stop-shop for data about the city for developers and start-ups. Future City Glasgow developed solutions and demonstrators using open data in the spheres of linked and community mapping, active travel, intelligent street lighting, energy and social transport. Future City Glasgow worked closely with several private companies for the development of its Future City demonstrators. The project ended in 2015 and the outcomes of the main demonstrators are found online.[113]

Manchester also received funding from Innovate UK to realise the CityVerve project with a team of 21 organisations, both public and private. The aim of the Manchester CityVerve project is to harness the Internet of Things technologies to create a smart and connected city for its citizens. Hence, the team behind the

[108] https://www.gov.uk/government/organisations/innovate-uk/about
[109] https://buildingdataexchange.org.uk/
[110] http://futurecity.glasgow.gov.uk/
[111] http://www.cityverve.org.uk/
[112] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/497758/Domestic_Building_Performance_full_report_2016.pdf
[113] http://futurecity.glasgow.gov.uk/reports/

Manchester CityVerve project is working to harness emerging technologies and explore new ways of collecting, analysing and presenting data.

Geospatial Data Ecosystem

Building Data Exchange

The Building Data Exchange project created a platform with the goal of providing easy access to building monitoring data, and stimulating the application of digital technology in the construction environment. In the Building Data Exchange project, the use of geospatial data played a secondary role.[114] Whilst all of the buildings were mapped on the map of the UK, the focus of the project was on the construction data of the buildings themselves. Geospatial data was also used, in combination with building performance data, to carry out climate impact analyses. In order to launch the project, the Building Information Modelling (BIM) team ran an open competition for new construction sites and new projects, to win funding to undertake the data collection surrounding the construction of their building. The BIM team could not pay for the construction of the building itself but only for the additional cost of building monitoring. The BIM team wanted to ensure that all of the buildings were measured in a standardised way, there was a standard data template and a standard set of information that had to be collected for each building participating in the project. There were 20 evaluators who were professionals from the industry.

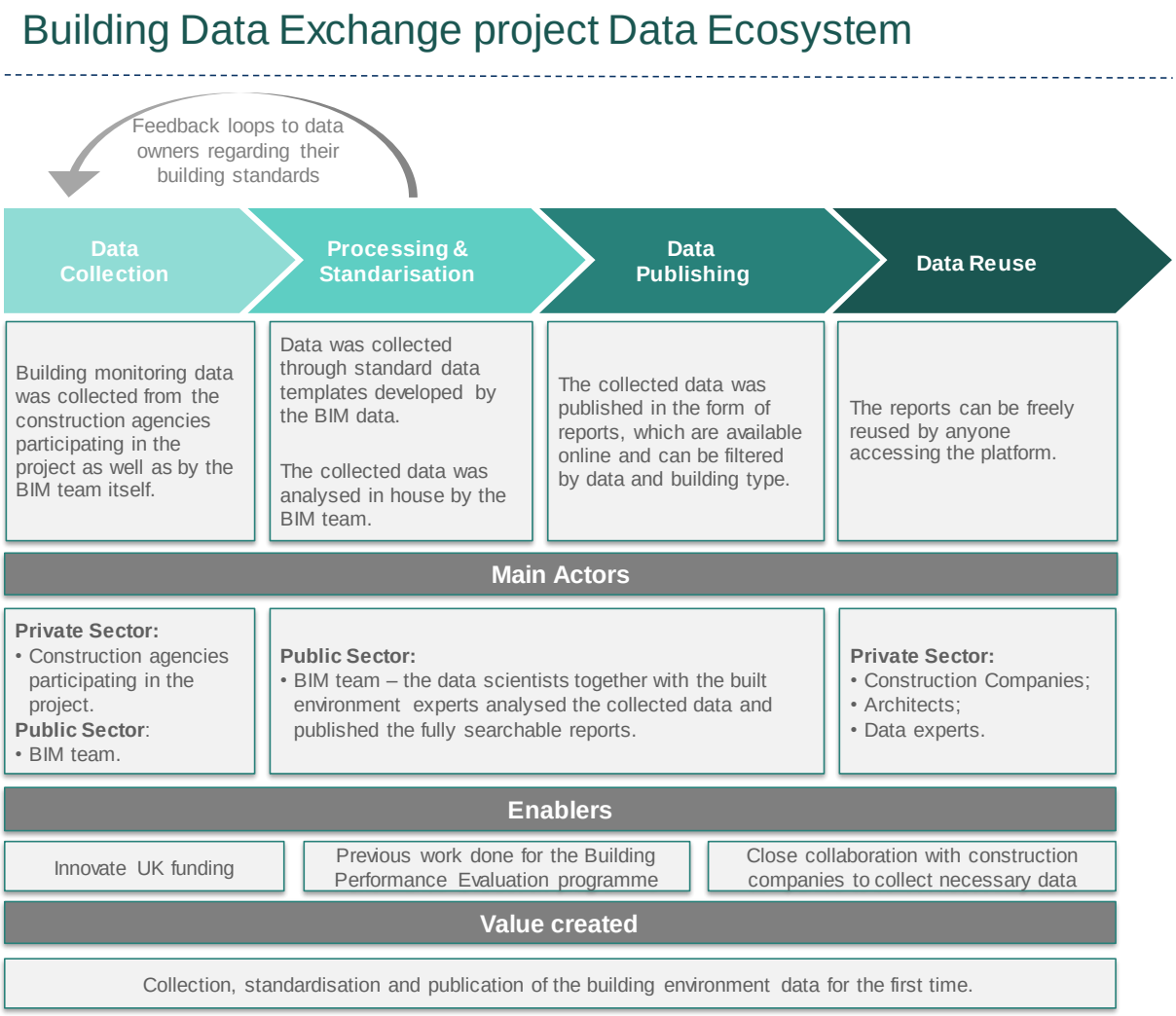
The process of data collection in the Building Data Exchange project was a joint activity. The BIM team installed sensors in the buildings participating in the project whilst the contractors provided the architectural data, assessments of the buildings and BREEAM ratings[115], among others. The BIM team developed a data template to ensure that data was collected in a standard way by all project participants. Data was processed and analysed by the BIM team and stored in the reports, which are now available online for the wider audience's reuse[116]. The reports can be filtered through several dimensions: design, energy demand, low and zero carbon technology, airtightness, fabric, etc. The Figure 5 below presents the data ecosystem surrounding the Building Data Exchange project in more detail.

There were several enablers that facilitated the realisation of the Building Data Exchange project:

- **Innovate UK funding** – the initiative was funded and managed by the Innovate UK team. Project funding allowed the BIM team not only to rely on the data collected by the construction companies participating in the project, but to also install their own sensors and collect additional building data;
- **Previous work done by the Building Performance Evaluation (BPE) programme** – the Building Data Exchange project was a follow up to the BPE programme. It reused a lot of the data collected through the BPE and also could rely on the expertise gained during the project and lessons learnt;
- **Close collaboration with construction companies to collect data** – the success of the Building Data Exchange project relied on successfully collecting all of the necessary building performance data. This would not have been possible without the data that was shared by the construction companies participating in the project.

[114] https://www.digitalcatapultcentre.org.uk/introducing-the-building-data-exchange/
[115] http://www.breeam.com/
[116] https://buildingdataexchange.org.uk/reports/

Figure 5 Building Data Exchange data ecosystem



Future City Glasgow

Future City Glasgow was amongst Future City projects funded by Innovate UK in 2013, it received a grant of £24 million. The Future City Glasgow consisted of three main work programmes, one of which focused on ensuring community safety, monitoring traffic in the city and public transport using big data and cutting-edge new technologies. The project used sensors to detect movement and regulate traffic lights as well as coordinating first responses in case of road accidents. Furthermore, sensors were invested on the city buses, collecting live bus data and providing real time optimisation routes and updating bus timetables.[117] Another work programme was concerned with the development of various future city demonstrators, which introduced intelligent street lights, helping to improve energy efficiency in the city.[118] Finally, the Glasgow city project also developed smart city maps for the citizens of Glasgow, to which citizens could contribute themselves. The maps comprise four different data categories for citizens: supporting thriving communities, improved health and wellbeing, protecting vulnerable people and employability[119]. Another geospatial data based application

[117] http://futurecity.glasgow.gov.uk/reports/FC_Reports_2015_SocialTransport_V1.pdf
[118] http://futurecity.glasgow.gov.uk/reports/FC_Reports_2015_StreetLighting_V2.pdf
[119] http://open.glasgow.gov.uk/load/

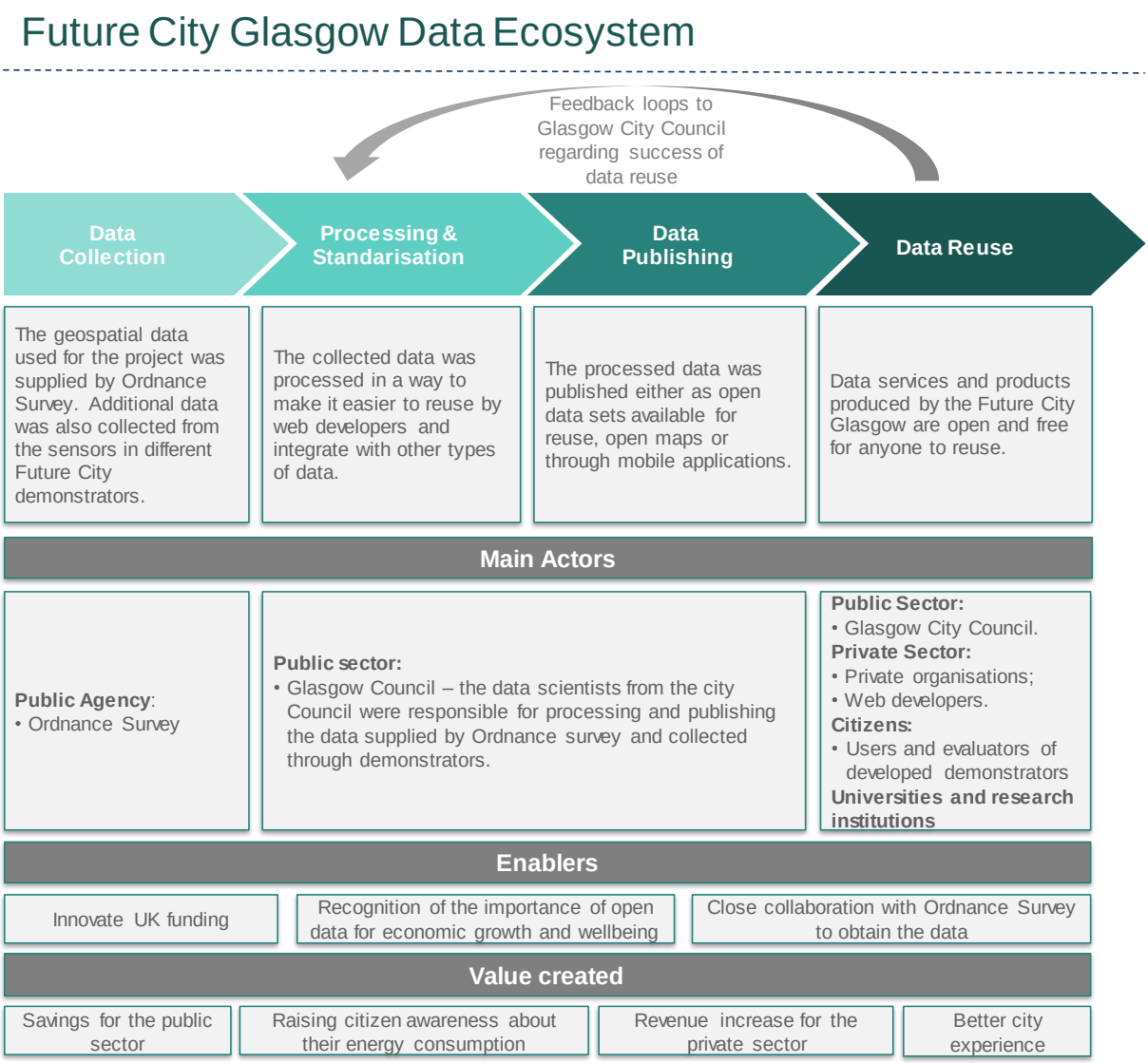
that was developed by the Future City Glasgow Operation Centre was an application, which would help future drivers pick the day for their driving test based on the weather and real time traffic conditions in the city.

All of the geospatial data for the Future City Glasgow as well as for the Manchester CityVerve project, described in more details below, was provided by Ordnance Survey, the UK's main mapping agency. Data processing was done by Glasgow City Council's data team to make it easily reusable for the web and application developers involved in different Future City demonstrators. The resulting data products, applications and websites were open for use by citizens, private organisations and web developers. Figure 6 below presents in more detail the data ecosystem of the Future City Glasgow project.

Given the scope and the size of the Future City Glasgow, there were several enablers that helped to facilitate its data ecosystem.

- **Innovate UK funding** – Glasgow City Council received a grant of EUR 27 million to realise the vision of Glasgow as a Future City. This was the key enabler for the Council in realising its ambitious objectives;
- **Recognition of the importance of open data** – the success of the Future City demonstrators depended heavily on Glasgow's public agencies opening up and sharing their data with project partners. Glasgow City Council is convinced that the common recognition of the importance of open data to facilitate economic growth acted as one of the key drivers in ensuring smooth cooperation in the project;
- **Collaboration with Ordnance survey** – in addition to the data obtained from public agencies, the Future City Glasgow project heavily relied on geospatial data, which was made available to all project participants by Ordnance Survey, the main mapping agency in Britain.

Figure 6 Future City Glasgow Data Ecosystem



Manchester CityVerve

The Manchester CityVerve project is managed by Innovate UK and seeks to harness the data from Internet of Things (IoT) devices in different areas of the city. It uses data from the domains of health, energy and culture, among others, to improve the welfare of the citizens of Manchester. In order to achieve this, the technical team behind the CityVerve project put together a 'platform of platforms' to bring together the data, systems and people in the city in one place. The architecture of the platform is designed to be fully flexible and scalable through the creation of a secure data catalogue that can be upgraded based on the city's evolving requirements. Furthermore, the platform is open access, allowing different target groups, ranging from entrepreneurs, start-ups and developers, to services providers needed to develop on the CityVerve platform.[120]

[120] http://www.cityverve.org.uk/platform-of-platforms/

In the CityVerve project, just like for the Future City Glasgow project, Ordnance Survey was the main supplier but also the collector of the geospatial data used in the project. For the CityVerve project, Ordnance Survey provided a large number of datasets, providing topographical and semantic data for the Manchester area. For the CityVerve project, Ordnance Survey captured great amounts of data from different pilots, such as street imagery data, which was then turned into geospatial data in both 2D and 3D formats by using lasers and sensors to collect and citizens to validate the data. Ordnance Survey used bicycle sensors not only to learn about optimal city biking routes but also about the quality of the roads around the city. The key role played by Ordnance Survey in the data collection and data processing cycle involved analysing the existing standards for data processing and identify standards needed to allow continuous innovation in future on top of the geospatial data. The available geospatial data was integrated with the data collected during the Smart City demonstrators and processed in a way to create different data products and applications for the various demonstrators.

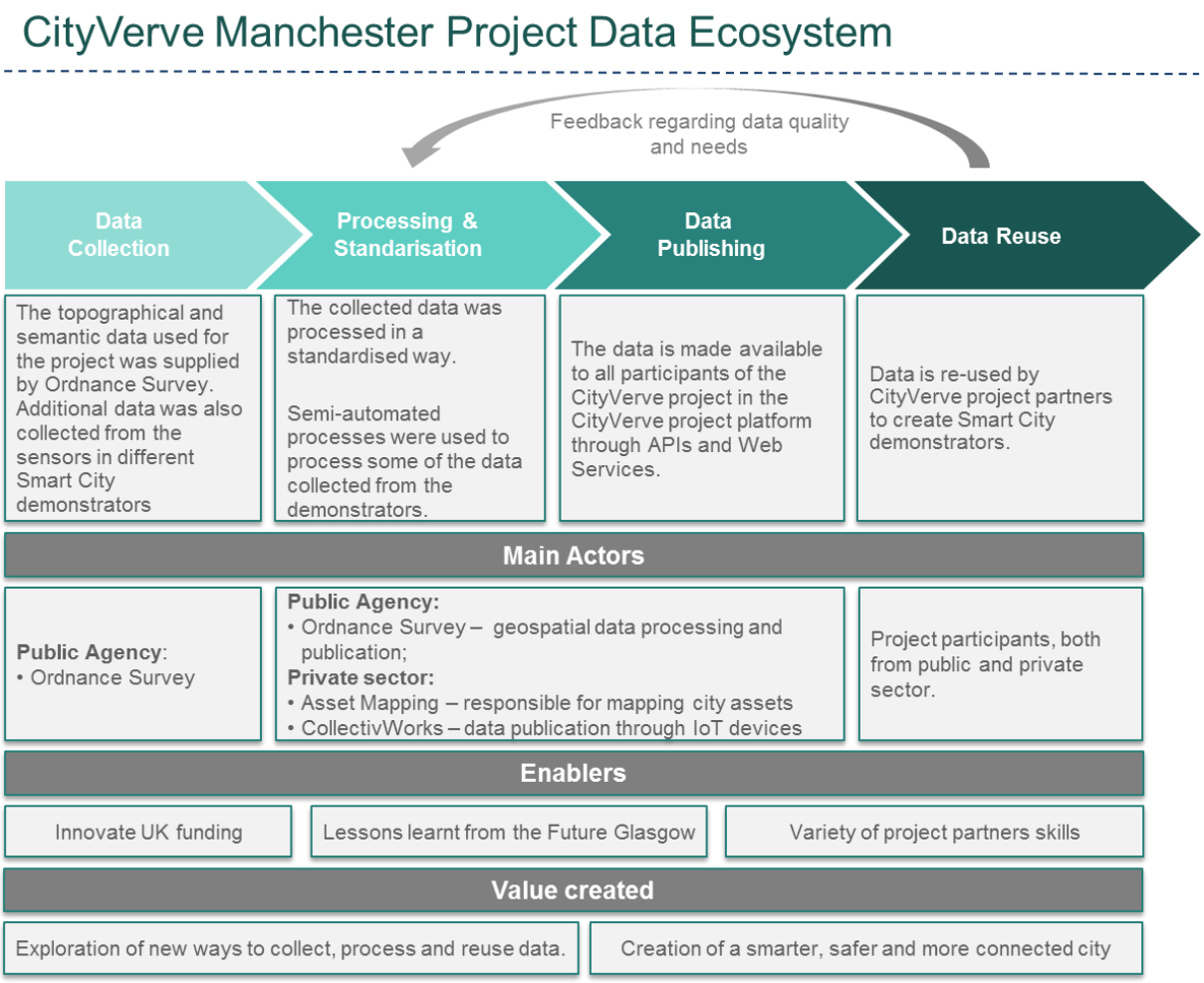
The data collected for the CityVerve project was quite heavy to process, especially when producing 3D visualisations. Hence, in order to simplify data processing and reduce the amount of required resources, Ordnance Survey started to develop automated processes, such as machine learning, automation techniques, and image recognition. All the geospatial data and other data used in the CityVerve project is standardised, allowing for its reuse. The data was published in the common platform, accessible by all project partners, enabling them to develop their Smart City demonstrators.[121] The CityVerve Manchester data ecosystem is presented in more detail in Figure 7 below.

Given the similarities between CityVerve and the abovementioned Future City Glasgow project, similar enablers facilitated the data ecosystem. In addition to receiving all the necessary geospatial data from Ordnance survey and benefiting from government funding, the CityVerve project benefited from the following enablers:

- **Lessons learnt from Future City Glasgow** – project participants held several meetings with the Future City Glasgow team in order to ensure the success of CityVerve. The lessons learnt regarding project scale up will be particularly useful in the second phase of the CityVerve project;
- **Variety of project partners skills** – CityVerve Manchester brings together over 20 partners from both public and private sectors, as well as the academia. The complimentary skills and expertise of the project partners help to ensure that the demonstrators being developed for the CityVerve succeed.

[121] http://www.cityverve.org.uk/partners/

Figure 7 CityVerve Manchester Data Ecosystem



Value Created

One of the strengths of the Innovate UK programme is the variety of the projects it supports and hence, a wide range of value it creates to society, business and research. In this section, value created from each analysed case study as well as some general trends will be presented.

The main value of the Building Data Exchange project is concentrated in the final reports that were produced. The reports are fully searchable, can be filtered and contain data useful for different stakeholders working in the construction industry but also act as an information source to policy makers.

The future City Glasgow project created significant value for its end users as well as project participants. Some of the main outcomes of the project for each beneficiary group are presented below:

- **Glasgow Operations Centre** – the use of geospatial data to enhance process efficiency has led to savings of up to £20 million for the centre since its inception. The centre has also benefited from the technologies that it deployed and gained 'know how' in terms of data analytics, which will be useful in future.

Enhancing process efficiency

- **Businesses** – several businesses reported increased revenue thanks to the city apps that were developed by the Glasgow Operations Centre and partners. The apps were of particular use to SMEs as a way to reduce costs and generate new investments.

Ensuring sustainability

- **Homeowners** – homeowners became more conscious of their energy consumption.
- **Renewable energy experts** – the custom maps produced by the Future City demonstrators could be used as a tool to decide where to install solar panels to maximise their effectiveness.
- **Citizens of Glasgow** – the citizens can enjoy a better city experience, thanks to the development of cycling and pedestrian maps, more effective public transport routes and schedules.

Improving city experience

Similarly to the Future City Glasgow, CityVerve project in Manchester created significant value for different user groups as well as project participants themselves. Given that the CityVerve projects is still ongoing, the list below is due to be expanded as more products are developed within the CityVerve project:

- **Project Partners** – the consortium partners participating in the CityVerve projects are constantly exposed to rapid innovation and are part of a new ecosystem emerging around the idea of a Future City. Thanks to this, they are able to develop and scale their products nationally and potentially internationally in the near future. Thanks to the unique environment in which project partners find themselves, a lot of in-house innovation surrounding geospatial data collection, processing and use is taking place. The project provides an open door to do research and develop an understanding about how new types of users can share and harness geospatial data.

Rapid innovation

- **Citizens of Manchester:** thanks to CityVerve, citizens' experience of the city is constantly improving. Due to the use of internet of things technology, the services citizens receive are constantly improving. Whilst the citizens themselves might not be the direct users of the developed technology, they are direct beneficiaries of services developed that harness the new technology.

Improving city experience

Barriers

Whilst Innovate UK funds a variety of different projects, those involving the use of geospatial data were faced with similar barriers. Table 6 below presents the barriers faced during project implementation and also those preventing the future growth of the project, as perceived by project stakeholders.

Table 6 Barriers identified across Innovate UK initiatives

Barriers to the project implementation	
Category	**Description**
Data standardisation	Obtaining standardised building performance data was an initial barrier to the BIM team. Since the project required data to be collected concerning the building site, its composition, and its structure, the BIM team prepared specific data templates. However, each building performance evaluator filled them out slightly differently. The BIM team realised that the templates should have been prepared from a data analyst perspective, not from that of the building environment analyst, as the data collected was overly descriptive and did not lend itself to analysis easily.
Geospatial data integration	According the Future City Glasgow, the project team faced a challenge working with geospatial data collected from different sources, the quality of the data was not always satisfactory and there were difficulties in relation to data integration due to the use of different data formats. This highlights the need for the Glasgow City Council to invest more in data maintenance infrastructure and to ensure data standardisation.
Silos within public agencies	In the Future City demonstrators, a significant barrier to the sharing of data was the silo mentality of various public agencies collecting and processing data. The barrier was eventually overcome due to a better understanding of the benefits of open data.
Data accessibility	In the initiatives where part of the data was supplied by the private sector, it was not always easy to obtain all of the necessary data. The Building Exchange programme faced challenges in getting construction companies to share bad building performance results, as this might damage their reputation. However, the barrier was overcome thanks to legal agreements between the participating parties in the project.

Barriers to the project implementation	
Category	**Description**
Organisational constraints	All consulted projects identified initial partner collaboration as a barrier which slowed down initial project delivery. Similarly to other case studies, stakeholders stated that it is crucial for partners to develop a strong and direct working relationship, especially for long-term projects. One take away for the CityVerve project was that different actors will need to learn to work together as new technologies continue to emerge and will affect stakeholders working with geospatial data regardless of their size or nature (public or private).
Barriers to future growth	
Category	**Description**
Access to finance	Several Innovate UK initiatives identified funding as a barrier to the future expansion of the programme. Whilst the projects are funded by Innovate UK, due to the ground-breaking nature of the projects, the deliverables and scope of the projects will be subject to change. Hence, project funding needs might increase.
Data licensing	According to Ordnance Survey, the extensive practice of data licensing could become an issue in the future. The existing view of geospatial data as a product should change as companies are increasingly valuing and using raw data to enhance their own products and services. Hence, data licensing could inhibit the reuse of geospatial data.
Data privacy	According to Future City Glasgow, data protectionism remains a problem when collecting data for a specific purpose, as there is a fear that the data might not be used for its intended purpose. It is therefore necessary to encourage a mind-set change concerning the purpose of open data.
Lack of appreciation of open data	A barrier to the growth of Future Cities is the lack of understanding of the value of data among public agencies and companies, as was seen in Future City Glasgow. Stakeholders need to understand that data has an economic value and that it is worth investing in data to become data-driven organisations.
Adaptability to rapid changing geospatial data environment	Ordnance Survey believes that in the near future organisations, governments and companies working with geospatial data will have to rapidly adapt their tools and processes of data capture. Geospatial data capture can be increasingly done by almost anyone. This abundance of data but also the lack of clarity of who owns the data and how it can be obtained, creates a blockage in data analysis. Furthermore, there is a potential for a technical skills gap to occur as new skills are needed to analyse this newly collected geospatial data.

Opportunities

According to the Building Information Modelling team, geospatial data could play a much bigger role than it currently does in building construction and performance monitoring.

Geospatial assets are particularly useful when monitoring a completed project to ensure its sustainability over time. On the other hand, the BIM team also pointed out that there is currently a skills gap in the construction environment. Even if geospatial technology for project monitoring was easy to use, it will tend to be adopted only by the more innovative building companies. Other companies, who are more short-term oriented, would prefer to avoid the cost of purchasing such technology. Encouraging the adoption of geospatial technology was a challenge that the BIM team faced when working with construction companies. In the UK the construction industry is running on relatively low productivity and margins that anything perceived as risky or expensive will not be used.

The BIM team foresees two scenarios for geospatial data to be better incorporated into the construction sector – the supply chain should push the technology upwards, and an ecosystem of informed and innovative clients' needs to be fostered to harness the technology. Government construction is perhaps the best way to adopt the geospatial assets used for building monitoring. Government should put the technology forward (the geospatial assets) as the maintenance and monitoring costs of the buildings or any infrastructure (road, rails, etc.) could be reduced through these technologies.

Another opportunity identified by the BIM team for geospatial data are geospatial underground assets and critical infrastructures. There is still a wide lack of knowledge of what is hidden underground in UK and more broadly in Europe. It is important for any new construction project to have a good understanding of what exists below the ground of their site. This is an acute problem in cities, particularly in older cities where there are many underground assets that are unknown. At the moment, for most new construction projects, the construction team will invest time and resources in surveying what is beneath the ground. It is likely that this information already exists somewhere but nobody holds or owns this information. It would be useful to have a central place for such information. In London, for example, there are multiple sites that have four or five generations of concrete piling beneath them. It is a huge cost for new developers to remove them. Whereas if there was better awareness of how old they are and what they are made of, they could potentially be integrated into new buildings and not destroyed. Hence, production of mapped information about the conditions of the ground and the structure could be very valuable. There potentially is no need to pull them out the ground if they can be reused, but just to know what they are and how deep beneath the ground they are located.

Despite the official closure of the Future City Glasgow project, Glasgow City Council plans to work towards improving public health, energy efficiency, further deployment and the improvement of intelligent street lights and scale projects through its central management systems. The Council also hopes to harness mobile technology to create tools for citizens. The Council will aim to harness geospatial data to implement more effective evidence based policies for the city of Glasgow, especially in light of increased data sharing and cooperation amongst different public agencies.

The opportunities associated with geospatial are vast, and not just in the scope of Future City projects. Geospatial data can be harnessed in different sectors to unlock new views of the world. The easier it is to integrate geospatial with other types of data, the more uses of it can one expect to see. The CityVerve team, now entering into the second phase of the project, will aim to commercialise and standardise their data products, to allow them to be reused by other cities not just in UK but also in Europe.

3.5 Case study 5 – Danish Basic Data programme

The Danish government created the Basic Data programme following the publication of 'Good basic data for everyone – a source of growth and efficiency'[122] (*Gode grunddata til alle – en kilde til vaekst og effektivisering)* in 2012. The programme was introduced by the Ministry of Finance, with the backing of the government and politicians and is financed upfront. The aim of the Basic Data programme is to make basic data the high-quality common foundation for public sector administration, efficiently updated at one place, and used by everyone – including the private sector[123]. The Basic Data programme consists of several sub-programmes, detailed under the 'Good basic data for everyone – a source of growth and efficiency', which complement the political and economic efforts of the Danish government in this domain. The Basic Data programme has been implemented, since 2012, by the Danish Agency for Data Supply and Efficiency[124] in cooperation with Danish national and subnational authorities.

The main objective of the programme is to have all the basic information that public authorities register about citizens, companies, property, buildings, addresses, etc. described using the same standards and available freely for use and reuse by private and public bodies. More precisely, the programme aims to:

- Foster growth in the private sector;
- Enhance efficiency in the public sector;
- Foster more innovation.

Under the programme, all the data available from the Danish registries is collected by the Danish Agency for Data Supply and Efficiency in one place under the term 'Basic data'. All the data is available and distributed via the shared distribution platform of the Agency for Data Supply and Efficiency[125], from where it can safely and easily be (re)used – with respect for personal and sensitive information.

According to official figures, the Danish Basic programme offers several benefits not only for the Danish public sector but for the Danish economy as a whole. It has been estimated, that in municipalities, regional authorities and central government, the Basic Data Programme can deliver economic benefits of around DKK 3.5 billion (equivalent to EUR 50 million) per year[126]. It also encourages new business growth as it gives Danish businesses access to standardised and connected basic data.

Geospatial data ecosystem

The Danish Basic Data programme has defined a very clear, yet highly comprehensive process for the collection, processing and publication of open data in Denmark, as illustrated in Figure 8.[127] The Danish Agency for Data Supply and Efficiency (henceforth, the Agency) is the main agency responsible for the day-

[122] https://www.fm.dk/publikationer/2012/gode-grunddata-til-alle
[123] https://www.digst.dk/~/media/Files/.../Grunddata_UK_web_05102012_Publication.pdf
[124] http://sdfe.dk/
[125] http://datafordeler.dk/
[126] https://www.digst.dk/Servicemenu/English/Digitisation/Basic-Data/Basic-Data-in-brief
[127] https://www.digst.dk/~/media/Files/.../Grunddata_UK_web_05102012_Publication.pdf

to-day management of the Danish Basic Data programme. According to the Agency, Denmark has a long tradition of sharing public sector data in national registers. Approximately 15 of Denmark's registers, including those related to geospatial data, fall under the scope of the Basic Data programme. Hence, they were among the main sources of the geospatial data made public through the programme. The Agency collects the majority of the geospatial data that falls under the programme. It uses several data collection means for this purpose: aerial photography, orthophoto, satellite information, laser scanning, surveying, inputs from administrations regarding administrative changes, such as new road names, receipt of errors and deficiencies via a reporting portal[128]. The Agency has recently began investigating the usage of drones as potential means to collect data from more distant locations such as Greenland and the Faroe islands.

Once the Agency collects geospatial data from the registries, municipalities and through means of its own, it will share the data with the subcontractors who will then digitally process the data. The data is processed according to common data specifications produced by GeoDanmark[129], an association composed of the Danish GeoData Agency[130], Cadastre[131] and Danish municipalities. All the data is stored in a central geospatial database where it is maintained and modelled according to a common data model. From the model database, one can obtain a whole range of different views of the data, including one that is INSPIRE compliant. Hence, this 'data bank' offers its users with a rich, value-added view of the data as Denmark recognises the importance of publishing the '*right kind'* of open data to enable its reuse. Users can access the data, which is made available through the Agency's data platform via OGC standardised web services. Furthermore, recognising the importance of metadata for the private sector, especially for SMEs, the Agency maintains a dedicated geospatial portal to store its metadata, geodata-info.dk, which was established through the implementation of the INSPIRE Directive. The national authorities responsible for the registers are also responsible for ensuring that relevant metadata is supplied to the Agency and made available in the metadata portal. Finally, the Agency has its own portal for publishing data that is collected directly by the agency[132].

The open data is subsequently used predominantly by the other public administration departments and municipalities. Denmark has a dedicated website where users of geospatial data can share their uses of open geospatial data[133]. There are also several private sector users of the data in Denmark. While most private sector organisations use open geospatial data to further complement their already existing products or services, Septima[134] built its entire business based on the data made available through the Danish Basic Data programme. The official launch of the Danish Basic Data programme served as a positive push for the seven creators of Septima as they saw the business potential of such data. Upon the launch of the Danish Basic Data programme, many Danish registries had to be harmonised and standardised across several agencies. Those agencies served as the initial client base of Septima. Septima is a Danish SME, which does consultancy work to help public and private companies better understand and use Danish basic data in

[128] http://sdfe.dk/saadan-arbejder-vi-med-data/indberetning/
[129] http://www.geodanmark.dk/Service/In+English
[130] http://gst.dk/
[131] http://eng.gst.dk/danish-cadastre-office/
[132] www.kortforsyningen
[133] http://brugstedet.dk/eksempler/
[134] http://www.septima.dk/

combination with their own in-house data. Septima also performs Danish basic data enrichment activities to create their own data products. Septima provides the following products or services to its clients[135]:

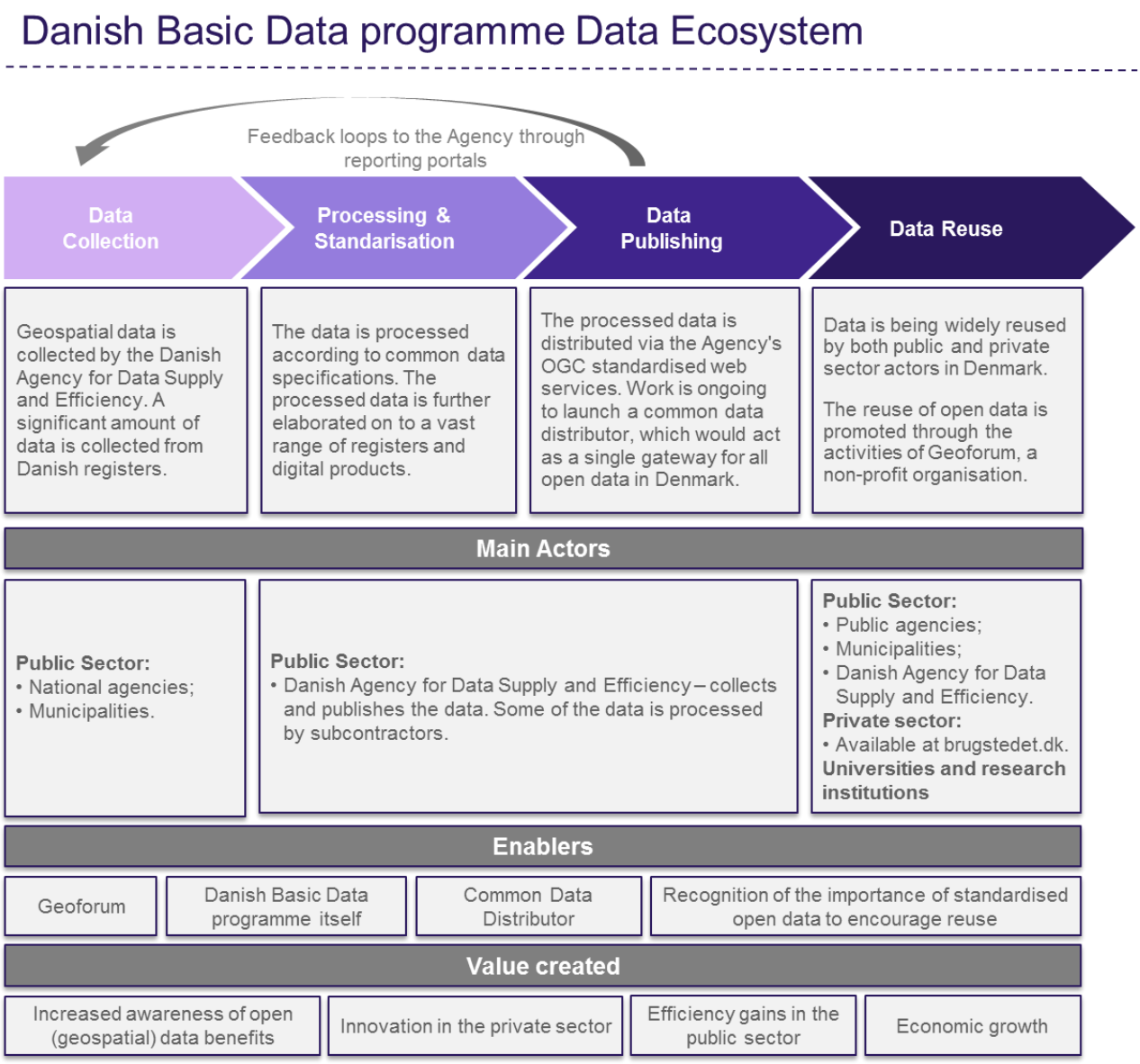
- IT development to support the processing and management of geospatial data;
- Sells SeptimaWidget, a software tool, which is developed in-house[136], allowing users to search for different types of Danish basic data;
- Services based on data obtained from the Danish Basic Data programme or received from clients;
- Routing services such as route calculation and optimisation;
- Interactive mapping tool, which can be integrated in client's websites;
- Helping Danish municipalities set up their own data scripts to support the harvesting of their data;
- Helps Danish municipalities and agencies make their geospatial data INSPIRE compliant.

All services provided by Septima are built on top of the data that is made available through the Basic Data programme. Septima takes the raw data, at the stage of collection, and then standardises it as well as enriching the data in-house. When delivering data to the client, the final data product is either delivered directly through a GiS or is shared via web services. 80% of Septima's client base is composed of public sector bodies. Septima views the Danish Basic Data programme as a major enabler for innovation in Denmark.

Another integral actor in Denmark's geospatial data ecosystem is Geoforum, an NGO working to promote the benefits of geospatial in Denmark and hence facilitate the reuse of open data in the country.[137] Members of Geoforum come from the public, private and education sectors. In 2016, Geoforum had 250 company and 350 personal members. Geoforum plays a reporting role and participates in the coordination activities of the Danish Basic Data programme. While Geoforum does not create any geospatial data services or products, it promotes their usage in Denmark through several dissemination channels, such as their own websites, regular events and conferences and the bi-monthly magazine. Geoforum was one of the key players involved in the introduction of the Web Map Service (WMS) and Web Feature Service (WFS) standards in Denmark, which are now a 'common currency' for geospatial data sharing. Geoforum also actively promotes the benefits and potential of Geospatial data among young people interested in GiS. They have also created a Facebook page 'Young GiS Users', *Unge GiS brugere,* which has over 1000 followers[138].

[136] https://www.septima.dk/widget/index.html
[137] http://geoforum.dk/
[138] https://www.facebook.com/UGISbruger?fref=ts

Figure 8 Danish Basic Data programme data[139] Ecosystem



Given the large scope of the Danish Basic programme, there were several enablers contributing to its overall success:

- **Recognition of the importance of the 'right type' of open data:** the mind-set under which public agencies and municipalities should not just publish any type of open data, but highly standardised and interoperable data was crucial to the success of the programme. While significant resources were required to develop the common data model, as 15 different registers had to be mapped onto it, the recognition of the importance of this process, facilitated the efforts;
- **The Common Data Distributor platform:** the platform, which is currently under development will facilitate the easy access to all open data in Denmark. It will serve as a one-stop-shop for end users searching for open data;

[139] Whilst the Basic Data Programme includes data beyond geospatial, the Figure illustrates the geospatial data ecosystem of the Danish Basic Data Programme to ensure consistency with other ecosystems the study.

- **Geoforum:** the NGO with a mission to facilitate the reuse of the open geospatial data is a crucial element of the geospatial data supply chain in Denmark. It significantly contributes to raising the awareness amongst different groups of end users in Denmark about the existence of open geospatial data, hence enabling its wider reuse;
- **Danish Basic Data programme itself:** given the ecosystem of open geospatial data in Denmark, the Danish Basic Data programme is a crucial facilitator of the opening and sharing of geospatial data.

Value created

Socio-economic value of open geospatial data

According to a study conducted to evaluate the effectiveness of the Danish Basic Data programme, the opening of geospatial data in Denmark had both a production effect and an efficiency effect – it has led to both more growth and innovation, as well as enhanced efficiency and savings in both private and public sector[140]. It has been estimated that the socio-economic value of the open geospatial data in 2016 was DKK 3.5 billion (EUR 500 million), DKK 2.5 billion of which were attributed to the production effect and around DKK 1 billion to the efficiency effect. The efficiency effect stems from time saved experienced by the public sector due to the fact that standardised basic data is now available in one place[141]. The value of geospatial data to the Danish economy was estimated at DKK 1.6 billion (EUR 220 million) in 2012.

Increasing geospatial data awareness

According to the Agency, an important positive effect that one might not be able to measure is the constantly increasing awareness of the value and possibility of using open geospatial data in different sectors. Since the launch of the programme in 2012, increasingly many sectors and companies have begun reusing some aspects of the geospatial data. The increasing awareness of how geospatial can add value to ones' business contributes to the creation of more uses of the data.

Fostering innovation

Septima is one of the several new businesses that emerged thanks to the Danish Basic Data programme. Septima believes that the final data products that they create for their users are an example of innovation as, while the data and the technology that they use is not new, they are delivering a new service to the public and private clients.

One enlightening example of the value of open data was seen when Simon Kokkendorf and Thorbjørn Nielsen of *Geodatastyrelsen*, the Danish Geodata Agency, used the Danish basic data to recreate the entire country of Denmark in a 1:1 scale in the game Minecraft[142]. What has begun as a unique project that has gathered significant media attention, is now being used in schools across Denmark to teach children about the geography of the country.

Barriers

The Danish Basic Data programme comprises many different actors and covers a wide array of open data. Hence, there were and currently still are several barriers that the actors involved in the ecosystem of geospatial data ecosystem in Denmark face, which are summarised in Table 7 below.

[140] http://efkm.dk/aktuelt/nyheder/nyheder-2017/marts-2017/frie-geodata-har-en-vaerdi-paa-3-5-mia-kr/
[141] https://inspire.ec.europa.eu/sites/default/files/presentations/366_pdf_copy_of_presentation.pdf
[142] http://www.minecraftxl.com/denmark-minecraft-map/

Table 7 Barriers identified in the Danish Basic Data programme

Barriers to the project implementation	
Category	**Description**
Geospatial data linkage	There were several difficulties in mapping the geospatial data to the common data model in order to deliver data in the agreed standard and the agreed quality. The resulting common data model was quite complex as it is a single model covering 12 different registers, which contain data collected for different purposes. It was a time and resource consuming process to agree on the semantics and descriptions of the basic data amongst all involved actors.
Access to finance	The opening of the Agency's data induced a reduction in the availability of revenue streams. Prior to the launch of the Basic Data programme, the Agency made its profit mainly by selling geospatial data products, primarily maps. Yet, with the Basic Data programme, all the data is now available freely for reuse. The Agency is now financed by the Ministry of Finance. The Agency had to readapt its working processes in order to be able to constantly provide evidence to the Ministry of Finance on how open data is being used, what value it creates and how different and better quality data is constantly needed.
Silos within public agencies	According to Septima, which works closely with municipalities and public agencies, some agencies initially were not willing to share their data, even if demanded by the Danish Basic Data programme. Agencies were initially worried how the data will be used and there were some concerns that their data might not be 'good enough' for the purposes intended. Yet, this barrier was eventually overcome as more information became available and municipalities as well as agencies got better acquainted with the Danish Basic Data programme.
Barriers to future growth	
Category	**Description**
Data availability	According to Septima, private companies would benefit even more from more varieties of geospatial data being open for reuse through the Danish Basic Data programme. Some data that is related to geospatial data, such as meteorological data is still paid-for. The Agency echoes this argument, stating that a considerable amount of useful data has not yet been made available. A lot of this data contains sensitive information.
Geospatial data integration and linkage	According to Geoforum, some private reuses of open data have reported technical issues regarding the integration and standardisation of geospatial data. More tutorials and help tools would be welcome from the public sector.
Data accessibility	According to the Agency, the main barrier to a wider reuse and application of geospatial data is on the users' side. There is a need to create better user interfaces for both the Agencies' map supply and for the new data distributor platform that is currently being developed. At present, users need to be skilled and knowledgeable about geospatial data to use the web services of the Danish Basic Data programme. Users should be invited 'to the room' so that data service providers can learn what works best for different user groups.
Lack of communication with the private sector	The creators of the Danish Basic Data programme need to communicate more clearly with the private sector in terms of what sort of geospatial data they are planning to open and how it will be processed. This would allow the private sector to form the right expectation in terms of what software they will require and what services they might be able to create from the open data. The current lack of clarity, and hence profit prospects for private firms, might be seen as a deterrent to growth.

All different actors involved the in Danish Basic Data programme appear to agree on one point: easier access to the open geospatial data should be ensured, not only the data made available by the programme but also the data from other governments in Europe. While the data is open for anyone's reuse, the web services are quite difficult to grasp for users who have less knowledge and experience working with geospatial data. Namely, those users that do not work primarily with geospatial data but would like to integrate some aspects of geospatial data in their projects. If in the end, the users of the open data have to pay somebody to process and combine the open data or spend a lot of time and resources doing this, it will defeat the purpose of the Basic Data programme.

Opportunities

There are several opportunities associated with the expanded use of geospatial data in Denmark. First of all, the Agency of Data Supply and Efficiency together with several subcontractors are working on launching a new centralised data distributor platform, which would enable better access to all of the open data in Denmark. It is expected that the new data distributor will have better user interfaces, and 'ready-to-use' data packages targeted to specific user groups. This should made the access and reuse of data in a wider range of domains possible.

An even closer collaboration with the private sector is foreseen. An improved understanding of the needs of private users of open data and why they occasionally prefer to use other types of data, would be of help in the provision of better quality data.

According to Geoforum, a key opportunity brought by geospatial data lies in the possibility of combining it with different types of data to enable better data analysis, and new product creation. In order to allow for an easier integration of geospatial data with other types of data, it is crucial to make the data more easy to use by a wider range of user groups. One of the domains currently being explored by the Danish Ministry of Energy Utilities and Climate is climate change and climate change adaptation. A new environmental data portal has been launched, showing which basic data from the programme is being used for climate change actions[143]. It is hoped that geospatial data will be more widely used to tackle climate change in the years to come.

Finally, the Danish Agency for Data Supply and Efficiency hopes to explore ways to harness the new technology – business intelligence or analytics and use it for open data.

[143] http://en.klimatilpasning.dk/

3.6 Trial case study – EULF Transportation Pilot

The European Union Location Framework (EULF)[144] transportation pilot[145] aimed at improving the flow of up-to-date road safety data between road authorities and private sector map providers in Sweden and Norway. The pilot supported concretely the needs of businesses and citizens, addressing the policy requirements of the Intelligent Transport Systems (ITS) Directive[146], which envisages the integration of accurate public road data in digital maps. The pilot also drew from the provisions of the INSPIRE Directive through the usage of authoritative and seamless INSPIRE compliant data. Furthermore, the pilot also tested whether linear referencing and exchange standards (the TN-ITS protocol[147]) are more efficient in supporting geospatial data exchange than other types of standards.

The EULF transportation pilot was preceded by another initiative, ROSATTE[148], which developed some specifications for data exchange between road public authorities and private map providers in the context of road safety attributes. In the context of the Intelligent Transportation Systems Directive, ROSATTE paved the way for the exchange of data between public authorities and private map providers. It was funded by DG MOVE, but was not implemented by the Commission. Through ROSATTE, a network of cooperating companies and institutions was established. TN-ITS was then created to serve as a recognised body dealing with data exchanges between road public authorities and private map providers. The Commission and the other stakeholders decided to put in place a more concrete pilot to further develop the specifications of the project and to apply them to real cases. Hence, the EULF transportation pilot was launched.

The EULF transportation pilot involved several partners, including the JRC-led EULF project, ERTICO (a public/private sector European mobility solutions partnership)[149], Norwegian and Swedish Road Authorities, TomTom[150] and HERE[151] (commercial navigation system providers), as well as Norwegian and Swedish Mapping Agencies (partners of the European Location Framework).

Geospatial data ecosystem

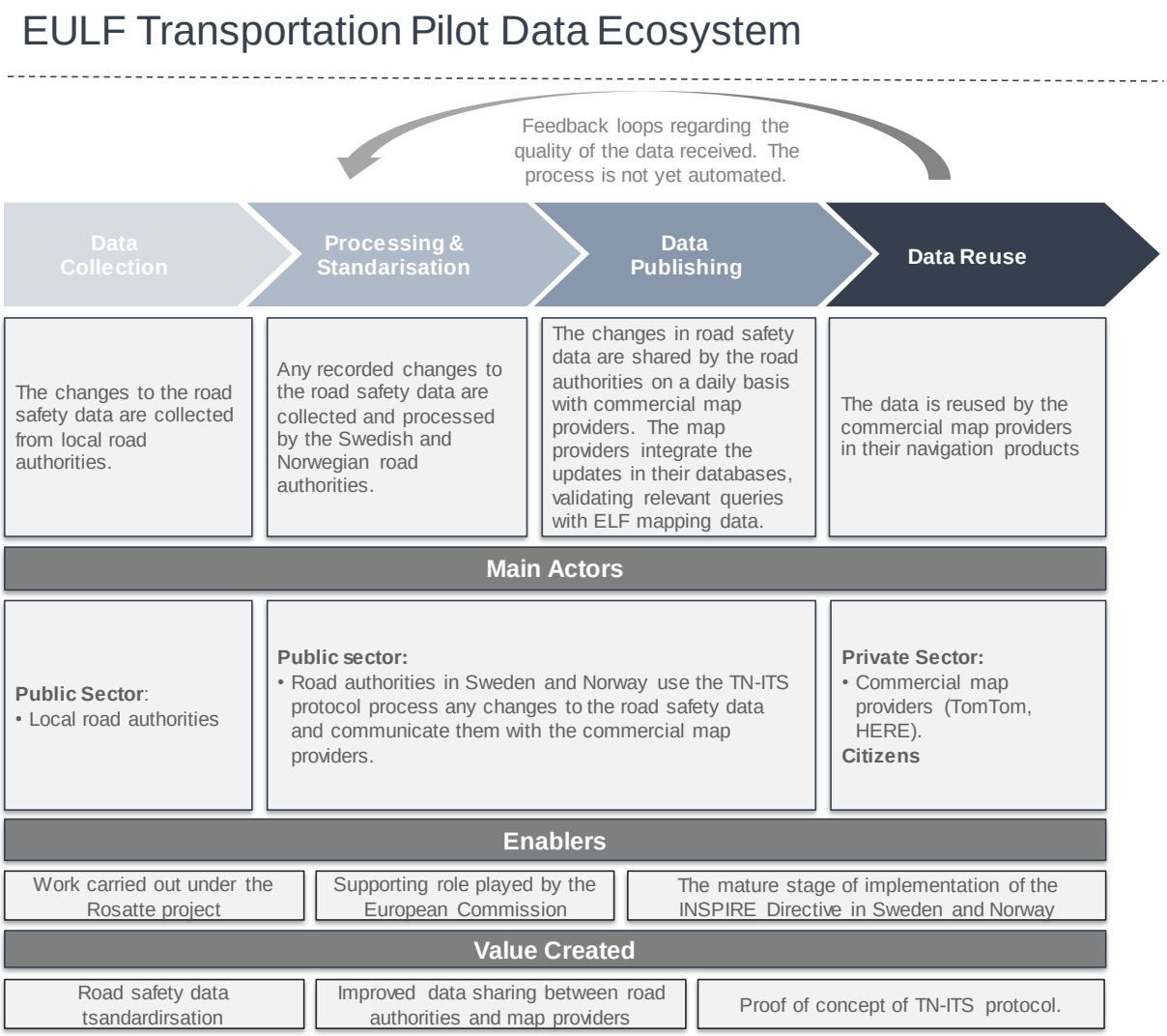
The EULF Transportation pilot involved several stakeholders in its geospatial data ecosystem as the pilot covered two countries and is an example of collaboration between public authorities and private mapping providers. The pilot is a successful example of how the adoption of the TN-ITS protocol helps improve the flow of data between road authorities and private map providers to ensure a timely update of data.

The main data owners as well as data providers in the pilot were the Swedish and Norwegian road authorities, who provided data related to road safety attributes, such as speed limits and their locations across Norway

[144] https://joinup.ec.europa.eu/community/eulf/home
[145] https://joinup.ec.europa.eu/community/eulf/og_page/eulf-transportation-pilot
[146] Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport, OJ L 207, 6.8.2010.
[147] http://tn-its.eu/about/
[148] http://tn-its.eu/rosatte-project/
[149] http://ertico.com/vision-and-mission/
[150] https://www.tomtom.com/fr_fr/
[151] https://here.com/en

and Sweden. The data, and more importantly the updates of the data, such as any changes to speed limits or their location, were consumed by the private sector map providers TomTom and HERE to update their maps and applications and ensure the safety of drivers on Norwegian and Swedish roads. The European Commission, who supported the project, did not provide any data but facilitated the process of data exchange and adoption of the TN-ITS protocol, including testing whether the linear referencing[152] of geospatial data is more effective in identifying safety attribute corridors compared to other types of location referencing. Figure 9 below presents the summary of the data exchange process in the EULF Transportation Pilot.

Figure 9 EULF Transportation Pilot Data Ecosystem



Value Created

The EULF Transportation pilot has proven to be successful and has created significant value to the main stakeholders involved in the pilot, namely the road authorities and private mapping agencies.

[152] https://inspire.ec.europa.eu/glossary/LinearReferencing

Firstly, the pilot successfully established an up-to date flow of road safety data between road authorities and commercial map providers in Norway and Sweden (TomTom and HERE). The EULF transportation pilot revealed several benefits to using the TN-ITS protocol for the exchange of updates to the data. The piloted process reduced the speed limit error rates from 25% to 7%. Furthermore, thanks to the use of the TN-ITS protocol, which only involves changes to the data, road authorities switched from quarterly to daily updates to map providers. Hence, this helped ensure a continuous flow of data from road authorities in the two countries to the companies TomTom and HERE, and finally to the end users of their applications. The map providers were also able to improve accuracy using linear referencing and validate queries through access to data from ELF. The ultimate beneficiaries of the updated frequency of data exchange were consumers of TomTom and HERE's applications. Citizens and businesses in both countries benefit from having more up-to-date road safety data. There is now also the possibility for the road authorities to receive feedback from the private sector map providers on any inconsistencies they find. The road authorities also improved the efficiency of their data update process as they could now rely on more automated data updates.

Improved geospatial data sharing

The map providers, in addition to receiving more accurate data more frequently, also benefited from working with the same standards in two countries, which significantly simplified the data update process. Norway and Sweden now have the same road data licensing and use the same standards to describe or exchange data.[153]

Standardisation

Finally, the European Commission has benefited from running this pilot as it successfully demonstrated the benefits of the TN-ITS protocol and served as a proof-of concept. Due to the success of the pilot, DG MOVE has decided to expand the scope of the countries covered by the pilot. There is now a project in five countries under the Connecting Europe Facility and a plan to expand to further countries in the near future. The EULF Transportation pilot also demonstrated that the INSPIRE Directive can serve as a valid framework for harmonising the geospatial representation of the transportation networks in maps across Europe.[154]

Proof of concept of TN-ITS protocol

Barriers

Whilst the EULF Transportation pilot proved to be successful, there were several barriers to its implementation, which are listed in Table 8 below. Overall, the results of the EULF transportation pilot revealed the need to put in place effective data sharing and collaboration agreements between different parties (both public and private), alongside a common location referencing method to facilitate road data exchange, as well as improving data collection processes for the public road authorities to supply up-to-date information to the private sector.

Table 8 Barriers identified in the EULF Transportation pilot

Barriers to the project implementation	
Category	Description
Organisational constraints	It was challenging at the onset of the pilot to have the actors working together and to agree the ground rules for cooperation. The organisation and launch of the pilot took project partners one year. It is always a complex process to get collaboration in place.
Access to finance	If there would have been project funding, it could have helped to solve the organisational barrier mentioned above. All of the project partners, private and public were participating in the pilot on a voluntary basis.

[153] https://joinup.ec.europa.eu/sites/default/files/ckeditor_files/files/EULF%20Factsheet%20Transportation%20Pilot%20v1%20final.pdf
[154] https://joinup.ec.europa.eu/sites/default/files/ckeditor_files/files/17-01866_%20poster%20-%20portrait%20-%20v3.pdf

Legal constraints	There were some concerns by the private map providers regarding their property rights. There was some caution in the beginning of the pilot regarding sitting together in a room and discussing it in front of each other. Several one to one calls, as opposed to group calls, had to be organised for this reason.
Barriers to future growth	
Category	**Description**
Multitude of standards	The EULF transportation pilot introduced another way of standardising road safety data shared between road authorities and private sector map providers. The difficulty that might arise in the future will be ensuring that all Member States adopt the same standards, from many currently available. There might be a challenge in maintaining the cooperation as regards standards, and also between countries operating to those standards.

According to JRC, one lesson learnt from the pilot is that it is very important to obtain agreements between all parties as early as possible, in order to avoid organisational constrains. It is also very important to have a 'good story to tell' about the project in order to facilitate partner participation and cooperation.

It is also absolutely crucial to ensure that there is a win-win for all the parties involved, especially if geospatial data is shared between public and private organisations. It is important that the public organisations benefit from increased efficiencies or better feedback loops regarding the data they provide, and that private organisations see a clear benefit in order to overcome their commercial sensitivity.

Finally, in order to secure the sustainability of the pilot, it is important to ensure that public sector bodies adapt their business processes along with the changing models of data exchange. Regional and local levels must make sure they provide up-to-date and high quality road safety information to the national level so that this data can be shared with private sector map providers.

Opportunities

Given the fruitful results of the pilot, there is an ongoing CEF project to extend the application of the TN-ITS protocol to five more countries and a plan to involve other countries beyond that. These new pilots also plan to analyse the possibility of automatic feedback loops from private sector map developers to road authorities and identify the potential barriers in this area. The growth of the pilot in future would help private map providers move from fragmented national processes of data updates to more standardised processes across Europe.

It is also important to extend the application of the TN-ITS protocol to other, perhaps smaller or more local, private sector map providers, not only TomTom and HARE. In order to ensure the sustainability and long term application of the TN-ITS protocol, it is important to involve smaller map providers and local road authorities.

4. Conclusions

This chapter presents the conclusions of the study based on the findings from the case studies, the feedback collected during the INSPIRE conference 2017[155] and additional data collected through desk research. The conclusions are presented as follows:

- Two sections on the **geospatial data ecosystem** and the **value created from the use of geospatial data** to address **RQ1 -** How and in what context do public and private organisations create value from geospatial data and the delivery of geospatial data based products and services?
- A section on the **main actors involved in the geospatial data ecosystem** addressing **RQ2 -** Who are the main actors involved in the processes of creating value from geospatial data and the delivery of geospatial data based products and services?
- A section on the **identified opportunities associated with reuse of geospatial data** addressing **RQ3 -** What are the main opportunities that can be found through a more extensive use of geospatial data and the delivery of geospatial data based products and services?
- A section on **identified barriers to the reuse of geospatial data** addressing **RQ4 -** What are the main barriers that limit the access and reuse of geospatial information, held either by a public or private organisation, by potential users?

Overall, some of the conclusions confirm and complement the findings of similar studies. In particular, the conclusions presented below strongly support the recommendations presented in the EULF Blueprint[156], the smeSpire Final Report[157] and confirm the barriers identified in EU Communication on Building a European Economy[158]. The conclusions of the study can also be used as a source of information for the review of the PSI Directive, as they have a strong emphasis on the need to share geospatial data in user centric ways.

Geospatial data ecosystem

This section describes the context in which public and private organisations create value from open geospatial data and use geospatial data to deliver products and services.

The analysis of the five case studies and the EULF Transportation pilot reveals that there are three main ways in which geospatial data is shared and used:

- **Through governmental geospatial data or open data portals**. The Danish Basic Data programme is an example of a government initiative that facilitates the standardisation, opening up and reuse of geospatial data. In Denmark, geospatial data is collected from various public agencies and national registries, processed according to a common data model and made available to users through a geoportal belonging to the Danish Agency of Data Supply and Efficiency.

[155] https://inspire.ec.europa.eu/sites/default/files/presentations/elise_new_directions_workshop_agenda_v1-0.pdf
[156] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC104177/jrc104177_eulf%20blueprint%20v1%20final%20pubsy%20fp.pdf
[157] http://www.smespire.eu/wp-content/uploads/downloads/2014/03/D1.3_FinalReport_1.0.pdf
[158] https://ec.europa.eu/digital-single-market/en/news/communication-building-european-data-economy

- **Through digital platforms**[159]. The data collection and exchange that took place in the FOODIE project is an example of a digital platform where different actors can come together to provide and reuse data. The FOODIE platform offers several functionalities to its end users – it not only has the geoportal, data dashboard, farmers' tools and training materials, it also contains a marketplace, where registered users can upload and sell their own data products and services.[160] At the moment the FOODIE platform is mainly used by the participants to the project's pilots.
- **Through integration with and linking to other data types to facilitate innovation**. Future City initiatives are an example of the integration of several data types with geospatial data. In both the Future City Glasgow and Manchester CityVerve projects, geospatial data is combined with data such as building construction data, meteorological data, economic data (such as fuel prices), citizen data (heat maps of where city visitors spend most time). As a result, geospatial data, while not directly reused by the citizens and other users, acts as an underlying component of the final products and services created. By combining geospatial data with other types of data, services and products can be created in numerous domains, going beyond purely geospatial products and services.

It must be noted that the above mentioned are not mutually exclusive, as platforms can also contain data from more than of one type. The distinction is made for the sake of clarity, as each way of sharing geospatial data differs in the level of complexity.

Main actors involved in the geospatial data ecosystem

The identified actors in the geospatial data ecosystem can be clustered into four main categories: **data providers**, **data processors**, **publishers**, and **end-users**. Figure 10 summarises the main actors involved in each stage of the data sharing.

Regarding **data collection**, most public bodies working with geospatial data, such as cadastres, road authorities or agricultural agencies, act as geospatial data providers as seen in the **PDOK**, **Danish Basic Data programme**, **Transportation Pilot** and the **Portugal-Spain Pilot** case studies. However, this does not mean that private actors are not active in sharing their own geospatial data for product and service creation. The FOODIE project is a good example of private actors sharing their data with the geospatial data experts to receive ready-to-use data products and create value for farmers from improved farm management and the reduction of transportation costs. The Transportation pilot also involves feedback from map providers to public authorities.

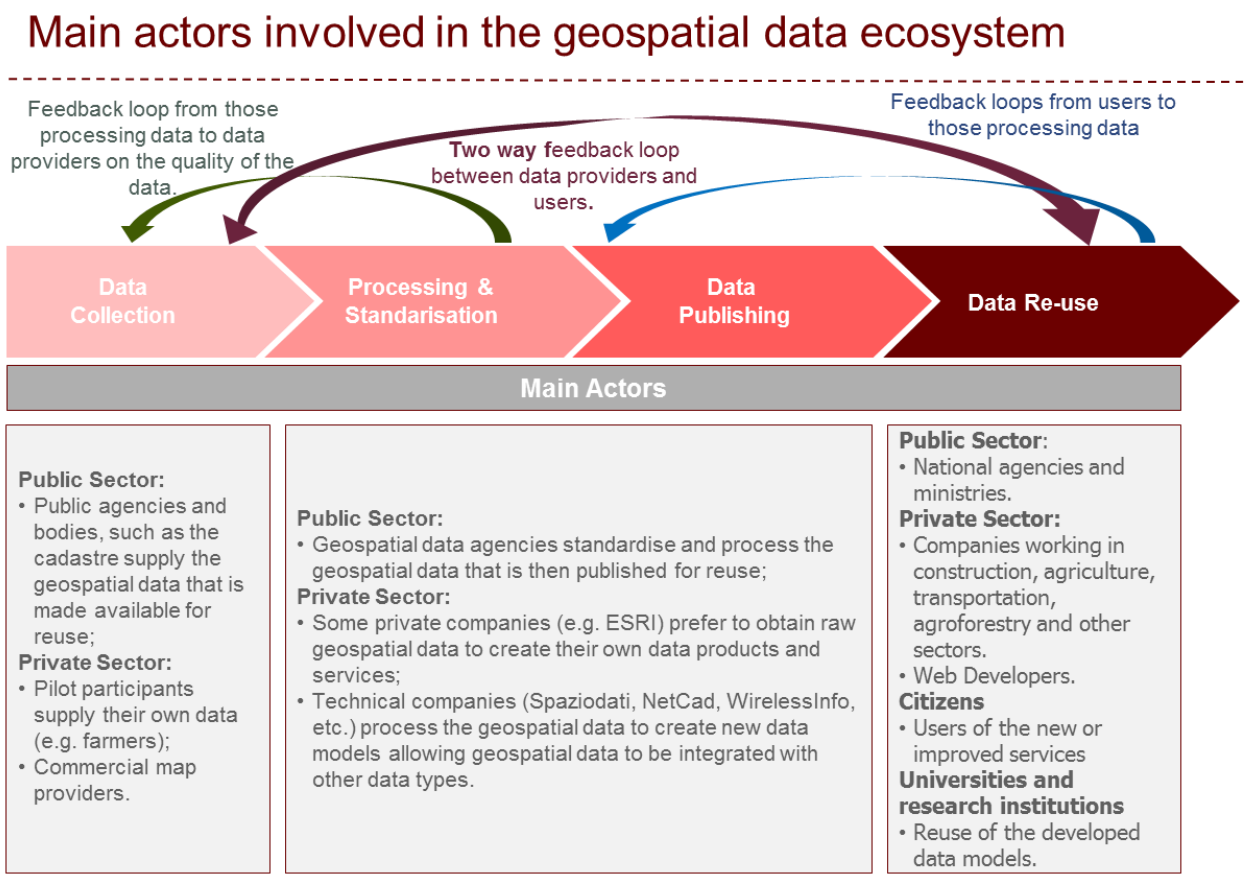
Both public and private actors are involved in the stages of **data processing and publication**. In the case of government geoportals, governmental data scientists often perform the data processing and standardisation in-house. Yet, in the Netherlands, there are private companies (e.g. ESRI) preferring to obtain raw geospatial data and process it themselves to create bespoke geospatial data products and services, instead of using the standardised data made available through government portals. Every so often, the data products and services are themselves sold back to the public authorities in the form of improved software, interactive maps or standardised data. Semantic web companies are another important player in the data processing and data

[159] For the purposes of the study, a digital platform is defines as a business-driven framework that allows a community of partners, providers and customers to share and enhance digital processes and capabilities, or to extend them for business benefit. This framework allows for combinations of business models, leadership, talent, delivery and IT infrastructure platforms that power digital business ecosystems.
[160] https://www.foodie-cloud.org/

publishing as they use their expertise to model the data according to project needs and publish it on project platforms or portals. Finally, the widest range of actors is identified in the **data reuse** stage. Both public and private sector actors reuse the published data. Additionally, universities and research institutions are active users of created data models and citizens benefit from data products such as maps and applications.

Regardless of the context in which the geospatial data is shared and the actors involved, **common feedback loops** between data collectors, processors, publishers and users can be identified as shown in Figure 10. The most common feedback loop identified within the case studies is that **between data users and data processors**. In the case of PDOK, there is a help desk where users of geospatial data can report back the issues they encounter while navigating the portal. PDOK is currently planning to expand the help desk functionality. Another common feedback loop is **between data processors and data providers**. Those processing and standardising the data report back to data providers on the quality of the data. This feedback loop was most evident in the **PDOK**, **Portugal-Spain Pilot**, and **Building Data Exchange Programme** case studies. A final identified feedback loop is **between data users and data providers**, either in terms of new data that providers collect from the end users of products and services or feedback on the quality of the data products, as can be seen in both the **Foodie Project** and the **Future City initiatives**.

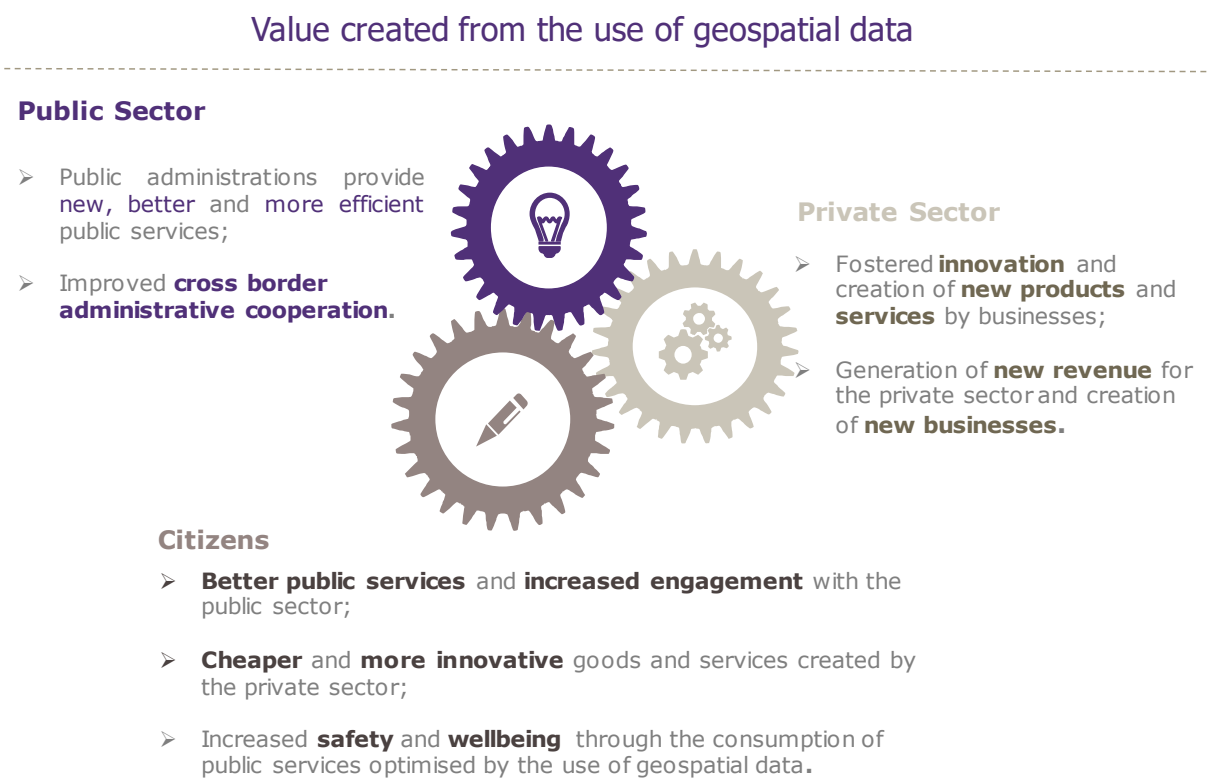
Figure 10 Main actors involved in the geospatial data ecosystem



Value created from the use of geospatial data

This section presents the main findings relating to the value created from the use of the geospatial data by three different user groups – the **public sector**, the **private sector** and **citizens**[161]. Figure 11 below summarises the value created from the use of geospatial data in the analysed case studies for each of the user groups.

Figure 11 Value created from the use of geospatial data



The **value created from the use of geospatial data products and services by the public sector** is, to a great extent, linked to the increased public services delivery efficiency. The use of geospatial data enables the public sector to provide new, better and more efficient public services. For example, thanks to the Future City Glasgow and Manchester CityVerve projects, citizens of both cities can enjoy more reliable and efficient public transportation. Additionally, Glaswegians could now use their interactive maps detailing available public services in their area. Furthermore, as illustrated through the Portugal-Spain pilot, making standardised geospatial data available in one central platform helped improve cross border administrative cooperation between the participating countries, as they could now easily access the useful data. Thanks to governmental data portals that collect, process and standardise geospatial data, the process of sharing and using geospatial data amongst public agencies and ministries is improved. The representatives of both Danish Basic Data programme and PDOK cited the efficiency gains as one of the most important benefits of standardising and collecting geospatial data in one location.

[161] The value created for citizens, whilst not the initial focus of the study, can nevertheless be highlighted due to the positive spill-over effected created through the use of geospatial data by public and private sector actors.

For the **private sector**, it was observed that the **value created by the use of geospatial data** depends on the extent of access to geospatial data made available by public administrations**. The opening up of geospatial data enables businesses to innovate and create new geospatial data based products and consequently to generate new revenue and create new businesses**. As the public sector makes more geospatial data accessible (sometimes for free) and facilitates its use (e.g. is standardisation, interfaces, geoportals and platforms), businesses are able to create geospatial data products and services with reduced investment and generate new revenue using the data. GeoNext, an SME in the Netherlands, is an example of a company creating additional revenue from data opened up by the public sector. GeoNext claims that, thanks to the data made available by PDOK, it makes an additional revenue of up to EUR 100k each year. GeoNext provides 3D maps of Dutch cities using PDOK's AHN[162] (Netherland's height models) data sets. Another example of new business creation from the use of geospatial data (including government data) is Septima, a Danish SME. Septima was created based on the possibility of using geospatial data (and other government data) made open through the Danish Basic Data programme.

Furthermore, the **private sector creates value from geospatial data by integrating it into their business processes**, to either improve their existing or create entirely new services and products for their clients. As illustrated by FOODIE and Future City initiatives, open geospatial data acts as a significant catalyst to innovation in different sectors, ranging from agriculture to transportation and urban planning. During the Czech pilot of the Foodie project, data collected from farm machinery was combined with estimates of the yield potential of farms (based on the existing crop, meteorological and open geospatial data) to help farmers optimise their use of pesticides and estimate crop yields in the following years.

Finally, citizens are the ultimate recipients, and hence beneficiaries, of services and products optimised by the use of geospatial data. Citizens benefit from better and more efficient public services created using geospatial data. To illustrate this, Septima, working together with the Danish Tax Authority, created a customisable map detailing tax collection activities across Denmark. The citizens of Glasgow and Manchester benefited from increased safety levels through the introduction of intelligent street lightning, optimised traffic lights and the creation of customisable cycling routes in the city, to name a few. Geospatial data can also help public administrations increase citizen engagement, Glasgow City Council used applications and maps to allow citizens to contribute to data collection processes whilst Septima Wizard is a tool that allows public agencies to integrate an interactive map on their website, allowing them to collect direct input from citizens. Thanks to geospatial data, citizens also benefit from cheaper and more innovative goods. The participants of the FOODIE project, through the geospatial data collected from sensors, optimised truck transportation routes and reduced transportation costs by 5-10%.

In addition to the above mentioned value creation stemming from the use of geospatial data for product and service creation, there are several more case study-specific examples of how harnessing geospatial data can add value to one's project. For example, harnessing geospatial data helped improve overall farm management processes. Similarly, Future City demonstrators created significant value to the citizens of both Glasgow and Manchester. Citizens benefited from interactive energy consumption maps, which allowed them to compare their energy consumption to that of their neighbours, and thanks to maps indicating where solar panels would be best placed, renewable energy companies could plan their investments better. Finally,

[162] http://inspire.ec.europa.eu/SDICS/ahn

citizens using commercial mapping applications were the ultimate beneficiaries of the EULF transportation pilot, as they received more up-to-date road safety data.

Identified barriers to the reuse of geospatial data

The section presents the main barriers that limit the access and the reuse of geospatial data held either by a public or private organisation. The summary of the barriers limiting the use of geospatial data for product and service creation is presented in two parts – identified barriers to project implementation and barriers to the expanded application of geospatial data. The former focuses on the identified barriers that project teams encountered when working with geospatial data. The latter sheds light on the identified barriers to the further reuse of geospatial data.

Barriers to project implementation

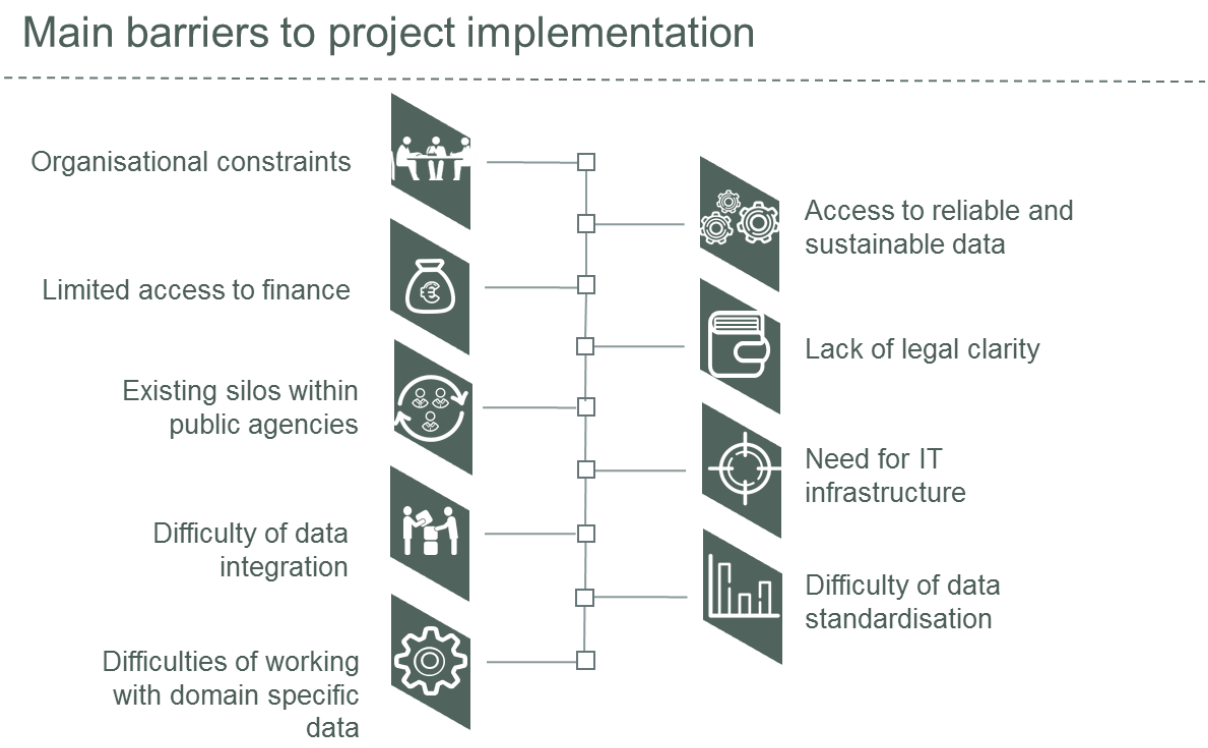
Figure 12 below lists the main identified barriers to project implementation. Case study analysis revealed that the most common barriers to project implementation and working with geospatial are the following:

- **Difficulties of cooperation** (e.g. organisational constraints,) is one of the most common barriers faced by project teams. The barrier mainly stems from the fact that most projects using geospatial data involved several actors with different skill sets and from different sectors.
- **Access to reliable and sustainable data in the right format** is amongst the most common challenges faced by project teams aiming to collect data from various sources. The data is either not published in the right format or it is not clear whether the data will continue to be open in the future. These concerns were shared by SMEs working with geospatial data both in Denmark and the Netherlands.
- Limited **access to finance** is a barrier strongly linked to projects that are exposed to a lot of innovation and are financed upfront, such as the Future City initiatives. As project teams develop new data products and services, the scope of the projects may also change. Yet, the available budget imposes a limit to how much the project can deviate from its original scope.
- **Lack of legal clarity** further complicates the process of data access, especially in projects where data from private individuals or businesses is used. In the Portugal-Spain Pilot and the Future City Glasgow project, organisations responsible for the data collection encountered public agencies, which, even when required by law, appear to be reluctant to share their data as they are uncertain about the data's future use. In the case of Manchester's City Verve as well as the Portugal-Spain Pilot, the legal concerns of project partners where an initial barrier to project implementation, usually delaying the start of the project.
- **Existing silos within public agencies** contribute to the difficulty to access necessary geospatial data. This barrier was faced by project teams in the Glasgow Future City initiative and the Portugal Spain Pilot where some public agencies were reluctant to share the required geospatial data.
- **The need for extensive IT infrastructure** further complicates the process of data standardisation as large amounts of data need to be stored and processed. This is a particular challenge for private sector organisations. The core aspect of the FOODIE project, namely, the creation of a digital

platform on the cloud, was also one of its challenges. One of the reasons for PSNC's[163] participation to the project was the fact that it could provide the necessary infrastructure for the platform's deployment on the cloud.

- **Difficulty of integrating and linking geospatial data sets with other data types** is a significant barrier slowing project implementation. In the instance of the Portugal-Spain pilot, W3C claimed that the semantic web and geospatial data 'spoke two different languages' and that common vocabularies and data models needed to be created to facilitate data integration, linking and publication on the web.
- **Difficulty of data standardisation** can be seen in how government bodies in charge of developing governmental data portals, such as the Danish Agency for Data Supply and Efficiency, collect data from different sources, which then need to be transformed into a common data model. Standardising data from multiple registries requires significant resources and can result in delays to the project schedule, as was the case for the Danish Basic Data programme.
- **Difficulties of working with domain specific data:** this barrier holds true for projects in which very specific types of geospatial data are used, namely in the FOODIE and Portugal-Spain pilot. Both pilots initially used and then deviated from the INSPIRE compliant data model to create something more specific to their domain.

Figure 12 Main barriers to project implementation



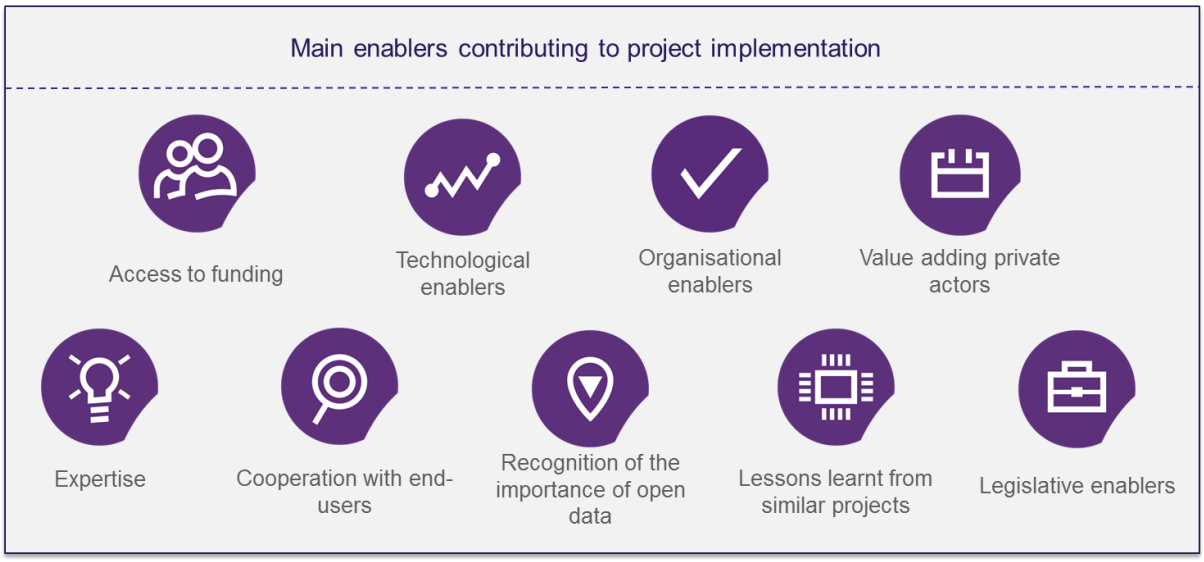
Most of the abovementioned barriers were successfully overcome by project teams within the analysed case studies. Several enablers contributing to project implementation can be identified. The identified enablers are

[163] http://www.man.poznan.pl/online/en/

summarised in Figure 13 below. Despite financial constraint being the main barrier to project implementation, **project funding** is also cited most frequently as an enabler to project implementation. Neither the Portugal-Spain pilot, nor the FOODIE project or the Future City initiatives would have taken place without government or European Commission funding. Similarly, having **access to the right technologies** and **a clear organisation** of the project, significantly contributes to the smoothness of project execution. Complementarity of partner skills and a clear division of roles and responsibilities helps to speed up project implementation. Both PDOK and the Danish Basic Data programme benefit from the **added value generated by private actors** who help increase the reuse of open geospatial data. Geoforum, for example, is a non-profit organisation dedicated to the promotion of geospatial data in Denmark. Furthermore, the **expertise** and specialisation of project partners as well as lessons learnt from previous similar projects served as important factors ensuring smooth project delivery.

The FOODIE project is an example of another important enabler, namely the **close cooperation with end users**. Pilots of the FOODIE project were successful largely due to the fact that farmers were involved in most stages of product development. Furthermore, whilst silos within public agencies act as a barrier to data access, both the Danish Basic Data programme and Future City Glasgow overcame this barrier thanks to the **mutual recognition of the importance of opening up data from all parts**. Without this recognition, it would be more difficult to encourage project participants to share their data. **Lessons learnt from similar projects**, like in the Future City Initiatives (namely, Future City Glasgow's lessons learnt fed into Manchester CityVerve project), help to ensure project success. In addition to the recognition of the importance of open data, a comprehensive **Legal understanding** is another important enabler that facilitates the opening up of data.

Figure 13 Main enablers facilitating project implementation



Barriers to expanded application of geospatial data

In addition to the barriers faced by project partners when executing their initiatives, multiple barriers to the expanded application of geospatial data for product and service creation can be identified. The main identified barriers to the future use of geospatial data are data accessibility, difficulty of geospatial data integration and linking, and the sustainability of the business model. The latter is a particular challenge to projects that are still in the pilot phase, given that project scale up is a complex and risky process.

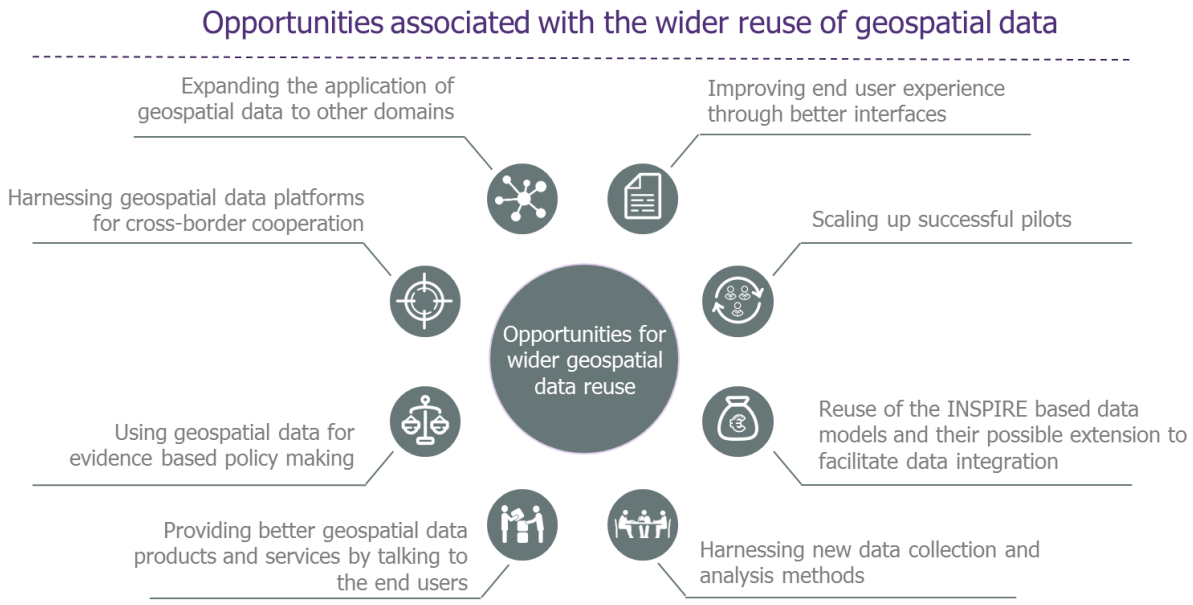
The remaining barriers to the sharing and reuse of data can be grouped into those faced by public bodies and those faced by private actors. Competitor sensitivity is a barrier increasingly faced by governmental geoportals as they seek to expand their services. As governmental geoportals add more free functionalities, they are putting private sector firms providing the same service at cost in a disadvantaged position. The lack of platform and portal visibility as well as a lack of awareness about the available geospatial data services is an additional barrier to the expanded reuse of open geospatial data for product and service development. The frequently slow feedback loops between geospatial data users and providers further slowdown the geospatial data reuse processes. There can also be a lack of communication between the open geospatial data providers and the private sector inhibiting the publication of open geospatial data. The private sector would benefit from knowing what sort of data the government is planning to publish and in which format. Such communication would be equally beneficial for public sector actors, as they could better understand the private sector's needs.

Private sector actors face several challenges when reusing open geospatial data for product and service creation. Data licensing and data privacy concerns prevent the private sector from accessing the necessary geospatial data for their business development. Furthermore, the multitude of standards across EU Member States and the complexity of the INSPIRE Directive prevent the harmonised access to necessary geospatial data and further complicate the process of geospatial data integration, linking and standardisation. Finally, given the rapid innovation taking around data collection and data processing methods, as illustrated through the Future City initiatives, the lack of adaptability to a rapidly changing geospatial data environment and failure to learning how to harness the emerging technologies is posed to be another barrier to the wider reuse of geospatial data.

Identified opportunities associated with the reuse of geospatial data

The main opportunities associated with a wider reuse of geospatial data for product and service development can be summarised in Figure 14 below.

Figure 14 Opportunities associated with reuse of geospatial data



The greatest opportunity associated with the wider **reuse of geospatial data is the potential to expand its usage to multiple domains**, such as agriculture, healthcare, environment and public safety, amongst others. Similarly, if **INSPIRE specifications based data models** and their extensions are used for the easier integration and linking of geospatial data with other data types, new data products and services could be created more effectively.

Agencies responsible for sharing open data also see an opportunity to ensure wider geospatial data reuse through **improved user experience**. More specifically, they are planning to improve their feedback loops and provide data through APIs, simplifying data access and reuse. Data publishers also see a big potential **in harnessing new data collection and processing methods**, such as image recognition and deep learning to process the necessary data faster. This would help to make even more data available and would reduce the resources required to collect and process data.

While sustainability of the business model is one of the barriers to further geospatial data reuse, platform and project scale up are an opportunity identified in several case studies, such as the Future City Initiatives and the FOODIE Project. **When a pilot is successful, project teams can see an opportunity to scale up their initiatives** and spread them across borders, allowing more end users to benefit from their services and products. Due to successful implementation and expansion of pilots, there can be vast opportunities to begin using geospatial data based products and services for **evidence-based policy making**. To illustrate this, local city councils could use the products created and data collected through the Future City initiatives to create better policies for their citizens. Similarly, if geospatial data infrastructures like the one in the Portugal-Spain Smart Open Data pilot move beyond their pilot phase, they could be harnessed to **improve cross border administrative cooperation** between national authorities in various domains.

Finally, another potential future opportunity for geospatial data use for product and service creation is the **establishment of cooperation between data scientists and end users**. Digital platforms and similar collaborative spaces could help to facilitate this process and create more tailored and better-targeted geospatial data products and services for end users.

5. Recommendations

This section presents the recommendations that can be put forward based on the case studies analysed in the study. The recommendations also take into account the feedback collected from the 'Workshop on Conclusions and Recommendations' of the study held in November 2017 with experts in INSPIRE and the geospatial domain from JRC.

The recommendations of this study are coherent with the Digital Single Market (DSM) Strategy for Europe[164] and especially with the third pillar, 'Economy and Society'[165]. The third pillar of the DSM focuses on the need to implement standards and ensure interoperability in the key areas of the European market, as well as addressing barriers in the European Data Economy. The study recommendations are designed to facilitate a better sharing and re-use of geospatial data and highlight the need for further work on its standardisation and interoperability. Furthermore, t**he recommendations should also be seen in light of the 'Tallinn Declaration on eGovernment'[166], which marks a new political commitment from Member States to implement the main eGovernment principles[167].** In line with the Declaration, the recommendations below further highlight the importance of user centricity, and the importance of standards and interoperability. In line with the scope and methodological approach of this study, as defined in RQ5 (see section 2.2), the recommendations suggest **actions that policy makers at European and Member States' level should take to improve the use of geospatial data and the delivery of geospatial data based products and services**.

The recommendations of this study put forward **actions, which complement or reinforce the importance of the work being conducted by the Commission, notably by DG JRC**. Whenever ongoing work or similar recommendations could be linked to the recommendations derived from the conclusions of this study, these are referred to in each recommendation. The referred Commission work is limited to data sources consulted during the development of this report.

Recommendation 1. Continue promoting the implementation of the INSPIRE Directive

The most common barriers encountered when working with geospatial data highlighted in this study are the **difficulties of integrating and linking geospatial data with other data types, the difficulties of geospatial data standardisation and the extensive IT infrastructure needed to support standardisation of large amounts of data**. These barriers could be overcome if the involved stakeholders would make maximum use of the 'infrastructure for spatial information'[168] as mandated by the INSPIRE Directive. For example, one opportunity highlighted in the study conclusions is **the reuse of the domain specific INSPIRE data models** and their extensions for the easier integration and linking of geospatial data with other data

[164] COM/2015/0192 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Single Market Strategy for Europe, 2015
[165] https://ec.europa.eu/digital-single-market/en/economy-society
[166] http://ec.europa.eu/newsroom/document.cfm?doc_id=47559
[167] https://ec.europa.eu/digital-single-market/en/news/communication-eu-egovernment-action-plan-2016-2020-accelerating-digital-transformation
[168] According to Article (3) 1, the INSPIRE Directive 'infrastructure for spatial information' means metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures, established, operated or made available in accordance with this Directive;

types, so that new data products and services could be created more seamlessly across different domains and sectors.

Proposed Action(s)

- The Commission should **continue promoting the use of resources (i.e. infrastructure for spatial information') supporting the implementation of the INSPIRE Directive**, and ensure that the INSPIRE Directive is well understood by all relevant stakeholders.
    - On one hand, the Commission should **act in collaboration with public administrations responsible for geospatial data collection and publication at national and sub-national levels to encourage and actively promote the INSPIRE Directive**.
    - On the other hand, the private sector should also be more aware of the INSPIRE Directive and work in collaboration with public administrations to help on the implementation of the Directive and make use of it effectively. The **collaboration between public and private sectors** could be achieved, for example, through dedicated networks or forums of stakeholders working in specific common interest areas, such as the SmeSpire network[169]. These could serve as platforms for sharing best practices for working with INSPIRE.
- The European Commission, national and sub-national public organisations should make efforts not only to provide support regarding the implementation of the INSPIRE Directive but to also **highlight the benefits obtained by the implementation of the INSPIRE Directive**. This could, once again help to ensure a timely implementation[170] of the Directive and would also raise awareness of its relevance for different stakeholders within the domains covered by the INSPIRE themes[171].

This recommendation is aligned with the results of the INSPIRE mid-term evaluation[172] and the aforementioned actions complement and reinforce the importance of the work being conducted by JRC such as the INSPIRE Knowledge Base[173], the INSPIRE community[174], INSPIRE Maintenance and Implementation Group (MIG)[175], INSPIRE conferences[176], INSPIRE Thematic Clusters Platform[177], INSPIRE in practice[178], etc. shows examples of resources already available in the INSPIRE knowledge base. Moreover, the recommendation is **complementary to and aligned** with the recommendations cluster 'Governance, Partnerships and Capabilities' of the **European Union Location Framework Blueprint**.

Figure 15 shows examples of resources already available in the INSPIRE knowledge base. Moreover, the recommendation is **complementary to and aligned** with the recommendations cluster 'Governance, Partnerships and Capabilities' of the **European Union Location Framework Blueprint**[179].

[169] http://www.smespire.eu/joinus/
[170] https://inspire.ec.europa.eu/inspire-roadmap/61
[171] https://themes.jrc.ec.europa.eu/
[172] https://www.eea.europa.eu/publications/midterm-evaluation-report-on-inspire-implementation
[173] https://inspire.ec.europa.eu/
[174] https://inspire.ec.europa.eu/document-tags/community
[175] https://ies-svn.jrc.ec.europa.eu/
[176] https://inspire.ec.europa.eu/portfolio/inspire-conferences
[177] https://themes.jrc.ec.europa.eu/
[178] https://inspire-reference.jrc.ec.europa.eu/
[179] https://ec.europa.eu/jrc/en/publication/european-union-location-framework-blueprint?

Figure 15 Examples of resource available through the INSPIRE Knowledge Base[180]

Recommendation 2. Continue promoting the use of interoperable INSPIRE based specifications

The conclusions of this study highlight on the one hand, the **difficulties of working with domain specific data**, especially within domains not covered by the 34 INSPIRE themes[181], and on the other hand, the opportunities to **expand the use of geospatial data to these domains** through the **use of INSPIRE based specifications, including INSPIRE data models and their extensions**.

Proposed Action(s)

- The European Commission, should **promote and support the development of INSPIRE compliant specifications, which could be easily extended to domain specific applications while preserving their interoperability (e.g. modular specification)**. This would encourage the application of INSPIRE in domain specific cases and increase interoperability among different geospatial data sets.
- The Commission should **promote the use of INSPIRE based specifications whenever a new European initiative requires the use of geospatial data or integrating and linking any other kind of data with geospatial data**. This can be done in collaboration with the Interoperability Unit of DIGIT, which currently advises on the assessment of ICT implications in the early stage of the European legislative process. Such action would also increase the awareness of INSPIRE at the EU level, and facilitate the horizontal coordination of existing policies or policies that are about to be implemented that could affect or be affected by INSPIRE.

This recommendation **complements and reinforces** the importance of the work being conducted by JRC under the ARE3NA[182] ('Guidelines for the RDF encoding of spatial data'[183]) and under ELISE (e.g. 'Spatial

[180] Print screen of http://inspire.ec.europa.eu/, accessed on 23 January 2018.
[181] https://inspire.ec.europa.eu/Themes/Data-Specifications/2892
[182] https://joinup.ec.europa.eu/collection/are3na/about
[183] http://inspire-eu-rdf.github.io/inspire-rdf-guidelines/

Data on the Web - Tools and guidance for data providers'[184]and the Energy Pilot[185], extending INSPIRE data models with energy-related attributes). Similarly the recommendation is **complementary and aligned** with the recommendations cluster 'Standardisation and Reuse' of the **European Union Location Framework Blueprint**[186].

Recommendation 3. Facilitate access to funding of initiatives aiming to increase interoperability of geospatial data, products and services

Funding was identified in this study as a barrier as well as a major enabler to the geospatial data initiatives in scope. The study shows that geospatial data funding should not be seen within a geospatial data silo, but rather in the broader context of data management, which includes geospatial data. Given the high production, procurement and update costs of geospatial data, funding should also be available for initiatives that aim to increase the interoperability of geospatial data, products and services.

Proposed Action(s)

- The Commission should **facilitate access to the funding of initiatives aiming to increase the interoperability of geospatial data, products and services**, especially those initiatives that have a high impact on businesses and citizens, and on the delivery of public services. These can be:
  - Existing initiatives which need funding for scaling up (and therefore sustain impact);
  - 'Future' initiatives with a solid business case to realise expected benefits;
  - Initiatives aiming to eliminate 'silos' by integrating or linking harmonised geospatial data with non-geospatial data;
  - Coordinating activities to increase the interoperability of geospatial data, products and services.
- When funding is already available, the Commission can **support businesses by providing information and user friendly guidelines on how to access the correct funding opportunities**. As an initial step to facilitate access to funding, the Commission could **undertake a study to identify and assess the most effective funding instruments available** for supporting the interoperability of geospatial data products and services.

This recommendation is **complementary to and aligned** with the recommendations cluster 'Return on investment' of the **European Union Location Framework Blueprint** [187] as well as with the recommendations on funding highlighted in the **'eGovernment in local and regional administrations: guidance, tools and funding for implementation'**[188].

[184] https://inspire.ec.europa.eu/sites/default/files/presentations/Spatial_Data_on_the_Web_-_tools_and_guidance_for_data_providers.pdf
[185] https://joinup.ec.europa.eu/page/eulf-energy-pilot
[186] https://ec.europa.eu/jrc/en/publication/european-union-location-framework-blueprint?
[187] https://ec.europa.eu/jrc/en/publication/european-union-location-framework-blueprint?
[188] https://ec.europa.eu/digital-single-market/en/news/egovernment-local-and-regional-administrations-guidance-tools-and-funding-implementation

Recommendation 4. Ensure transparency regarding the reuse of geospatial data across the EU

While the conclusions of the study highlight the lack of legal clarity as a barrier for the use of geospatial data, legal clarity is also highlighted as a major enabler for organisations to provide geospatial data-based products and services.

Proposed Action(s)

Given that **geospatial data** is considered the most significant category of open government data due to its high production, procurement and update costs, as well as its relevance to multiple thematic areas and domains[189], **the Commission should take the opportunity of the revision[190] of the PSI Directive to ensure legal clarity regarding equal and easy access to geospatial and other open data across the Union**. The following specific points, addressed by the public consultation of the PSI Directive, were identified as the most relevant tin the context of this study. These should be followed-up closely in relation to the reuse of geospatial data:

- Data should be made discoverable and more accessible through web services, APIs and platforms. It is important that Member States move from data catalogues to digital platforms and harness the benefits of network effect.
- European citizens and businesses should have the possibility to request, discover, visualise and download (open) geospatial data.
- Ensure that data generated in the context of the provision of a public task by publicly owned companies or by independent economic operators is available for reuse. The same should apply to data in the area of public transport and data produced by utilities (e.g. in the energy, waste and water sectors).
- The publication of sensor and other geospatial data should be further facilitated.
- The European Commission should aim to standardise data reporting practices (in several policies). Public sector bodies should make available data they hold as well as its metadata in a mandatory standard format.

This recommendation is **complementary to and aligned with** the recommendations cluster 'Policy and Strategy Alignment' of the **European Union Location Framework Blueprint** [191] and with the new activities of JRC in analysing the role of location information in Governmental APIs and digital platforms.

Recommendation 5. Support the creation of a harmonised licensing framework for geospatial data

Whilst access to privately held geospatial data was not explicitly analysed in the study, several consulted stakeholders identified the lack of a clear licensing framework as a factor that prevents access to geospatial data, raises project costs and complicates the implementation of projects involving several countries and

[189] EU Project Publica Mundi – Publishable Summary, (2014) available at: http://cordis.europa.eu/docs/projects/cnect/8/609608/080/publishing/readmore/PublicaMundi-Periodic-Publishable-summary-2014Y1.pdf. Last accessed on 29/09/2017.
[190] https://ec.europa.eu/digital-single-market/en/news/revision-psi-directive
[191] https://ec.europa.eu/jrc/en/publication/european-union-location-framework-blueprint?

partners. The barriers and opportunities presented in the conclusions of this study as well as 0 on the provision of more transparency to the access and use of geospatial data points out to the need of a harmonised licensing framework for geospatial data across the EU.

Proposed Action(s)

The Commission, in collaboration with national responsible public administrations, should facilitate the creation of and promote a clear and harmonised licensing framework for geospatial data across the EU. The participation of Member States in such an exercise is fundamental given that such framework should be applied at national and sub-national levels

This recommendation complement and reinforce the importance of the work being conducted by JRC such as the **'Study of the terms of use applied in the INSPIRE resources and their usability barriers'**[192], which is a technical report having a twofold scope. Primarily, it provides an overall picture of the data sharing approaches applied in the INSPIRE resources as available within the metadata provided by the Member States, and accessible through the INSPIRE Geoportal. Furthermore, it highlights the user barriers to data-sharing and possible solutions to reduce them.

Recommendation 6. Support the adoption of new technologies into the geospatial data ecosystem

One of the opportunities associated with the reuse of geospatial data highlighted in the conclusions of this study is the potential **to harness new data collection and processing methods.** Given the rapidly changing technological landscape, new ways of collecting, processing and using geospatial data are emerging. Technologies, such as image recognition, use of data provided by sensors and satellites (e.g. Copernicus[193]) as well as machine learning allow to collect and process the necessary data faster and with less human effort. Additionally, the harnessing of new technologies helps enable the realisation of new geospatial data related initiatives (e.g. Smart Cities, Internet of Things, building performance evaluation, amongst others).

Proposed Action(s)

- The Commission, in close cooperation with national and sub-national relevant public administrations, geospatial, IT and any other private companies working in the geospatial sector, **should promote and integrate into their own processes innovative ways to collect and process geospatial data**. This would help equip both the public and private sector with the necessary expertise to harness the new technologies and foster innovation.
- The Commission should also aim to facilitate the exchange of best practices on the use of new technologies for collecting and processing geospatial data.

In this regard JRC has recently started two actions on new technologies relevant to geospatial data:

- **Digital platforms:** the aim of this study is primarily to understand how location enabled digital platforms are expected to impact EU digital governments and the digital and data economy in

[192] This study is foreseen to be publicly available online in the first semester of 2018.
[193] http://www.copernicus.eu/

general, providing the current state of play along four key perspectives: **collaboration** and **governance frameworks**, **different business models**, **technologies and benefits in the use of location data** in these platforms.

- **Digital transformation** (digital government, blockchain and APIs): this study aims to identify key aspects in the Digital Transformation of Government, assess the current state-of-play in Europe, including leading examples, and identify key players in different disciplines and assess the public sectors' use of APIs, blockchain, and other distributed ledger technologies.

Recommendation 7. Ensure a user centric approach when opening up geospatial data

The conclusions of this study highlight **close cooperation with end users** as an enabler of the implementation of geospatial data initiatives. Additionally, closer cooperation with the direct users and final end users of geospatial data based products and services is also highlighted as a major opportunity associated with reuse of geospatial data and the provision of better geospatial data products and services.

Based on the conclusions of this study, public organisations responsible for geoportals and geospatial platforms (at EU, national and sub-national levels), are advised to **ensure a user centric approach in their decision making process as regards the publication of geospatial data as well as the provision of geospatial data products and services**. User centricity implies working in close collaboration with end users (e.g. businesses, universities, research institutes and citizens) and taking user needs into account as well as informing end users on the decisions and future plans regarding data publication. It is especially important to take into account the needs of the direct users of the geospatial data made available by the public sector, such as companies working in the geospatial domain. User centricity would, for example, allow businesses working with geospatial data to **know about the new data and data products to expect from their relevant public administration** and hence would allow them to plan in advance. Moreover, a user centric approach to data sharing, would enable a dialogue between data providers and data users. This would ensure that **geospatial data is made available in a more user friendly ways, hence overcoming the lack of 'geospatial data literacy' among end users**.

Proposed Action(s)

- **Public administrations should make efforts to identify the most appropriate channels to reach out to the end users of geospatial data products and services** (participation in different conferences and events, inviting them to open consultations, user surveys, etc.).This, in addition to raising awareness about the available geospatial data, would also help to **ensure that the right geospatial data is published in ways that meet users' needs, facilitate its reuse and overcome the lack of 'geospatial data literacy' among end users.**
- JRC should leverage other actions of the Commission such as the efforts of DIGIT's interoperability unit, which runs an action dedicated to ensuring a user centric approach when opening up geospatial data.

This recommendation is **complementary to and aligned** with the Recommendation 8 of the **European Union Location Framework Blueprint** on the need to 'Adopt an open and collaborative methodology to design and improve digital public services that are location-enabled', which urges policy makers to adopt

user-centric design principles. The recommendation is also aligned the underlying principle of user-centricity of the revised **European Interoperability Framework**[194]**.**

Recommendation 8. Perform an assessment of the value created by (open) geospatial data

One of the difficulties faced by this study was the lack of quantitative data available on the value created from the use of geospatial data. While the study team was able to collect qualitative data on the value created from the use of geospatial data from almost all stakeholders consulted, very few of them have actually quantified (or monetised) this value. A case study analysis reveals the benefit of such an evaluation. Firstly, it helps public administrations to justify the opening up of geospatial data and more importantly, having a quantified estimate of the value of open data for the economy, helps raise understanding and awareness of the importance of opening up data.

Proposed Action(s)

National and sub-national public administrations planning to open up their data should perform an ex ante, interim and ex post cost-benefit analysis on the standardisation and opening up of geospatial data. Assessing the economic value of (open) geospatial data can help overcome political barriers and departmental silos during the process of data standardisation and opening up. It is also important to note, that the cost-benefit assessment of the value should take into account not only the value created for the economy of the country but also for policy making, as geospatial data has the potential to pave the way for evidence-based policy making.

This recommendation is **complementary to and aligned with** the recommendations from several studies on the value of geographic information[195] and the benefits of the INSPIRE Directive[196] to opening up data, highlighted in the **'eGovernment in local and regional administrations: guidance, tools and funding for implementation'**[197] as well as with the recommendations cluster 'Return on Investment' of the **European Union Location Framework Blueprint**[198].

[194] https://ec.europa.eu/isa2/sites/isa/files/eif_brochure_final.pdf
[195] http://www.geovalue.org
[196] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0273&from=en
[197] https://ec.europa.eu/digital-single-market/en/news/egovernment-local-and-regional-administrations-guidance-tools-and-funding-implementation
[198] https://ec.europa.eu/jrc/en/publication/european-union-location-framework-blueprint?

6. Annexes

Annex I Proposed ideas for future research

During a 'Workshop on Conclusions and Recommendations' held at the JRC on 8 November 2017, future research topics arising from this study were discussed. The main outcomes of the discussion are summarised briefly below:

- JRC could further investigate the **impact that geospatial data based products and services have on citizens**. The main focus of this study was on the reuse of open government and privately held data by the public and private sector, citizens were not in the list of stakeholders analysed by the study. Nevertheless, positive spill-over effects from the use of geospatial data for product and service creation affecting citizens were identified in all of the case studies. Hence, it would be interesting, using the consumer panel approach, to investigate what are the effects (positive or negative, if any) of the geospatial data based products and service on this stakeholder group.
- Ensure that the **results of the study are reflected in the EULF Blueprint**. The EULF Blueprint is a collection of best practices and recommendations for EU Member States regarding the sharing and the usage of the geospatial data for eGovernment purposes, including the adoption of INSPIRE. Given the six case studies analysed in the study and the lessons learnt from them, some conclusions and case study specific examples could be used to update the EULF Blueprint in order to make it more of a practical and illustrative guide for the concerned stakeholders.
- Examine further how open data initiatives are **incorporated into strategic documents and funding documents of the Union**. Given the need of horizontal coordination when implementing the INSPIRE Directive and encouraging the ruse of geospatial data, it is important to review whether initiatives affecting or being affected by open (geospatial) data, are aware of the impact. It is also important to review the documents in the entire European Commission funding vertical since the cross-border and transnational funding (MRS - macro regional strategies) are very important in that context.
- Potentially measure the **economic value** of geospatial and create a database of specific cases illustrating different values created by harnessing geospatial data. Given that data acts as an input to many processes that generate value, it would be interesting to explore what it creates in different scenarios. In addition, a broader **socio-economic study** of the benefits of the geospatial data could be carried out.
- European Commission could investigate the channels allowing public sector to be prepared to work with and handle **non-authoritative geospatial data** and the **new types of data emerging from the adoption of new technologies** (both from the licensing point of view and from the privacy related aspects).

Annex II Secondary data sources

Table 9 below presents the list of secondary data sources consulted as part of the desk research activities of this study.

Table 9 List of secondary sources

Title	Author	Publisher	Year
Value Creation on Open Government Data	Attard, J. Orlandi, F., Auer, S.	Presented in 'System Sciences Conference'	2016
Unleashing Internal Data Flows in the EU: An Economic Assessment of Data Localisation Measures in EU Member States	Bauer, M., Ferracane, M. F., Lee-Makiyama, H., van der Marel, E.	ECIPE	2016
European Union Location Framework Blueprint	Boguslawski, R., Pignatelli, Fr.	DG-JRC	2016
Towards faster implementation and uptake of open government	Bremers, J., Deleu, W.	European Commission	2015
Big and open data in Europe - A growth engine or a missed opportunity	Buchholtz, S., Bukowski, M., Snigocki, A.	Demos Europa	2014
Final Report	Cipriano, P., Easton, C., Roglia E., Vancauwenberge, G.	SME SPIRE	2013
The Big Data Value Chain: Definitions, Concepts, and Theoretical Approaches	Curry E.	New Horizons for a Data Driven Economy	2016
Assessment of the Economic Value of the Geospatial Information Industry in Ireland	Indecon	Ordnance Survey Ireland	2014
UK Location Information Infrastructure Blueprint for the UK Location Information Infrastructure	Manning, T., Murray, K.		2009
An Economic Policy Perspective on Online Platforms	Martens, B.	DG JRC Technical Reports	2016
Raising European Productivity Growth through ICT	Miller, B., Atkinson, R., D.	The information technology and innovation foundation	2014
From Data to Decisions: A Value Chain for Bid Data	Miller, Mork	IT Professional	2016
The digital economy: promise and peril in the age of networked intelligence	Tapscott, D.	McGraw-Hill	1995
The Value of Spatial Information - the Impact of Modern Spatial Information Technologies on the Australian Economy	Tasman, A.	Spatial Information Systems Limited	2008
Creating Value through Open Data	Tinholt, D, Carrara, W.	European Data Portal	2015
Alignment Study of Spatial Data Supply Chains		CRC-SI	2012
EU Project Publica Mundi - Publishable Summary		Publica Mundi Project	2014
The ICT sector and its R&D performance in the EU		European Commission	2016
An Open Data Value Chain		Making Data Flowers Bloom	2011
Data Value Chain Database v1		Open Data Incubator	2016
Spatial Industry Ecology		SIBA	2014
The Emerging Digital Economy		Economic and Statistics Administration of the USA	1998

Annex III Interview Guide

Introduction

The Communication on Building a European Data Economy adopted in 2017 proposes policy actions addressing the issues of the free flow of data, data access and transfer, legal responsibility for data based products, and data portability, interoperability and standard. In this context, the Joint Research Centre (JRC) of the European Commission has contracted Wavestone to study the economic opportunities and barriers related to geospatial data in the context of the Digital Single Market.

The study focuses on five different case studies where geospatial data is used to create and deliver a product or service to citizens and businesses. *[Insert case study name]* has been selected as one of the case studies that we will analyse in this study. *[Insert one sentence on case study context].*

In this interview, we will not only ask you about your expert views on the potential opportunities of geospatial data, but also how the barriers to the access, process and use geospatial data impacted (or may impact) your organisation.

Your answers will help us to assess the economic opportunities and barriers faced by organisations using geospatial data to deliver products or services in Europe. The results of this assessment will be reported as part of the study 'Assessment of economic opportunities and barriers related to geospatial data in the context of the Digital Single Market'. We thank you for your time and kind attention.

For data protection purposes, please be advised that individual answers will be treated anonymously and will remain confidential, only to be disclosed to the evaluation team and used solely for research purposes. The information collected during the interview will be used to elaborate the final report on the external study mentioned above.

Please read the specific privacy statement before proceeding with the interview.

Section 1 Respondent Information

The information provided in this section will be used only when answers need to be further elaborated or clarified.

Name	
Surname	
Organisation	
Role in the organisation	
Email address	
Telephone	

Section 2: Interview Guide

The following questions should be answered in the context of the [*insert case study name*]:

1. Please describe in more detail the main objective and the scope of the [*insert case study name*]:

2. Please describe the main geospatial data based product(s) and service(s) provided by your organisation for the *[insert case study name]*. Please also specify how and what type of data is used for product creation and delivery.

3. Please describe the main processes and actors involved in the creation and the delivery of your product or service // implementation of *[insert case study name]* ***(the phrasing of the question to depend on the case study).***

Activity	Please describe in more detail the activity and the actors involved in it
Data Collection	
Data Processing	
Data Use	
Other	

4. **[If a cross-border case study or a project involving multiple different actors]** Could you please detail the agreement, if any, that you have between different actors involved in [*insert case study name*] in order to facilitate the exchange and processing of data?

5. **[If a broad pilot]** Could you please let us know what uses of the data will be most interesting in the context of our study, and who we should contact to find out more about these applications?

6. Based on your experience, what is the value created to the main actors using these product(s) or service(s)?

Actor	Please describe in more detail the value created
[insert actor's name]	

7. Can you provide us with some quantified estimates of any point made above in question 4?

8. What were the barriers your organisation faced (or may face) when creating and delivering these product(s) or service(s) // implementing the [insert case study name]?

Barriers category	Please describe in more detail
Access to geospatial data	
Integration and processing of geospatial data	
Organisational constraints	
Access to finance	
Legal constraints	
Others	

9. How did your organisation overcome or is currently overcoming the abovementioned barriers?

10. From the perspective of your organisation, more broadly, what are the associated barriers preventing the growth of the geospatial data based product(s) and service(s) in your industry?

11. What were the main opportunities motivating your organisation to use geospatial data when creating and delivering geospatial data based product(s) or service(s) in the context of the [*insert case study name*]?

12. From the perspective of your organisation, more broadly, what are the future opportunities associated with the expanded application of geospatial data in your industry?

13. Is there anything else you would like to add that you think might be useful for the purposes of our study?

Annex IV – Long list of Case Studies

Table 10 below presents the long list of case studies from which the final five case studies that were analysed in this study were chosen. Each case study is described in line with the selection criteria and a brief description is provided for each. Using the long list of case studies, the ELISE team of DG-JRC selected the final five case studies.

Table 10 Long List of Case Studies

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
1	Copernicus Border Surveillance	The border surveillance service is delivered by FRONTEX in the frame of EUROSUR, with data coming from Copernicus. The service is fully operational since early 2016, building on R&D activities (SAGRES, LOBOS). With the support of Copernicus, data from Earth observation satellites is combined with other surveillance sources, such as ship reporting systems and other intelligence, to support border management authorities in their efforts to assess risk and detect irregular migration and cross-border crime.	G-G	Data held by public organisation: FRONTEX. In order to develop the service FRONTEX uses public data provided by Member State National Coordination centres, EUSC and EMSA, as well as by Copernicus in support to EU's external border surveillance information exchange framework (EUROSUR). Data used by public organisations to provide public services: National border management authorities.	Stakeholders involved: EU institutions and agencies, national border management authorities. Geographical coverage: EU wide	Border surveillance.	The border surveillance component of the Copernicus Security Service complements the services already delivered by FRONTEX and significantly enhances the Agency's intelligence capabilities based on space-borne observations.	Feasible

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
2	Copernicus Security Service in Support of EU External Actions	The Security Service aims to support related EU policies by providing information in response to the security challenges Europe is facing - providing crisis prevention, preparedness and response capacities. Copernicus Service in Support to EU External Actions (SEA), operated by the European Union Satellite Centre (SatCen), can provide rapid, on-demand geospatial information for monitoring of events or activities outside Europe that may have implications in European and global security. Service provision in several areas was tested and validated through two projects financed by the EU's FP7 Research Framework Programme, from 2013 to early 2015: G-NEXT, providing preoperational services and G-SEXTANT, aimed at bringing technology to a level of maturity allowing operational deployment.	G-G	Data held by publication organisation: Copernicus Service. Data used by public organisation: EU External Actions Centre, for monitoring events or activities outside and inside EU.	Stakeholders involved: EU Institutions and agencies. Geographical coverage: EU wide and geospatial data also covers areas outside EU.	Crisis prevention.	Copernicus Service in Support to EU External Actions (SEA) can provide rapid, on-demand geospatial information for monitoring of events or activities outside Europe that may have implications in European and global security.	Feasible
3	Core location pilot in Belgium	The pilot demonstrated that the core location RDF vocabulary can be used as a foundational RDF vocabulary to harmonise address data that originates from disparate organisations and systems; the vocabulary can also be flexibly extended with experimental INSPIRE RDF vocabularies and the use of standard web interfaces can simplify the use of this data both for humans and machines. The pilot was funded and initiated by the ISA programme. A total of four national data centres contributed geospatial data for the creation of a homogenous address data set using INSPIRE RDF vocabularies.	G-G	Data held by public organisation: a total of four national data centres contributed geospatial data for the creation of a homogenous address data set using INSPIRE RDF vocabularies. Data used by public organisation to provide public services: Belgium public authorities.	Stakeholders involved: EU institutions and agencies, regional data centres, national public administrations. Geographical coverage: Belgium	Citizen address.	The use of the Core Location Vocabulary makes general Belgian address data interoperable and linkable; the use of standard Web interfaces and query protocols simplify the use of location data; an increased use of address and geospatial data leads to improved quality of address data; ability to deliver (cross-border) public services more efficiently.	Feasible

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
4	French IGN portal	French national geospatial portal, Le Geoportal relies on IGN repositories and on institutional data producers to provide to receive data on French territory.	G-G	Data held by public authorities: IGN repositories and institutional data producers. Data used by public organisations: all French national authorities now upload data to a single geospatial platform.	Stakeholders involved: National public administrations, IGN repositories and institutional data producers, citizens. Geographical coverage: France	Land cadastre, sea and coastline, protected areas, administrative units.	The Geoportal site facilitates access to geographic information of reference, that is to say public information and official source on the national territory. The availability of reliable and comprehensive data, constantly updated, is essential for the implementation of public environmental and spatial planning policies. It responds to the simple needs of localisation (locating a parcel, searching for an address ...), as well as the needs for co-visualisation of information on the territory.	Feasible, assuming JRC has contacts.
5	INSPIRE Marine Pilot	The aim of the INSPIRE marine pilot is to help improve the understanding of INSPIRE in the management of Marine Strategy Framework Directive (MSFD)-related spatial information, and to provide guidance and tools that facilitate the mentioned obligations. It allows countries to easily benefit from each other's collected data, thanks to it being described in the same fashion and using the same standards. Better pollution and hazard prevention is ensured. The pilot was successfully completed in Denmark, Germany and the Netherlands.	G-G	Data held by public authorities: Belgian, Dutch and German marine organisations. Data used by public organisations: the data, which is now interoperable and describe in the same way can be easily used by maritime bodies in other countries.	Stakeholders involved: EU Institutions and agencies, national maritime organisations and authorities. Geographical coverage: the pilot has been implemented by the, Netherlands, Germany, and Denmark.	Maritime.	Now the three countries can easily benefit from each other's collected data, thanks to it being described in the same fashion and using the same standards. Better pollution and hazard prevention is ensured.	Feasible

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
6	OSLO Pilot	The portal is publishing the Belgian Business register, inter-linking data from the Regional address register (CRAB), and containing geographical positioning for each of the addresses in Flanders.	G-G	Data held by public organisation: The portal, run by the Flemish Geographical Information Agency (AGIV)., uses interlinked data from the Regional address register CRAB, containing geographical positioning for each of the 3 million addresses in Flanders and the Belgian Business register. Data used by public sector: Flemish eGovernment Coordination Unit and all other Flemish public administrations.	Stakeholders involved: V-ICT-OR, the Flemish Organisation for ICT in Local Government; Flemish ICT service providers, Ghent university, and public administrations. Geographical coverage: Flanders.	Address data.	Better harmonisation of the authentic data and a better adoption of the authentic data, through the use of an open and extensible data format.	Feasible
7	Smart Open Data Portugal-Spain Pilot	The pilot will focus, by using Open Data from environmental INSPIRE compliant databases, cartographic services and remote sensing data, on building a collaborative spatial data infrastructure with the goal of promoting sustainable agroforestry management. It will be a collaborative tool for environment protection and economic development of rural areas, and a key factor for water management and drinking water protection.	G-G	Data held by public organisation: open data compliant with INSPIRE Directive.Data used by public sector: public bodies working with forest management and land use planning.	Stakeholders involved: EU institutions and agencies, national public bodies involved in forest management and land use planning. Geographical coverage: Ourense province in the North West of Spain, and the region of Castelo the Bode Dam, in Portugal.	Agroforestry management.	The pilot will result in easy access to the environmental information in both Portugal and Spain and it will develop decision making tools and services available and helpful for public and private agroforestry managers. Results and outcomes will be open, standardised and of public access including web services and information management applications.	Feasible

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
8	Monitoring platform for critical transport	CTAT, which has been set up to monitor critical transport assets, such as tracking of vehicles and personnel in the field, communicating in real-time to strengthen the coordination and situational awareness at an operational level.	G-G	Data held by public organisation: SPARTACUS data. Data used by a public organisation for delivery of a public service: reuse of data by a consortium led by Johanniter-Unfall-Hilfe, comprising of the Ministry of the Interior of Austria, Crisis Management Centre Finland, Danish Emergency Management Agency and the Italian Civil Protection Department.	Stakeholders involved: EU institutions and agencies, national research centres, crisis management centres, local ministries, railway authorities. Geographical coverage: EU wide.	Vehicle tracking, crisis management.	Through successful integration of a wide array of tools, standards and protocols CTAT successfully manages to track and locate vehicle locations.	Feasible, given there are contacts through JRC.
9	Real time traffic management in UK	Real time traffic management plays a key role in keeping London's road network moving. Significant improvements in TfL's systems, processes and procedures over recent years have given the capital World Class operation. Technology based systems play a significant systems play a significant role in successful operation of the network on a day to day basis. A priority for the future is to open up these systems, so that the information they contain can be made available to the public.	G-G	Data held by public organisation: TFL London. Data used by public organisation: TFL London, with possibility to open up data for wider public.	Stakeholders involved: Transport for London, road operators, bus operators, data managers. Geographical coverage: London, UK.	Traffic management.	Real time traffic management allows passengers to plan their journeys in real time and to adjust traffic flows when necessary.	Feasibility assessment needed.

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
10	Innovate UK initiatives (Future City Glasgow)	Innovate UK, is an independent public body dedicated to encouraging innovation by cooperating with innovating partners. They provide funding assistance to promising science and technology ventures, but also provide strategy support by helping innovators identify promising new science and technology ventures and pairing them up with prospective partners. It has among other initiatives, funded the Future City Glasgow initiative with £24 m in 2013, which makes extensive use of data to make the city more sustainable and deliver improved services to its citizens. In particular, this initiative harnesses the data from citizens to produce new mapping opportunities for their own benefits, by for example using cyclists' data to generate new cycling routes, but this can also be applied for rubbish collection, flood protection and transport. With this initiative, geospatial can not only make the city identify better city trends and plan accordingly, but also help visualise city developments and trends to Glasgow citizens.	G-G	Data held publicly, combining separate dataset, made available for the use of the public, businesses and citizens through open data. Data used by public sector bodies: the main beneficiaries will be other public authorities, which will be able to enhance services such as flood prevention thanks to the availability of data, such as spatial data.	Stakeholders involved: public authorities and entities delivering public services, but also the residents and businesses of Glasgow. Geographical coverage: UK.	Geospatial data, that can provide information on traffic, flooding.	Responding to real-time events such as flooding and congestion, in order to develop the appropriate measure of response services to address the issues. This would positively affect the well-being of citizens and improve first response costs. The environment would be positively affected by smarter street lighting and smoother cycling and other forms of transportation.	Feasibility assessment needed.

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
11	Stuttgart 3D Building Data Exchange	The driver of the project Stuttgart3D, which is an initiative of the Stadtmessungsamt and the GIS-AG of Stuttgart (it is a cooperation of geo-data producer and geo-data user at the municipality of Stuttgart), was the necessity to build up an application for all the users of 3D-data at the municipality. The goals of the project Stuttgart3D are defined as follow: bringing the 3D-data together into one database; use the data infrastructure and the network of the municipality; view the data in a quick way, by using an access control. City-GML data format is used and the visualisation are in line with International Organisations of Standardisation guidelines.	G-G	Data held by public sector: local authorities in Stuttgart, data is also supplied by project partners. Data used by both private and public.	Stakeholders involved: geospatial data experts at the municipality, local authorities. Geographical coverage: Stuttgart, Germany.	Building information.	Thanks to the development of the Stuttgart 3D building performance data exchange, municipalities can access the 3D data all in one place and the data is easier to use now.	Feasibility assessment needed.
12	PISO	PISO (Prostorski Informacijski Sistem Občin) - Location information system for municipalities offers a variety collection of data and services supporting local municipalities in daily decision making processes.The program contains two entry points - public, open for everyone, internal, open for employees of municipality. PISO is also available as a mobile application for citizens.	G-G	Data held by public organisation: different municipalities across Slovenia. Data used by public organisation: the information is used by the staff of same municipalities. Some information, like maps, etc. are also open for public access.	Stakeholders involved: local municipalities, citizens, anyone working with cadastre systems, planning, hydrography, etc. Geographical coverage: Slovenia.	Information system.	PISO acts a central access point for all municipalities across Slovenia to upload and reuse geospatial data and associated services.	Feasible, assuming JRC has a contact.

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
13	French open address initiative	The French national open address initiative aims at setting up a database capable of containing the entirety of addresses on the French territory for reference. It was possible to set up the database thanks to the collaboration of different entities, mainly the National Institute for Geographic Information (ING), the national mail service (La Poste), local administrations and communes. It also involves citizens through the OpenStreetMap project and the association OpenStreetMap France. Through this project, citizens can provide information about streets, rail tracks and buildings.	G-G	Data held by public entities, to which citizens can contribute Data used by public authorities.	Stakeholders involved: National Institute for Geographic Information, national mail service, private citizens, communes, local administrations> Geographical coverage: France.	Geographical data, address data.	Having all address in a single address benefits different economic actors, as the public sector can rationalise their decision making by having free access to the data base, which could also be the case if this was extended to the private sector. Additionally, the system allows for constant improvements as citizens can freely add and contribute.	Feasibility assessment needed.
14	ELF Platform Services (EuroGeographics)	The European Location Framework enables users to gain access to authoritative, harmonised geographical data from the National Mapping and Cadastral Authorities (NMCAs) based on common specifications.	G-G, G-B	Data held by public organisations: data is supplied by National Mapping and Cadastral Authorities (NMCAs) as well as INSPIRE Spatial Data Infrastructure. Data used by public and private organisations: the platform allows for service development and interaction for different, EU wide public authorities and private sector organisations working with geospatial data.	Stakeholders involved: EU institutions and agencies, national authorities, private sector bodies working in a geospatial domain, SMEs. Geographical coverage: EU wide, a total of 39 partners.	Platform services.	It is a centralised place for accessing geospatial data and creating products and services based on it. The new platform, EuroGeographics will aim to add value to INSPRIRE data by contributing to cross border harmonisation, build an even more high performance platform, and it will also be an even more user friendly interface to find, view and compare geo-spatial data.	Feasible

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
15	Galileo Localisation for Railway Operation Innovation (GaLoRoi)	Galileo Localisation for Railway Operation Innovation (GaLoRoi) will support the adoption of European Geostationary Navigation Overlay Service (EGNOS) by using it as an augmentation system, leading to increased accuracy of train location determination, even before the roll-out of the Galileo Safety of Life Service. The project acts as an appropriate base for the migration from conventional localisation equipment to the use of Galileo for transportation. The localisation through the satellite based localisation unit allows a continuous localisation which will increase capacity in comparison to discrete localisation of track side equipment. In terms of practical usability in the railway system, another main objective of GaLoRoi is the certification of the localisation unit according to European safety standards like the Common Safety Standards and Common Safety Targets of the European Railway Agency.	G-G, G-B	Data held by public organisation: Galileo (public data) satellite data is used to develop the on-board train localisation unit, which can be part of an automatic train control system. In this train control system, existing and new technologies will be integrated for efficient and safe operations in the railway network. Data used by public and private sector: Public and private railway companies.	Stakeholders involved: national and private train operators, train control system developers, EU institutions and agencies, national research centres. Geographical Coverage: EU wide, research centres and companies from France, Germany and Belgium are involved in the system development and testing.	Train transportation	A satellite based train localisation unit reduces high manufacturing, installation and maintenance costs because it only needs to be installed on trains and requires no track side equipment. As nearly 50% of all railway lines in Europe are secondary railway lines, this sector may be considered a niche that could become a mass market, based on the number of locomotives in Europe (close to 50,000). This project will result in an on-board localisation unit that is ready for the market. This will lead to a significant reduction in costs, promoting train transport as a sustainable mode of transport ready for the future. As a result, GaLoRoi will provide innovations in operations, safety and efficiency, as well as social and economic benefits.	Feasible

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16	UrabanSIS	Urban SIS (Sectoral Information System) provides city specific climate data and impact indicators in support to the energy, infrastructure and health sectors operating in those cities. The objective of Urban SIS is to develop, demonstrate and put into production a method to downscale climate and impact indicators to the urban scale (~1x1km2), delivering the information in such format that it is directly useful to the end users. The Essential Climate Variables (ECVs) that have been developed are: precipitation (also expressed as snow), water vapour, urban temperature, wind speed and direction, surface radiation budget, regional background concentrations of NO2, O3, PM10 and PM2, regional scale soil moisture and river discharge. The information will be delivered in a format useful for urban planners, or for consultants and urban engineers/scientist as input to local models or dimensional calculations for urban hazards driven by intense rainfall, heat waves and air pollution.	G-G, G-B	Data held by public organisation: The Copernicus Climate Change Service (C3S) data, operated by ECMWF. Data used by both public and private sector: the information will be delivered in a format useful for urban planners, or for consultants and urban engineers/scientist as input to local models or dimensional calculations for urban hazards driven by intense rainfall, heat waves and air pollution.	Stakeholders involved: EU institutions and agencies, national governments, national meteorological and hydrological institutions, universities, consultancies. Geographical coverage: for the development of the service, Swedish, British and Italian organisations are involved. Future coverage: EU wide.	Climate change, infrastructure, healthcare and energy sector.	The creation of the Urban SIS applications allows policy makers and service workers in infrastructure and health sector to better prepare for potential extreme changes in climate, such as heat waves or floods.	Feasible
17	Climatic Energy Mixes	The purpose of European Climate Energy Mixes is to enable the energy industry and policy makers to assess how well energy supply will meet demand in Europe over different time horizons, focusing on the role climate has on energy supply and demand. The team is putting together a climate service demonstrator, including an online web interface, for improved assessment of energy mix options over Europe. For a given energy scenario, such tools will provide: I. Energy supply profiles for each country and generation type II. Energy demand profiles for each country III.Assessment of energy system adequacy at the country level.	G-G, G-B	Data held by public organisation: Copernicus satellite data will be used to co-develop, with extensive input from prospective users engaged through the Advisory Committee, a climate change service demonstrator. Data used by both public and private sector: energy industry and policy makers.	Stakeholders involved: EU institutions and agencies, universities, national electricity and energy companies, meteorological offices, and national administrations. Geographical coverage: for the development of the services, French, British, Italian organisations are involved. Future coverage: EU wide.	Climate change, energy demand and supply.	The demonstrator will help to assess the energy needs of different areas at different points in time, taking into account most recent climate changes. Furthermore, the demonstrator will offer a coherent approach for the climate variables/indicators used in power demand/supply balance, an added value with respect to current practice in the sector.	Feasible.

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18	Public Service on the Map (PDOK)	PDOK (is a central platform, which stores and distributes nationwide geospatial datasets provided by government organisations in the Netherlands. The web services contain both an online view and download services. It contains 111 datasets. About 250 web services (aimed at digital mapping) are available to the general public, private companies, organisations and the public sector. PDOK offers geographic data sets disseminated via different protocols: WMS, WMTS and TMS as well as complete geographic datasets for download (primarily in the GML or GeoTIFF format). These data sets can be used in Geographic Information System (GIS) packages such as ArcGIS, MapInfo Professional, GeoMedia and other GIS software. Data provided by PDOK is aimed for public authorities, educational purposes, managers, geospatial experts.	G-G, G-B	Data held by public organisation: Dutch National SDI (PDOK) files. Data used by both public and private organisations: different service levels for different target groups: PDOK Basic for public bodies, Educational (free of charge) and Fair Use, which is free of charge and allows small scale use of geospatial data services. The platform also offers free and some paid-for services (and software) for Managers and geospatial data experts.	Stakeholders involved: government organisations, general public, private companies. Geographical coverage: Netherlands.	Digital mapping.	Data is now described and held in one place and is open for anyone to use.	Feasible
19	Weastflows project	Weastflows is undertaking research and exploring ICT solutions to support better use of existing infrastructure and freight traffic flows and to encourage a shift from over reliance on road haulage to more sustainable rail, sea and inland waterway transport. These solutions are being piloted across a range of logistics networks to demonstrate how these approaches can deliver commercial as well as environmental benefits. The project is also looking at the need for better connected freight flows with the rest of Europe, Asia and North America.	G-G, G-B	Data held by public sector: transportation data. Data used by public sector: the project is led by French logistics and transport institute, CRITT TL and the Institute for Sustainability. The end users will also include private companies.	Stakeholders involved: rail, sea, inland waterway transportation companies, national authorities, research centres across EU, and a total of 22 partners. Geographical Coverage: EU wide.	Freight management.	Increased efficiency through time saving and more effective transportation routes, reduced emissions through more efficient traffic maintenance.	Feasibility assessment needed.

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
20	iObčina	iObčina is a location information system for municipalities offering a variety of data collections and services supporting local municipalities in daily decision making processes.	G-G, G-B	Data held by public organisation: municipal, regional and national spatial information Data used by other municipalities and private organisations: anyone who needs to can search for, view, analysis of the quantities of elements, measuring distances and surfaces of all kinds and types of information in a place that can be displayed on maps.	Stakeholders involved: municipal, regional and national authorities providing data. Geographical coverage: Slovenia	Geospatial data platform	All spatial data is stored in one place, which allows for efficiency gains and allows municipalities to exchange experiences of good and bad practices in relation to GIS data.	Feasibility assessment needed
21	City Data Exchange Copenhagen	Copenhagen is working with Hitachi Consulting to build a 'City Data Exchange' Hub, where data information can be stored to be accessed by the public or bought by other businesses. The platform is an example of a successful private/public partnership delivering value to both citizens and businesses. The platform will harness the power of data, including geospatial data, and advanced analytics to support city functions like green infrastructure planning, traffic management and energy use, by integrating data from multiple sources. This initiative, like other smart initiatives in the city, enjoys public support and funding.	G-G, G-B, B-G	Data held by both public and private bodies. Data used by both private public bodies to design more effective and appropriate services.	Stakeholders involved: businesses and public service providers, but ultimately also the residents who will enjoy the services. Geographical coverage: Denmark	Spatial data related to transportation, traffic and buildings among others.	The main benefits can be considered to be economic, as business can leverage greater data access to produce improved and innovative services. At the same time, the access to data will facilitate city planning, which could have beneficial effects ranging from livability to the environment.	Feasibility assessment needed.

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
22	Fix My Street	Fix my street is an online platform, which is operational all over the world. It allows users to submit any disturbances in their streets to local authorities. Fix My Street is an open source mapping software that any national, regional or local bodies can download, customise and start running in their area. Citizens then have an opportunity to easily report any problems they identify on their streets. Whoever wants to begin adopting Fix My Street in their area have to get the necessary geospatial data (if not already available on the OpenStreetMap, which is the default map for Fix My Street) from local authorities or any other place and also link it to all the email addresses of each of the departments responsible for the categories under which users can report issues in their streets.	G-G, G-B, B-G	Data held by both public and private sector: Fix My Street is developed by a social enterprise My Society, with OpenStreetMap combining both privately and publicly held data.Data used by both public and private sector: national, regional or local bodies can start running it in their area to ensure the delivery of more responsive public services.	Stakeholders involved: private bodies, national or regional agencies.	Neighbourhood maintenance.	Fix My Street empowers citizens to report any issues identified in their street directly to responsible authorities by linking geospatial data with administrative boundary data, (e.g. water department, highway department, etc.) with accompanying pictures and descriptions. This ensures better and more efficient service delivery.	Feasibility assessment needed.
23	Smart Emission M.App	The Smart Emissions project is a current research project executed by a consortium of Dutch knowledge institutes, government, (ICT- and sensor) companies together with citizens in the city of Nijmegen. The goal of this project is to monitor, visualize and communicate a real-time, fine-grained “environmental footprint” of the city. The project maps air quality, noise levels, vibrations and meteorological indicators, and provides the government and citizens with access to real-time data. Thanks to the visualised air quality data, researchers and residents can now communicate intelligently and make data-driven decisions. The efforts of this collaboration between the municipality, citizens, academic institutions and businesses have not gone unnoticed. In 2016, Nijmegen was awarded the Smartest City prize at the ‘De Slimste Binnenstad van Nederland’ contest	G-G, G-B, B-G	Data held by public and private sector: pollution data, citizen data, meteorological data, and noise data. Data used by public and private sector to deliver a public good: the application allows policy makers, citizens and academia to make better informed decisions.	Stakeholders involved: local government, citizens, researchers, application developers, meteorological, noise, and pollution scientists. Geographical coverage: the Netherlands	Air quality.	The application, by combining several types of data, allows users to visualise air pollution levels in their neighbourhood to allow for better decision making.	Feasibility assessment needed.

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
24	FOODIE Project	FOODIE project is creating a platform hub on the cloud where spatial and non-spatial interoperable data related to agricultural sector are available for agri-food stakeholders groups. It will offer an infrastructure for the building of an interacting and collaborative network; the integration of existing open datasets related to agriculture; data publication and data linking of external agriculture data sources, providing specific and high-value applications and services for the support of planning and decision-making processes.	G-G, G-B, B-G	Data held by public, private and third sectors: The platform will contain farming data such as maps, yield, fertilisation, etc.; public open data such as land satellite images, commercial data, voluntarily uploaded data. Data used by: stakeholders from the agriculture sector.	Stakeholders involved: EU institutions and agencies, farmers, advisory bodies, retail businesses, public sector bodies working in the agriculture domain, researchers for large scale experimentation, SMEs, technology providers. Geographical coverage: EU wide. Currently there are three pilots in Spain, Germany and Czech Republic.	Agriculture.	The geospatial platform hub will integrate external agriculture production and food market data using linked open data principles, and will support the planning and decision making processes of different stakeholder groups. It will also offer a marketplace where data can be discovered and exchanged with the additional contribution of external companies.	Feasible, assuming JRC has a contact.
25	Sonderborg ProjectZero	Zero energy initiative, with high involvement of stakeholders, and exchange of information, including renewable energy positions. The southern Danish city of Sonderborg aims to become carbon neutral by the year 2029 according to the zero project. This goal is to be achieved with the heavy analysis and deployment of data around household consumption of hot water, space heating and energy sources within a dynamic system responsive to external changes in energy supply and consumption. This effective use and coordination of data will aim to bring about a rationalisation of consumption in the city, supplying the appropriate resource usage mix according to real needs and changing conditions, which in turn will help meet its environmental targets.	G-G, G-B, B-G	Data held and used by both public and private bodies: exchange of data between public and private partners including in renewable energy consumption and production, but also space heating and domestic consumption.	Stakeholders involved: public authorities providing services, energy companies, but also the companies based in Sonderborg which is an industry hub in Denmark, and the local residents. Geographical coverage: Denmark	Energy consumption, energy supply and space heating.	The primary benefit, is primarily environmental as the project aims to reduce emission by a combination of smart methods monitoring the supply and demand of energy and the heavy application of renewable energy. There are however to be found economic advantages, as one of the stated goals of the project.	Feasibility assessment needed.

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26	European Flood Awareness System	The European Flood Awareness System (EFAS) is the first operational system that monitors and forecasts flood events across Europe. It provides its partners (national/regional authorities, as well as the European Commission's Emergency Response Coordination Centre) with a wide range of complementary, added value flood early warning information including related risk assessments up to 10 days in advance. In order to produce the information geospatial input data, which is outsourced to external companies, and model state variables maps are combined with meteorological forecasts to produce the LISFLOOD hydrological model. Model output is then processed to prepare easy, understandable and significant information, which is transported to the EFAS Website. Data analysis is executed onside the EFAS Computational Centre.	G-G, B-G	Data held by private and public organisations for delivery of a public service: the input geospatial and meteorological data is outsourced to external companies but the analysis of this data is executed onsite the EFAS Computational centre. Data used by public organisations: European Commission's Emergency Response Coordination Centre, national meteorological centres.	Stakeholders involved: EU institutions and agencies, private meteorological and soil data companies, national meteorological centres.	Floods.	Linking together soil and meteorological data coming from different sources allows to produce early warnings information, including related risk assessments up to 10 days in advance.	Feasible
27	Melodies Project	MELODIES project brings together 16 partners to develop eight new innovative and sustainable services, based upon Open Data, combining Earth Observation data with other data sources to produce new information for the benefit of scientists, industry, government decision-makers, public service providers and citizens. The project provides the service developers with a shared collaborative technology platform that gives the required high-level computing and data management capabilities.	G-G, G-B	Data held by public organisation: open data, linking Earth Observation data with other national data sources. Data used by: sixteen partners in eight different projects.	Stakeholders involved: national administrations and research bodies as well as relevant agencies for each of the eight projects. Geographical coverage: eight EU countries.	Emissions, urban accounting, land management, ocean status assessment, desertification indicators, crisis mapping, marine transportation, groundwater modelling applications.	The project provides the service developers with a shared collaborative technology platform that gives the required high-level computing and data management capabilities. This allows them to focus on the design and evolution of their service, enable collaboration on common tasks and will contribute towards the long-term sustainability of the services.	Feasible, assuming JRC has a contact.

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28	MAGDA 2.0	The Platform provides one common Web services platform for the Flemish Government's 190 agencies and 13 departments. MAGDA allows access to authentic sources of citizen and enterprise data, harnessing reusable technologies and applications that can be easily adapted to different government administrations, from the regional to the local level, and increasingly also to the federal level. The implementation of the MAGDA platform is a joint effort between the regional Flemish government and a private sector company. As such, the government is responsible for the overall strategy, functional design and system architecture, whereas the development itself is outsourced to the private sector. By streamlining redundant, labour-intensive manual processes, MAGDA optimises information gathering and ensures more complete, accurate data. The solution lays the foundation for migrating all government tasks to the Web, even local government processes such as applying for permits to build a house.	G-B	Data held by public authorities: is used by a private Flemish IT company to deliver public goods and services. More specifically, the platform includes data from Flemish Government's 190 agencies and 13 departments. Data used by: the platform is used mainly by citizens. As such, the government is responsible for the overall strategy, functional design and system architecture, whereas the development itself is outsourced to the private sector.	Stakeholders involved: national agencies, 13 public administration departments of Flanders, Flemish citizens, ICT developers. Geographical coverage: Flanders, Belgium.	Public service delivery.	By streamlining redundant, labour-intensive manual processes, MAGDA optimises information gathering and ensures more complete, accurate data. The solution lays the foundation for migrating all government tasks to the Web, even local government processes such as applying for permits to build a house. The Flemish Government is currently working to develop a digital process that connects communities to the state MAGDA solution.	Feasible

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29	Enhanced Road Safety	Enhanced Road Safety by integrating Egnos-Galileo data with an on-board Control system (ERSEC) is a key measure aimed at making the roads in Europe safer through the integration of satellite data. The ultimate aim of this project is the development of safer vehicles, which can prevent accidents through the increased security generated by the application of data and creation of a new measuring system. The project relies on the success and application of EICASDRIVE, a Collision Avoidance System developed by EICAS that automatically deviates the vehicle trajectory in the last fraction of a second before an impending crash. ERSEC is developing a measuring system able to detect the position of the equipped vehicle and all the obstacles (such as other vehicles, people and any kind of fixed or mobile objects) around it with a measurement accuracy of the order of 0.1 metre at a sampling rate of 100 Hz.	G-B	Data held by public organisation: Galileo (open data) satellite data is used by EICAS to develop EICASDRIVE, a Collision Avoidance System, which automatically deviates the vehicle trajectory in the last fraction of a second before an impending crash. Data used by private bodies: Anyone owning a car will be able to benefit from the system, hence it will be largely reused by private bodies.	Stakeholders involved: EU institutions and agencies, national research centres, and national automotive industries for product development, testing and launch. Geographical coverage: EU wide.	Road Safety, Automotive Industry, Space Industry.	Every year, road accidents in the EU cause on average 40 000 deaths and more than 1.2 million get injured. The aim of the application is to halve these measures as intended by the European Commission. Greater road safety also impacts employers' bottom lines as working time off due to injury is reduced, together with overall income to families which can be vulnerable to the injury or death of an income earner. ERSEC aims to broaden the scope of the road transport application of EGNOS/GNSS (and later Galileo) through an appropriate integration and data fusion with measurement data coming from other measuring instruments, providing the data needed by systems such as EICASDRIVE to save lives.	Feasible

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30	Scalgo	Scalgo uses algorithmic analytics of geospatial data in Denmark to allow public authorities and private bodies to make the most out of geospatial data. The SCALGO live flood risk, for example, is a national platform which analyses flood risks in the situations of climate adaptation, urban planning as well as preparedness and management of watercourses.	G-B	Data held by public organisation: Danish's government's open geospatial data. Data used by private organisation for public and private service development: The data is reused by Scalgo, a private company to create a product that can be used by utility companies, municipalities and consulting engineering companies to work with climate proofing.	Stakeholders involved: the Danish government, local Danish municipalities, utility companies and engineering companies. Geographical coverage: Denmark	Climate proofing.	Scalgo provides up-to-date data, which allows urban planners, local authorities and engineers to assess the impact of climate changes on their projects in any neighbourhood in Denmark. This significantly increases the efficiency, safety and accuracy of their work.	Feasible, we have contacts through JRC.
31	Bisbase	Bisbase offers its users financial insights into any of the thousand industries that they cover in Denmark. Users register and pay for the insights provided. Bisbase is a Danish firm, which makes use of Danish government's open data as well as open data from the Danish Business authority to produce unique business insights for its customers.	G-B	Data held by public organisation: Danish government's open geospatial data and combines it with open financial data from the Danish Business Authority. Data used by private organisation for commercial purposes: the analytics and insights are of Bisbase are used by private banks, anyone wishing to start a business or learn more about the state-of-play of different markets in Denmark.	Stakeholders involved: national government, business authority, and local businesses. Geographical coverage: Denmark	Finance.	The tool allows Bisbase users to obtain most relevant financial insights to them.	Feasible, given there are contacts through JRC.

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32	Copernicus App Lab	The Copernicus App Lab provides an easy data access platform that brings together the scientific Earth observation (EO) community and mobile developers, which is crucial to the success of EO business development. A proof-of-concept will provide data from the Copernicus Land, Marine Environment, and Atmosphere Monitoring Services in a linked open format (LOD) to promote the inclusion of EO data in mobile applications. The concept is based on the dissemination of data products in a loosely coupled manner based on a framework that facilitates distributed data access and processing. The App Lab will provide tools for different stages of the data value creation chain: tools for publishing, interlinking, querying, and visualising EO data	G-B	Data held by public organisation: Copernicus satellite data. Data used by private organisation for commercial and non-commercial purposes: the App Lab aims to encourage mobile application developers to reuse their data for app development.	Stakeholders involved: EU institutions and agencies, mobile application developers. Geographical coverage: EU wide.	Mobile applications.	Empowering the update of Copernicus services, improving data utilisation through providing easy-to-access and use data, opening up business opportunities, providing simplified access and smarter data, engaging the users.	Feasible
33	EULF transport pilot	The EULF Transportation Pilot aims to improve the flow of up-to-date road safety data between road authorities and private sector map providers in different countries, supporting the aims of the Intelligent Transport Systems Directive and drawing on INSPIRE. The transportation pilot focuses on improving the flow of road safety data between road authorities and commercial map providers (TomTom and HERE) in Sweden and Norway though the adoption of the TN-ITS protocol. The EULF transportation pilot showed significant benefits of using the TN-ITS protocol: time saving for map updating and improvement of the timeliness and quality of data. Swedish authorities switched from twice yearly to daily updates of data. In Norway, the frequency of updates went from quarterly to daily.	G-B	Data held by public organisation: road safety data provided by national road authorities. Data used by private organisations: commercial map providers (TomTom and HERE) in Sweden and Norway though the adoption of the TN-ITS protocol.	Stakeholders involved: EU institutions and agencies, national road authorities, commercial map providers. Geographical coverage: Sweden, Norway.	Road Safety.	Time saving for map updating and improvement of the timeliness and quality of data. Swedish authorities switched from twice yearly to daily updates of data. In Norway, the frequency of updates went from quarterly to daily. For National Mapping and Cadastral Agencies, the benefits linked to the pilot are mainly in terms of marketing opportunities for the ELF platform and from the possibility to test the linear referencing method.	Feasible

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34	Giant 1 and Giant 2	Both programs aim to support the introduction of EGNOS and Galileo services in the aviation market to drastically improve safety levels. The main objectives and challenges of the projects have been to provide a wide range of civil aviation users (airlines, regional/general aviation, helicopters) with first-hand experience on the benefits of GNSS for air navigation. Additionally, GIANT-2 intends to accelerate the adoption of EGNOS in niche markets, i.e. the areas of corporate and general aviation, school and training aviation, and helicopter SAR operations.	G-B	Data provided by public sector organisation: Galileo spatial data. Data used by private sector: aviation companies across Europe.	Stakeholders involved: EU institutions and agencies, operators and ground controllers. Geographical coverage: EU wide.	Air travel, air cargo, additional services reliant on air transport (e.g. health services), and oil industry.	A reduced incidence of accidents will reduce the danger to citizen's lives and the bottom line of air operators, which will add protection against losses in their flying stock. There is also the potential to rationalise conventional navigation aid infrastructure for air traffic. Other benefits can include reduced noise impact for citizens, as the geospatial data will provide better navigation for planes, potentially through more citizen-friendly routes. Moreover, the integration of geospatial data might lead to the creation of new navigation systems, which might represent a boon for some manufacturer of navigation utensils.	Feasible
35	Dalux	Dalux is a private enterprise, which uses Danish government's geospatial data to provide insights to anyone wishing to build or construct in Denmark. It is a free cloud software, anyone who registers can download their application to view building information models. The application allows for both quality and safety management of a construction process. The application can be used on a mobile device, a PC and a tablet. Dalux, is a private enterprise, which uses Danish government's open geospatial data for construction businesses. It uses cloud technology and at the moment the project covers a total of 15,000,000 m² of building information models.	G-B	Data held by public organisation: Danish's governments open geospatial data.Data used by private organisation for public and private service development: The data is reused by Dalux, a private company to create a product that can be used by organisations in the construction sector.	Stakeholders involved: national government, private developers, any construction project using the application.Geographical coverage: Denmark.	Construction, planning.	The application is cloud based and allows all parties involved in the construction process to use a single application, which allows to view building information, manage their safety procedures and quality.	Feasibility assessment needed.

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36	Ensurly	Ensurly is a start-up, which uses open data (from satellites) to provide heightened cyber security. It adds a geo-condition to digital methods in order to enable location matching, location dependency, location authenticity.	G-B	Data held by public organisation: European Space Agency. Data used by a private organisation for delivery of commercial and non-commercial services: Ensurly start up.	Stakeholders involved: start-ups, national administrations working with eGovernment and eRegulation, maritime industries, actors involved in the fintech and insurtech industries. Geographical coverage: predominantly Luxembourg.	Digital security.	By combining geospatial data with other customer data, Ensurly is able to ensure higher digital security of his client.	Feasible
37	My Lake Map	My Lake Map is a mobile application, which allows users to access detailed maps of lakes in Lithuania, with depth level, temperature and other variables shown on the map. Users pay for the maps using credits. At the moment the application has a total of 46 maps and almost 9000 registered users. Users can also post photos and leave comments linked to different lakes on the maps.	G-B	Data held by public organisation: Lithuanian geospatial data is combined with privately collected data on lake properties. Data used by anyone registered on the platform.	Stakeholders involved: data scientists, citizens (fishers), map developers, lake experts. Geographical coverage: Lithuania.	Fishery.	The maps are a unique product for fishers, allowing them to choose the most appropriate lake in Lithuanian for the type of fishing they want to do.	Feasibility assessment needed.

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38	Linked Open Earth Observation Data for Precision Farming	In LEO, partners of TELEOIS (UoA and CWI) joined forces with two SMEs (SpaceApps, VISTA) and one industrial partner (PCA) with relevant experience to develop software tools that support the whole life cycle of reuse of linked open EO data and related linked geospatial data. Finally, to demonstrate the benefits of linked open EO data and its combination with linked geospatial to the European economy, a precision farming application is developed that is heavily based on such data. The project was completed in 2015.	G-B	Data held by public organisation: open Earth Observation data. Data used by private organisation: data used by a consortium of private bodies for development of precision farming application.	Stakeholders involved: EU institutions and agencies, research centres, SMEs, a farming industry organisation, universities. Geographic coverage: EU wide.	Agriculture.	The project demonstrates the value of linked data in the domain of precision farming.	Feasible
39	PREG - reg	Surveying and Mapping Authority of the Republic of Slovenia has built a comprehensive system for the establishment, management and maintenance of the land cadastre data at the level of the central database. PREG-reg is enabling different view services based on the data from the public registers. This one is in particular intended for private companies having public authorities (e.g. surveyors).	G-B	Data held by public organisation: Slovenian national land surveying and mapping authority. Data used by private bodies: private companies having public authorities (e.g. surveyors).	Stakeholders involved: national mapping authority, anyone with the digital certificate to access the database. Geographical coverage: Slovenia.	Cadastral data.	All data from public registers in Slovenia are gathered in one centralised place.	Feasibility assessment needed

ID	Title	Description	Interaction Type	Interaction Description	Stakeholders	Domains	Value created	Feasibility
40	PREG - per	Surveying and Mapping Authority of the Republic of Slovenia has built a comprehensive system for the establishment, management and maintenance of the land cadastre data at the level of the central database. PREG-per is offering a view to a different data from various public registers to the real-estate owners based on the identification with a digital certificate.	G-B	Data held by public organisation: Slovenian national land surveying and mapping authority. Data used by private bodies: real-estate owners.	Stakeholders involved: national mapping authority, anyone with the digital certificate to access the database. Geographical coverage: Slovenia.	Cadastral data.	All data from public registers in Slovenia are gathered in one centralised place.	Feasibility assessment needed
41	EULIS	The European Land Information Service (EULIS) is a European Economic Interest Group (EEIG) governed by members, each responsible for land and property information in its own country or region. It owns a service that provides easy access to land and property information. The portal provides access to land registers across the EU.	G-B	Data held by public organisations: all member states of the EULIS provide their national land and property information. Data used by professional customers: notaries, bankers and other financial institutions.	Stakeholders involved: national authorities working with land, property, cadastral data and in charge of national registries from 23 member countries. Geographical coverage: 23 European member countries.	Property and land data.	Data of registered EU Member states is available in one central place for registered users.	Feasible, given JRC has contacts.

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42	Myplan.ie	It is a public information system about the development plan or local area plan in Irish citizen's local neighbourhoods. The aim of Myplan.ie is to create a one stop shop for information about plans and also to provide other information which is relevant to planning decision-making (census, heritage sites, patterns of housing development etc.) that will not only be of benefit to citizens but will also assist with coordination between local authorities and more generally with the delivery of public services.	G-B	Data held by public organisations: Irish national authorities. Data used by: Irish citizens and businesses.	Stakeholders involved: Irish local authorities, Department of Housing, Planning, Community and Local development in Ireland. Geographical coverage: Ireland.	Delivery of digital public services.	The one-stop-shop helps to smooth the process of decision-making related to planning and also helps with coordination between Iris citizens and local authorities.	Feasible, given JRC has contacts.
43	Transport for London open data access for developers	London's TFL actively uses open data to deliver enhanced service options to its citizens. Such open data use can be applied and positively affect different forms of public transports: road, cycling, tub and bus transport, allowing users to access real-time developments around the city and assess their best travel options. This includes the monitoring of live traffic disruptions, through the TIMS feed, which was built to replace the older Live Traffic Disruptions (LTIS) feed decommissioned on 1 April 2013. The new feed has been changed to capture a richer range of information about road disruptions, including improved spatial information, providing citizens with details of closures and more in-depth categorisation of the cause of a disruption.	G-B	Data publicly held by Transport for London. Data used: anyone accessing the database.	Stakeholders involved: public transportation passengers, private drivers, cyclists and London commuters and transport operators. Geographical coverage: UK	Open data, traffic live feed using spatial data.	Allowing citizens to plan their trip in advance and in light of updated transport information allows for citizens to plan effectively their next journey and make sound travel choices that minimise cost and stress on passengers. This can translate into economic gains, as less time is wasted in travel but also in reduced environmental impacts. Less stressful commutes can also impact positively driver and commuters' well-being.	Feasibility assessment needed.

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44	Basic data programme in Denmark for authentic key reference data	The basic data programme is a vast national programme in Denmark aimed at overhauling how public data is owned and utilised, and how it is made available to economic actors. It includes several sub-programmes for different data types; i.e. property data, geographical names, climate adjustment data, geographical data, basic citizen registration data, data about companies. The programme also proposes an infrastructure model for spatial information, which in turn offers recommendations aligned to those proposed in the INSPIRE Directive. The new infrastructure model ultimately aims to make the basic information held about citizens, companies and buildings available for reuse within the public sector and private sector, free of charge, in order to provide enhanced and timelier services.	G-G, G-B	Data held by public administration, to be shared and reused within the public sector, but also the private sector.Data used by: economic actors.	Stakeholders involved: public administration actors, public entities delivering services, private sector organisationsGeographical coverage: Denmark.	Spatial data, including data related to addresses, property, citizens, companies, geography and water management.	Some of the outcome that could be generated by this would be a unified national basic data for watercourses, which in turn can help coordinate a better response in light of information available about the terrain. Additional benefits could be felt in the economic fields, whereby actors such as banks would and real estate companies will have access to publicly available data, which would in turn provide smoother case handling processes, eliminate to the need to build new IT systems and thus in turn lead to economic gains.	Feasible, given JRC has contacts.
45	Microsoft® Bing™ Maps Platform APIs'	Bing™ Spatial Data Services Application Programming Interface (API) provides a Representational State Transfer (REST) interface that can geocode, store and query spatial data. This simple REST interface accomplishes tasks by setting parameters in a URL and then submitting the URL as an HTTP request. The HTTP response returns the results of the request. With the Bing Spatial Data Services, users can geocode and reverse-geocode large numbers of locations with the Geocode Dataflow API.; store and query entities with a location, such as set of retail stores or restaurants using our Data Source Management API and Query API.	G-B, B-G	Data held by private organisation: Bing, and also contains several public data sources. Data used by private bodies and individuals for developing services.	Stakeholders involved: providers of public data sources, Bing and users of the data. Geographical coverage; global.	Geocoding.	The portal allows users to use vast amounts of data and allows them to geocode, store and query spatial data all in one place/	Feasibility assessment needed.

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46	Traveline	Traveline is a public transport route planner service provided by a partnership between local authorities and transport operators in the UK to provide impartial and comprehensive information about public transport which has operated since 2000. The organisation receives no public funding and if any profit is put back into making their services better.	G-B, B-G	Data held by public and private organisation: the application is developed through a partnership between public authorities and private transport operators in UK. Data used by private individuals: the applications delivers a service allowing users to plan their journeys across UK.	Stakeholders involved: national authorities, transport operators (bus, rail, coach, ferry), application developers, all British transport companies. Geographical coverage: UK.	Journey planning.	The application allows users to accurately plan their journeys as it involves data from all British transport companies operating in the country.	Feasible, given JRC has contacts.
47	Map Alerter	Map Alerter is an application which enhances communication between Irish local councils and local citizens. The application gives Irish local authorities the ability to issue alerts for specific topics and service disruptions, and tailor the alerts based on citizens' locations. The application makes extensive use of geospatial information. The application won Best Local Government Service in 2012. Rather than informing an entire town about a water outage, all alerts are mapped so only the affected residents are notified.	B-G	Data held by private organisation: MapAlerter is developed and managed by Pin Point Alerts Ltd, a Kilkenny-based digital communications company. Data used by public organisation to deliver public service: the developed application is used by the local Councils in Ireland to alert their citizens of any potential changes in the domains of water, roads, community, flood, weather and planning in their area.	Stakeholders involved: 10 local councils and their respective local authorities in Ireland, and citizens who download application. Geographical coverage: Ireland.	Public service delivery. Water, roads, community, flood, weather and planning domains.	One great benefit of Map Alerter using geospatial data is that local authorities, through mapping alerts and citizen addresses, are able to notify only the citizens for whom the alerts are relevant.	Feasible, we have contacts through JRC.
48	SCIMAP	The software produces maps, which help to identify the locations in UK that could potentially be water polluting. The scientists at Durham University are developing a framework for modelling and mapping diffuse pollution risk across landscapes. It helps to identify where on the landscape the water polluting problem might be	B-G	Data held by private organisation: SCIMAP is developed by an expert team at Durham University and is funded by NERC and UK EA. Data used by public and private organisations: policy makers, local	Stakeholders involved: British Environmental Agency, local authorities, those working in the field of agriculture, urban design, and environment	Water pollution.	The service is associated with efficiency savings from spatial targeting, which offers a rare 'win-win-win' for regulators, farm businesses and the environment. Trough interdisciplinary research it	Feasible, we have contacts through JRC.

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		originating. Users of the tool can download the SCIMAP software for Windows or use the web based my.scimap tool for free from the SCIMAP website. The tool can also be combined with other types of data to create new products and services for different types of users groups (e.g. farmers).		authorities, those working in the field of agriculture, urban design, environment conservation, and others. Hence, both public and private users.	conservation. For example, rivers trusts in the UK have been using SCIMAP to inform and support integrated catchment management.Geographical coverage: UK.		is possible to quantify the economic and environmental benefits of using spatially targeted regulation on only high-risk land units (prone to generating pollution and hydrologically connected to the receiving waters) by making use of recent advances in surveillance science and risk profiling (SCIMAP). Thus farmers will mainly take control measures, and regulators will mostly inspect practices, on targeted high-risk 'leaky' land.	
49	Noise-Planet	It is as a free and open-source tool, integrated in the OrbisGIS software, designed to produce environmental noise maps on very large urban areas, with few computational resources. The tool consists of several applications services. Users can feed back data by using the Noise Capture mobile application to record noise levels in their neighbourhood. These are then mapped onto the 'Noise Community Map'. OnoMap, a Spatial Data Infrastructure (SDI), is a central component in the Noise-Planet project because it provides all the tools to store, catalogue, share and display noise data. Elaborate noise data can be accessed through Noise Modelling, which allows to view the maps in 3D, mesh data, and filter by regions and population densities. NoiseModelling plugin has been developed thanks to the Eval-PDU and VegDUD research projects supported by the French National Research Agency (ANR).	B-G	Data held by private organisation: Noise-Planet is developed by Eval-PDU and VegDUD projects. Data used by public and private organisations: researchers, students, teachers, engineers, policy makers.	Stakeholders involved: research centres, citizens, researchers, engineers. Geographical coverage: France.	Noise monitoring.	Users can assess and provide the levels of noise in their communities.	Feasibility assessment needed.

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50	NATO Core GIS	NATO Core GiS is an enterprise-level geospatial data and service infrastructure, which provides centralised geospatial services to NATO headquarters staff and command and control (C2) systems. The system delivers cartographic services, GIS developer toolkit Component-Based Framework. The services are the toolkits are deployed on each of the local area networks at 18 NATO headquarters in 12 countries.	B-G	Data held by private organisation: the platform was developed by ESRI. Data used by an international organisation for delivery of public services: NATO, its troops.	Stakeholders involved: private mapping company, international organisation, anyone involved in NATO's missions. Geographical coverage: NATO headquarters in 12 countries and in local missions.	Military	The central system ensures that everyone employed in NATO 'fights on the same map'. It is accessible and used by all 18 NATO headquarters and staff on missions.	Feasibility assessment needed.
51	Pitney-Bowes	Pitney-Bowes is a private company, which uses geospatial data to help companies and public organisations to improve their service delivery, enhance efficiency and reduce costs. They operate in financial services, insurance, healthcare, telco and utilities, retails and public sectors.	B-G	Data held by private organisation: Pitney Bowes Data used by: clients of Pitney Bowes, including public organisations across Europe.	Stakeholders involved: Pitney-Bowes, public organisations, health authorities, local councils, road authorities, police services and others. Geographical coverage: Global	Financial services, insurance, healthcare, telco and utilities, retails and public service delivery.	Geospatial data, together with other type of data is used to help clients enhance their operations.	Feasibility assessment needed.
52	Tom Tom developer portal	TomTom developer portal offers several commercial services/APIs (routing, traffic,…). The developer portal allows users to create applications, navigation solutions, creates applications using sports data and helps one to plan their routes.	B-G	Data held by private organisation: Tom Tom. Data used by private organisations and individuals for better service delivery.	Stakeholders involved: Tom Tom and developers using the portal. Geographical coverage: global.	Travel planning applications, traffic data.	The portal allows developers to use Tom Tom's maps and applications to create their own products and services.	Feasibility assessment needed.

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53	Google Maps APIs	Google Maps APIs are available for Android, IOS, web browsers and via HTTP web services. Google Maps APIs also contain solutions, which provide comprehensive, scenario-oriented guidance that addresses common users' business problems.	B-G	Data held by a private organisation: Google. Data used by private individuals and companies for delivery of services.	Stakeholders involved: Google Maps, users of APIs, both commercial and non-commercial. Geographical coverage; global.	APIs, service development.	Both paid and free service exist, users can make use of wide range of different APIs.	Feasibility assessment needed.
54	OpenWeatherMap	Our mission is to provide a global geospatial platform which is affordable to users and enables them to operate effortlessly with Earth Observation data like satellite imagery, weather data, and similar data sources. On their platform users can easily build new data-driven products for agriculture, logistics, retail, transportation, and many others using the available meteorological data and maps.	B-G	Data held by private organisation. Data used for delivery of public service: anyone accessing the website can check weather forecasts and users can also use the data to develop data-drive products in the different sectors.	Stakeholders involved: data analysts, service developers in the fields of agriculture, logistics, retails transportation, etc. Geographical coverage: global.	Service development using meteorological data.	The platform offers simple and clear API, interactive weather maps and satellite maps, raw data from 40,000+ weather stations and 24/7 tech support via our Support Centre	Feasibility assessment needed.
55	Openaddresses.io	Openaddress is a free and open global address database. All data on the database is publicly licensed and anyone is able to contribute a dataset.	B-G	Data held by private organisation: the data held by Openaddress is publicly licensed and user driven. Data used for delivery of service: the data is free for use by anyone.	Stakeholders involved: developers, individuals submitting the datasets. Geographical coverage: global.	Address data.	The platform contains public data and users can provide their own dataset to enrich the database.	Feasible, given JRC has contacts.

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56	Real time traffic management in Vienna	To receive realistic information, ITS Vienna Region uses PTV Optima - PTV's tool for real-time traffic management. The software combines reliable offline traffic modelling with the available real-time data (like Floating Car Data, ANPR or inductive loop detectors...) and real-time algorithms. The PTV solution also considers unpredicted traffic delays, as well as known disturbances in the form of accidents or construction sites. By respecting these data sources, PTV Optima calculates and visualizes the current and future traffic situation. The results are updated every seven minutes, improving the benefits of all connected systems like e.g. the national journey planer "AnachB".	B-G	Data held by: private organisation: PTV Optima. Data used by public organisation for the delivery of public services.	Stakeholders involved: ITS Vienna Region, PTV Optima, road management authorities, citizens. Geographical coverage: Vienna, Austria.	Real time traffic management.	Thanks to real time traffic management, the city of Vienna is able to optimise the functioning of its traffic lights and allow smooth flows of traffic in the city.	Feasibility assessment needed.
57	Telemetry based insurance vendors	The basic idea of telematics auto insurance is that a driver's behaviour is monitored directly while the person drives. These telematics devices measure a number of elements of interest to underwriters: miles driven; time of day; where the vehicle is driven (GPS); rapid acceleration; hard braking; hard cornering; and air bag deployment. The level of data collected generally reflects the telematics technology employed and the policyholders' willingness to share personal data. The insurance company then assesses the data and charges insurance premiums accordingly.	B-G	Data held by private sector: sensor companies who collect telematics data. Data used by private sector: insurance companies use telematics to assess insurance premiums.	Stakeholders involved: drivers, insurance industries. Geographical coverage: Global.	Car insurance.	Using telematics allows insurers to much more accurately assess the profile of the driver and, hence, provide a more accurate insurance premium.	Feasibility assessment needed.

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58	Building information modelling and possibly its relationship with INSPIRE.	BIM (Building Information Modelling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. Autodesk, for example, has a software that can be bought or used freely by students. Another software is OPORO.Different countries are channelling efforts to mainstream the usability of BIM. For example, in UK, CPIC is trying to promote and ease the use of BIM. In order to speed up the development, dissemination and adoption of standardised product data and to standardise the underlying hidden parameter required by many mainstream BIM authoring systems, BIM Hawk has developed a database that makes available for free product data templates and sheets with other digital toolkits.	B-G	Data held by: private organisations, most often.Data used by: anyone working in the construction, infrastructure, planning sectors.	Stakeholders involved: construction designers, engineers, software developing the BIM, sometimes national authorities for its promotion. Geographical coverage: EU wide.	BIM can be applied in infrastructure, architecture and construction sectors. It can also be used for structural, mechanical, electrical and plumbing designs.	BIM is revolutionising the way architects, constructors and engineers can visualise and plan new building projects.	Feasibility assessment needed.
59	Weather Underground API	The Weather Company makes its API reusable for developers with several different pricing options. Some APIs are used to create free online applications for end users.	B-G	Data held by: private organisation, the Weather Company. Data used by: private companies to develop applications, and potentially those delivering digital public service.	Stakeholders involved: data scientists, citizens (fishers), map developers, lake experts. Geographical coverage: Lithuania.	Weather forecasting, application development.	The APIs can be easily reused and integrated to create new applications using weather data.	Feasibility assessment needed.

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60	Digital Catapult, Building Data Exchange	The Building Data Exchange is a platform which will unlock one of the largest unexplored data sets in the Built Environment. It contains data collected through Innovate UK's Building Performance Evaluation programme, which analysed how well real buildings performed. The Building Data Exchange makes this data open and accessible to the built environment community, digital innovators, designers and entrepreneurs.	B-G	Data held by private sector: Digital Catapult Data used: the data is made public in the form of reports and can be used by the environment community, digital innovators, designers and entrepreneurs.	Stakeholders: Data experts, construction experts, environment community, digital innovators, designer, entrepreneurs. Geographical coverage: UK.	Building information	The reports provide detailed information for more than 100 projects around UK allowing end users to access building information in one central place.	Feasibility assessment needed.
61	CityMapper Bus, UK	Citymapper has launched, still in test mode, a free bus in central London. Called CMX1, the route runs from Southwark – near the company's headquarters – to Blackfriars, west to Waterloo bridge, and back along the south bank. Although it'll use existing bus stops, it does not look like the regular London bus: it'll use smaller, 30-seater vehicles, dubbed "Sprinters", painted bright green. Inside, the company has redesigned the bus experience: seats will offer USB charging points, large displays will advise users on when to get off. Up front, the driver will use a custom-built tablet interface to stay informed in real-time on traffic, passenger numbers, and headway (the distance between vehicles) advised by a central controller using Citymapper's demand data.	B-G	Data held by private sector: CityMapper. Data used by private sector for public service delivery: the bus uses real time data to avoid traffic and enrich route planning for passengers, at the moment the service is free.	Stakeholders involved: City Mapper, passengers. Geographical coverage: UK.	Real time travel	This is the first bus to use real time traffic to adjust its route and also to inform passengers.	Feasibility assessment needed.