ESPON

EUROPEAN UNION

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Inspire Policy Making with Territorial Evidence

TARGETED ANALYSIS //

DIGIPLAN – Final report

Evaluating spatial planning practices with digital plan data

Final delivery // June 2021

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Abbreviations

INSPIRE	INfrastructure for SPatial InfoRmation in Europe, European directive
WFS	A standard protocol to share geographical features (e.g. polygons of plan areas) online
WMS	A standard protocol to share georeferenced map images (e.g. a scanned image of a plan) online.

Foreword

When we met at the kick-off meeting in Copenhagen in January 2020, we did not have any imagination of what would happen a few weeks later. During March 2020, the continent locked down and COVID-19 has since changed our everyday life. All physical meetings have been cancelled. Interviews have been conducted online. Some team members have been hit hard with reduced work capabilities because of childcare duties, limited home office possibilities or shifting working conditions. Despite being proud of what we have achieved, including the extensive empirical material we collected, we want to stress that the absence of physical meetings has limited our abilities to unfold, debate and develop the topic in dialogue. Something we hope to catch up on in a different context in the future. However, during this pandemic we learned to make best use of digitalisation, in our regular meetings in the research team, with the three stakeholders and ESPON EGTC, but also in two online workshops with experts from planning practice in November 2020. The recently boosted use of digital media throughout the entire society highlights the importance of research dealing with digitalisation in the societally relevant field of spatial planning.

In the DIGIPLAN project we explored the development and state of digital plans and plan data in several European countries. It is the first of its kind; no similar research has been conducted before and the topic of inquiry was spanning wide from the beginning. An explorative approach was necessary to shed light on more or less advanced digital practices in different spatial planning contexts. However, we also present an early systematisation of general concepts, key terms and approaches, describing emerging digital plans and plan data and related practices.

Some highlights are

- State of digitisation of plans in 15 European countries.
- In-depth case studies with insights from experts and practitioners from six European countries.
- Five thematic papers on the character of digital plans and plan data, drives and purpose for digitisation, digital portals and accessibility, the legal status of digital plans and a collection of upcoming technical developments which will influence planning practice
- Policy recommendations and future research proposals based on our empirical material

While there is a huge diversity across the cases, they all have in common that there are high ambitions and continuous development in the field of digital plans and plan data. Although a targeted analysis for stakeholders from Denmark, Norway and Switzerland, DIGIPLAN findings can inspire a wider professional audience.

Denmark is one of the pioneers in the digitalisation of spatial planning. Since 2006, following a reform restructuring municipalities and region, Denmark has an official, countrywide digital plan register, an open geodatabase including e.g. over 34,000 effective local development plans. All plans made within the framework of the plan law have to be registered. The scope and quality of the plan data has increased significantly in the past two years because the data is used for a new property tax system that is under development. Denmark will use the outcomes of DIGIPLAN to inform the evaluation of recent changes in the planning law and other spatial policies, e.g. the national planning act, the development of the digital plan register, etc.

In Norway the government has committed itself in 2015 to focus on digitalization and formulated goals for full digital plan registers in all municipalities, The focus is on supporting the vertical dimension of zoning plans and digital provisions, better and clearer context between the map (the land use plan) and the provision – to enable faster decisions. Norway has used a common standard for all the zoning plan maps for many years, and that makes the analysis of this issue easier. Norway will use DIGIPLAN to provide guidelines and support to local and regional authorities.

In Switzerland the government has adopted a digitalisation strategy in 2016 and 2018, which supports the further digitalisation of plan data, especially in the framework of the Smart City/Regions initiatives. Furthermore, Switzerland being a federal State, all Swiss cantons have set up their own cartographic portals dedicated to spatial development in addition to the actions taken at national level. DIGIPLAN will further inform the evaluation of building activities in and outside planning zones, monitoring of zoned and built-up land as well as development of related spatial policies.

DIGIPLAN is a successful example of ESPON targeted analyses, a powerful mean to transfer knowledge, share experience and facilitate the use of territorial evidence rooted in real place-based policy development processes.

Enjoy reading!

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Executive summary

In the past decade, many European countries have taken significant steps to set up digital plan registers and digitise spatial planning processes. The digitalisation process is driven by ideas of efficiency, expressed for example in the concept of “smart cities” and “digital governance”, ideas of participation and improved public service, like “open government” and “open data”, and an aspiration for new economic growth and business opportunities based on this.

Digital plans and plan data open a range of new opportunities for new planning practices. However, evidence on the impact of this digitisation on e.g. efficiency, innovative practice or transparency in planning is lacking. In the DIGIPLAN project we explored the development and state of digital plans and plan data in several European countries as well as the obstacles and main drivers for the digitalisation. It is the first of its kind; no similar research has been conducted before and the topic of inquiry was spanning wide from the beginning. An explorative approach was necessary to shed light on more or less advanced digital practices in different spatial planning contexts. However, we also present an early systematisation of general concepts.

What is the digitisation of plans and plan data?

Although we touch upon different planning instruments in DIGIPLAN, our focus is on **municipal plans**, e.g., land use or zoning plans. Municipal planning instruments are also the most commonly digitised planning instruments[1]. Typically, there is a supervisory authority at the regional or national level and a desire to make plans and plan data accessible on a joint portal.

In the past decade, many European countries have taken significant **steps towards establishing digital plan registers** and digitising spatial planning processes. In particular, formal planning processes are being documented digitally and standardised. Data includes information on the planning process and the planning content.

In a broad sense, digital plan data includes all digital information (typically available online) related to a plan. This can include simple PDFs and images, georeferenced information and geodata or even highly structured, machine-readable regulations[2]. In a narrow sense, we **define digital plan data** as a specific form of geodata.[3] It is issued by spatial planning authorities and describes regulations and intentions, rights to the use of land (or space in more general) now and in the future, and it includes metadata on, e.g., the validity period. A similar definition is used by the EU initiative INSPIRE for the theme “Planned Land Use” (INSPIRE, 2013).

However, even if we can agree on such a definition, digital plan data includes a **wide variety of forms and formats**. The data may be available as raster (e.g., georeferenced images) or vector (scalable). Different parts of a plan may be available in different technical formats. Moreover, the procedural role and the legal status of digital plan data ranges from simple digital representations of analogue plans, which are only for information purposes, to fully digital plans, which are the sole legally binding plans.

The digitisation of plan data is not new. It began to emerge with the availability of GIS software with graphical user interfaces in the 1990s and innovative towns and individuals, who began to explore its potential. However, in the latest development, digital plan data has become **embedded within established planning practices**. Digital plans are becoming mainstream in planning processes and plan data has been integrated with other sectors and is now used beyond the traditional planning sphere, becoming part of a wider ‘integrated digital governance’.

[1] See section 2.1 and Annex 1 / Paper 2 “What are the drivers of the digitisation of plan data and what is its purpose?”

[2] See Figure Figure 1.3, page 21

[3] See section 1.2 and Annex 1 / Paper 1 “What is digital plan data?”

What is the state of digitisation in Europe?

There is great diversity regarding the level of digitisation in the field of spatial planning in Europe. DIGIPLAN only provides a snapshot of the status quo and processes in selected countries. To the best of our knowledge, no such study has been conducted previously. We applied an **explorative approach**, describing current states and development paths, discussing terms and drawing early lessons from the empirical material.

However, it is clear that many European countries and regions, e.g. in federal states, are **collecting digital plan data** and establishing registers. Some collect and even scan plans themselves, others require plans or certain data to be uploaded by local planning authorities, while still others have implemented a completely digital plan processing system[4].

The desire to provide harmonised and standardised plan data on a digital and open platform among spatial planning actors is especially clear from 2010 onwards[5]. There is often a difference between the **plan data that is accessible** online to the public and the data that is available internally or to restricted user groups. Such differences include how the data can be accessed (e.g., only viewing possible, not download), its format (vectorised or image) and the type of information (e.g., draft plans only available to restricted users). In this respect, **INSPIRE** has fostered open data (and metadata), but has not necessarily driven digitisation in the cases. However, differences have become clearer, which puts pressure on those lagging behind.

In terms of the role of digital plans or plan data, our cases demonstrate the breadth of the diversity[6]. In the majority of countries, **digital plan data (geodata) is only a representation** of the actual binding analogue plan, which is published in the town hall. The representation can also include more or less details of the plan, and is only for information purposes, highlighted with corresponding disclaimers in the online portals. Some cases operate digital and analogue versions in parallel, with corresponding mechanisms for comparison in the administration (some cantons in Switzerland and some states in Austria). The actual **digital plan data is legally binding** in only a few cases (the Netherlands, Portugal). In some cases, the PDF version of a plan is binding (Denmark, Tyrol/Austria). In practice, however, digital plan data is often used as if it were legally binding (de facto) in many cases when the quality of the data is high and it is easily accessible.

Differences in the organisation and publication of digital plan data reflect **differences in spatial planning traditions and competences.** This refers, for example, to the 'division of power': When a supervisory authority exists, it might demand access to digital plan data when inspecting plans. Furthermore, the existence of a legally binding symbology for plans provides a different starting point for digitisation than if plan requirements and standards are more loosely defined.

In general, planning authorities apply **many digital tools in formal planning process** to support everyday practice. These include data repositories, access platforms and management systems, online communication and dissemination platforms, open governance data services / open data etc.

Although all the cases studied in DIGIPLAN have their own story and are digitising with different priorities, we can identify four, common phases of the digitisation of plans and plan data in recent decades (Figure E.1). Firstly, experiments with digital plan data in administrations started in the 1990s. In the 2000s, the first guidelines for data formats were developed and implemented formally in planning laws. Digital portals were developed further for internal and external use. The past ten years can be considered as the implementation phase. In parallel, the development of the portals continued with improved plan data submission methods, new functions for users, or the adaptation to planning processes (or also the other way around). The current phase can be called integration. Digital plans and plan data are becoming increasingly integrated in digital administration and governance. Plan data is available on open geoportals and increasingly used.[7]

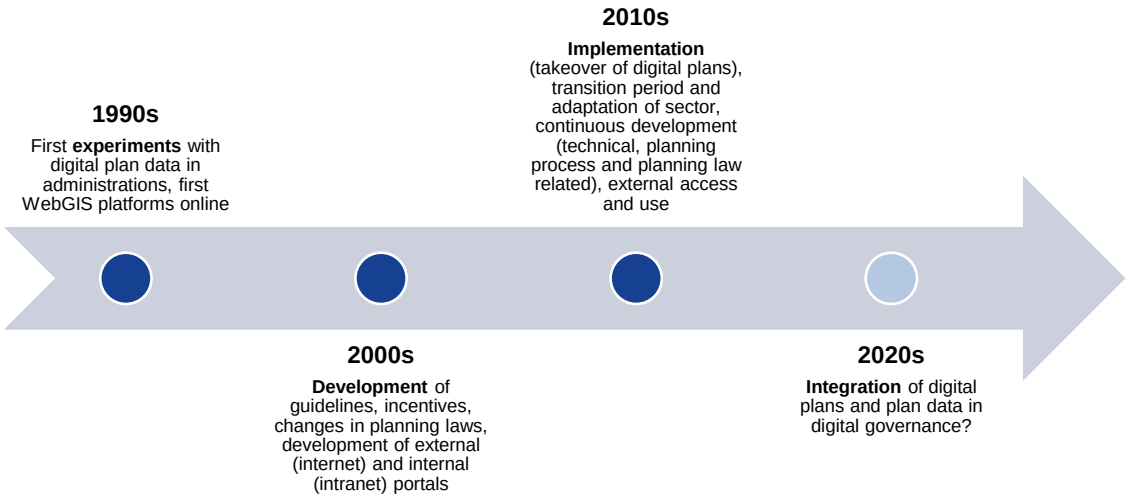
[4] See section 2.1 and Annex 2 (fact sheets on 15 countries).

[5] See section 3 and Annexes 3-8 (reports on Austria, Denmark, France, Germany, Norway and Switzerland).

[6] See section 2.2 and Annex 1 / Paper 4 "Are digital plans and plan data legally binding?"

[7] See Annex 1 / Paper 1 "What is digital plan data?"

Figure E.1
Simplified development in digital plans and plan data in the past decades



Source: Authors

How does planning practice change?

For planning authorities, digital plans and plan data have primarily **increased the efficiency** (i.e., reduced the time needed for the same task) of workflows. Even though systems are in constant development, the availability of digital plan data was mentioned many times as being a huge advantage in formal plan processes compared to the time when only analogue data was available. Furthermore, in cases where digital and analogue plans are handled in parallel, and new tasks regarding comparison need to be introduced, it was seen as an advantage as at least some of work could be based on digital data.[8]

Digital plan data and associated standards and data models enable **data exchange**. This means, for example, closer integration with the building sector, nature management, infrastructure, and service provision. The standardised data also improves the potential for analysis and innovative practices, e.g., following up on plan implementation. Many planning authorities are now starting to conduct more **structured analyses** and are still exploring the potential.[9] In general, the digital format allows questions to be asked of the data, which had not been considered when the data was produced. Open and structured data supports innovation in a wide sense. However, this poses the risk that plan data is used out of context. Certain plan regulations only make sense when seen in a bigger picture, such as a regional setting. An analogue plan can present the necessary context. Digital plans and plan data can be disaggregated, divided, and split without limitations.

Nevertheless, this also allows users, e.g., citizens, to obtain the **exact information** they need. Many plan data portals allow users to select and analyse plan data, create excerpts, or download geodata, often additionally listed in open data portals. This increases **transparency** and **involvement** in planning matters, especially of professional interest or lobby groups, but it also limits access for potential users when technical barriers are too high. In this respect, digital plans and plan data can support participatory processes when used appropriately. The formal **participatory** processes related to a plan (**official hearing**) have, in some cases, already been integrated into digital plan data platforms.[10]

[8] See section 2.1 and Annex 1 / Paper 2 “What are the drivers of the digitisation of plan data and what is its purpose?”

[9] See Annex 1 / Paper 5 “Future technical developments and opportunities”

[10] See Annex 1 / Paper 3 “Who can access digital plan data and does it change involvement?”

The use of digital plans and plan data requires **new skills** for plan making and an adaptation of technology in planning authorities and planning consultancies. The introduction of new technologies and systems is not always seen as a contribution to making planning on the ground easier or better. In particular, when system development has been driven by national/regional authorities or policy domains that are not directly connected to planning (e.g., because of a general requirement in public administration), it can cause long transition periods or even result in a dysfunctional system.

With digitisation, planners need to provide **highly detailed data**, which is often much more detailed than what was necessary for the equivalent analogue plan with a fixed scale and no possibility to overlay with other data. Requirements for **plan accuracy** are changing, even if not stated in planning laws. Issues of scale, fuzziness, ambiguity, context, accessibility, and legal status also illustrate that traditional plans were not designed for a digital format. In some cases, planning processes have been adapted to **new digital routines**. Nevertheless, not all planning instruments (especially those of a more visionary or strategic character) are digitised in the same degree as, e.g., municipal land use plans, while some, such as the Danish maritime spatial plan, are set up from scratch in a digital format.

Policy recommendations

DIGIPLAN provides a wide range of recommendations, formulated in each thematic paper as well as for each case study. To structure the recommendations in this summary, we use three ideas which are very often named as the major purposes or drives for digitising plans, but also digitalisation in more general: **Improving efficiency, enabling innovation and increasing transparency.** The recommendations are based on the overview of 15 countries (section 2 and Annex 2), the case work (section 3 and Annex 3-8) as well as the thematic work (section 4 and Annex 1).

Digitise to improve efficiency

#01 Know your planning system

The digitisation of the public sector, planning systems and planning practice is ongoing and evolves with technology. To anticipate the path of digitisation, it is important to understand the planning system and the historical roots of planning instruments. It is an important condition to know your planning system for improving efficiency. The potential of digitisation varies, and it faces different challenges, which depend on the division of power in a planning system, the level of the planning authority, the regulations on plan content as well as the wider legal system.

#02 Develop standards

A good starting point for the digitisation of plans and plan data is to define standards and data models, establish metadata, and develop technical requirements for digital plan data that work across the whole country (planning system). Digitisation offers many new opportunities and advantages. To ensure future use and continued development, establishing a comprehensive data structure is crucial. A coordinated data review, probably shared between stakeholders, may be necessary. In Germany, XPlanung is an example of a feasible approach for creating digitalisation standards in spatial planning, particularly in a federal country. In France, a multi-stakeholder council develops joint standards.

#03 Ensure compatibility between plans and plan data / standards – address actual needs

If plans are not fully digital yet, a challenge in the development of digital plan data can be the compatibility and comparability between the digital plan data and the legally binding plans, e.g. in the form of pdfs, as is the case in Denmark. The data models for reporting the digital plan data do not always correspond with the decrees and explanatory texts of the legally binding plans themselves. As a result, the digitised plan data can be different from what has been politically adopted, as there is a translation of the plans to the available data model taking place. In Norway, digital plan data is strongly formatted by their own standard and the need for harmonization of regulatory planning instruments. At stake here is the scope of digitalisation, whether "everything" needs to be digital, or whether one should focus on a production and exchange of more targeted and relevant data according to the topic of a decision. This may reduce the amount of information needed, and the costs related to its production and consumption.

#04 Reduce workload for plan administration

Digital plan data can reduce workload in the everyday administration of plans and plan regulations. E.g. the possibility to retrieve planning excerpts, helped to reduce the workload and costs and speeds up the planning processes in Luxembourg.

#05 Digitisation makes plans easier accessible and improves collaboration

In general, the study shows that digital plans and plan data are seen as a big advantage in terms of being accessible online to everybody, allowing to use the data for various purposes. Digital plans and plan data also seem to improve exchange between authorities. This is further boosted, when digital plans are legally binding or are at least de facto used as if they were the original data.

#06 Develop digital process chains to facilitate cooperation

Digital process chains can be developed to increase efficiency and coherence of various administrative processes. The German standards of XPlanung and XBau enable the link between strategic planning, land-use planning, architectural design, construction, and monitoring of the built environment. If they can be pursued together, they foster unprecedented synergies in the planning and construction context.

#07 Use digitisation to improve flexibility in the planning process

During the COVID-19 crisis, planning departments with a high degree of digitalisation had an advantage in regards of workflows, especially when people have to work from home and need to have access to plans. Furthermore, it also highlighted the problem with required building site meetings during the lockdown. Even though, public life opens up again, digital processes could improve such meetings.

#08 A clear strategy (and funding) to implement efficiency gains

Development of digitisation is often slowed due to missing financial back up, massive tasks related to digitization, and prioritisation. It is recommended to have clear strategies instead of focusing on short-term developments.

#09 Go for fully digital plan data

Many cases do not implement fully digital plans, but e.g. use the Raster-Ring approach (Germany) or have parallel systems, with analogue and digital plans (Austria). This might be a feasible solution for the transition, but fully digital plan data (as e.g. in the Netherlands) offer better opportunities to satisfy future needs of spatial planning.

#10 Address digitisation in rural areas

Our study indicates that smaller and/or rural municipalities, which are not part of metropolitan or intercommunal cooperations lack behind in some countries (France, Germany). This gap might even widen over time, as digitisation, so far, seems to get more complex with more standards, more data, more portals and more demands. This makes it difficult to catch up for those lacking behind. A review of the standards, so they fit also smaller authorities could be considered. Also, the national or regional level could help digitising plan data in less resourceful municipalities, e.g. by providing funds or expertise.

Digitise to enable innovation

#11 Ensure accessibility to digital plans and plan data

Accessibility to plan data is key to facilitate business and open to new actors; e.g. real estate, building sector but also for citizens. Digital plans enables municipalities to reach a greater number of citizens and in addition, the digital plans make it easier for citizens to find the right planning information.

#12 Can citizens or the private sector be more active involved in the development?

The current plan data governance structures are often closed around public authorities. While being cautious with influence of non-elected bodies in public administration, it could still be beneficial to consider a more active involvement of citizens or the private sector in the development of digital plans and plan data, and not only see them as data consumers. Citizens and the private sector have insights from specific places, practices or professions and have valuable knowledge to share. Involving them could contribute to make plans

and the plan portals more useful to a wider audience and enable innovative practices (see e.g. Denmark or France).

#13 Share knowledge and examples of digital plans and plan data use, national and international

The example of France showed that there are strong national standardisation tendencies, but at the same time an enormous activity at the local level. Cities can be very advanced in digital plan data. Sharing these and similar experiences in the community can inspire good practice and accelerate digitisation. Furthermore, the project work during DIGIPLAN, e.g. in the interviews or the workshops we participated, also showed the high interest in sharing knowledge internationally.

#14 Make use of digital plan data to evaluate planning

The steady of increase of building land is a recurring topic in the public debate. Digital plan data can help to get an overview as well as to conduct analysis on what, where and when new building land is zoned. The use of this data can provide the highly necessary evidence to base future spatial planning policy on. In Switzerland and Austria first analysis have been done.

#15 Consider a better monitoring of the use

At the portals and data providers, very often, knowledge on data use is missing. Typically, general online statistics are available, but it is unclear who is using what for which purpose. A more qualitative monitoring, getting in touch with users directly, is important to keep up the relevance of the portals and data and ensure that they actually fulfil their purpose. Not least this is important when digital plans should have the status of being legally binding. Regular workshops and networks as organised in Denmark or France, although mainly focused on experts, might be a first step.

#16 Parallel systems as a compromise for transition

Having parallel systems in place, whereby an analogue version of a plan co-exists with a digital version (legally binding or not) may be a practical compromise during transition periods (e.g. Austria). Even if this means that redundancies will occur, it can help to ensure a smoother transition, while at the same time reaping the benefits related to accessibility, analytical insights and an increase in skills internally and in the wider planning community.

#17 Adapt the planning system

It may prove necessary to adapt existing plan instruments so that they are compatible with digitisation. Such adaptations range from the need to make changes to aspects of the plan layout such as symbologies and annotations, to regulations that stipulate how plans must be published and how they are accessed. At the same time, it is necessary to be aware of the potential to lose plan information when digitising, e.g., losing contextual information when there are no limits to the scale.

#18 European institutions can support exchange, not least in cross-border areas

It is very likely, that in the next few years, digital plan data of rather good quality and detail will be available from all EU member countries. The GeoRhena sub-case showed the need for data exchange between regions of different countries. European institutions such as Eurostat or ESPON can support this also in the area of plan data, especially regarding the data collection and provision as well as the provision of important meta data (e.g. what a certain plan/regulation implies), but also to support knowledge exchange. INSPIRE can be the technical platform to build on.

#19 Support exchange between planning and GIS community and interdisciplinary collaboration

Minimizing the knowledge gap between planners/politicians and GIS-technicians to improve the use of existing plan data and geodata. In general, interdisciplinary communication should be supported. The more information, the better conditions for enabling discussion of land use, because everything has a clear spatial reference.

Digitise to increase transparency

#20 Digital plans can improve transparency regarding current regulations

The transparency aspect regarding the idea of getting tailor-made information on plan regulation for a specific parcel is quite advanced in many cases or also the more general possibility of accessing plan information easily over the net.

#21 Employ digitisation to make plan process visible, not only the final document

The use of digital plans before they get adopted, e.g. in a participation process, is not that spread yet. Most plan data portals document only the current state of plan regulations. Digitisation and new ways of communicating and accessing data and plans could be used to also improve and open up the plan making processes as well as the implementation and evaluation following.

#22 Have the users in mind, provide different entry points and use an open data approach

The digitisation of plans and plan data also involves an increase in complexity. Digital portals often also display a range of data related to, e.g., nature, socio-economics or public services. The joint visualisation is though often not optimal, compared to printed products where a lot of effort is done to increase readability. For users, different entry points to plans and plan data should be considered to reduce complexity. The depth of information, the tools to interact with, or the presentation of data can then be tailor-made for the selected purpose. For example the Danish digital plan platform has been developed further to become easier, more logical, and intuitive regarding both the reporting module for municipalities and the interface for users. In Norway, the importance of local portals has proven to be an important feature of the planning system, at its current state of digitalisation. Besides specific entry points, a general open data approach supports accessibility. This allows innovative use and assures universal access in the future.

#23 Develop the portals collaboratively

The development of digital plans and access portals needs to be conducted in dialogue with all target groups (planners, software producers, municipalities or municipal associations, citizen groups) in order to ensure that the digital plans can actually be used for planning and are not just there because it is technically possible. In many cases, this has been done by formal (e.g. specific councils/conferences) and informal (e.g. workshops) collaborations between different planning authorities and other stakeholders. Informal and voluntary collaboration can play a rather important role to increase later acceptance of new standards, processes, technologies etc. and ensure their relevance.

#24 Digitisation can benefit all levels of governance

Although different drives and purposes in mind, all levels of governance may benefit from digitisation of the planning system. Funding or financing of digitisation therefore needs to account for these wider effects which digitisation.

#25 Enhance communication and participation of stakeholders with digital plan data

Easy access to digital plan data increases their user community, on the one hand. On the other hand, their versatile usability enables communication with various stakeholder groups and supports their involvement in planning processes. For example, the recent open data decisions of the Swiss Federal government underpin this recommendation.

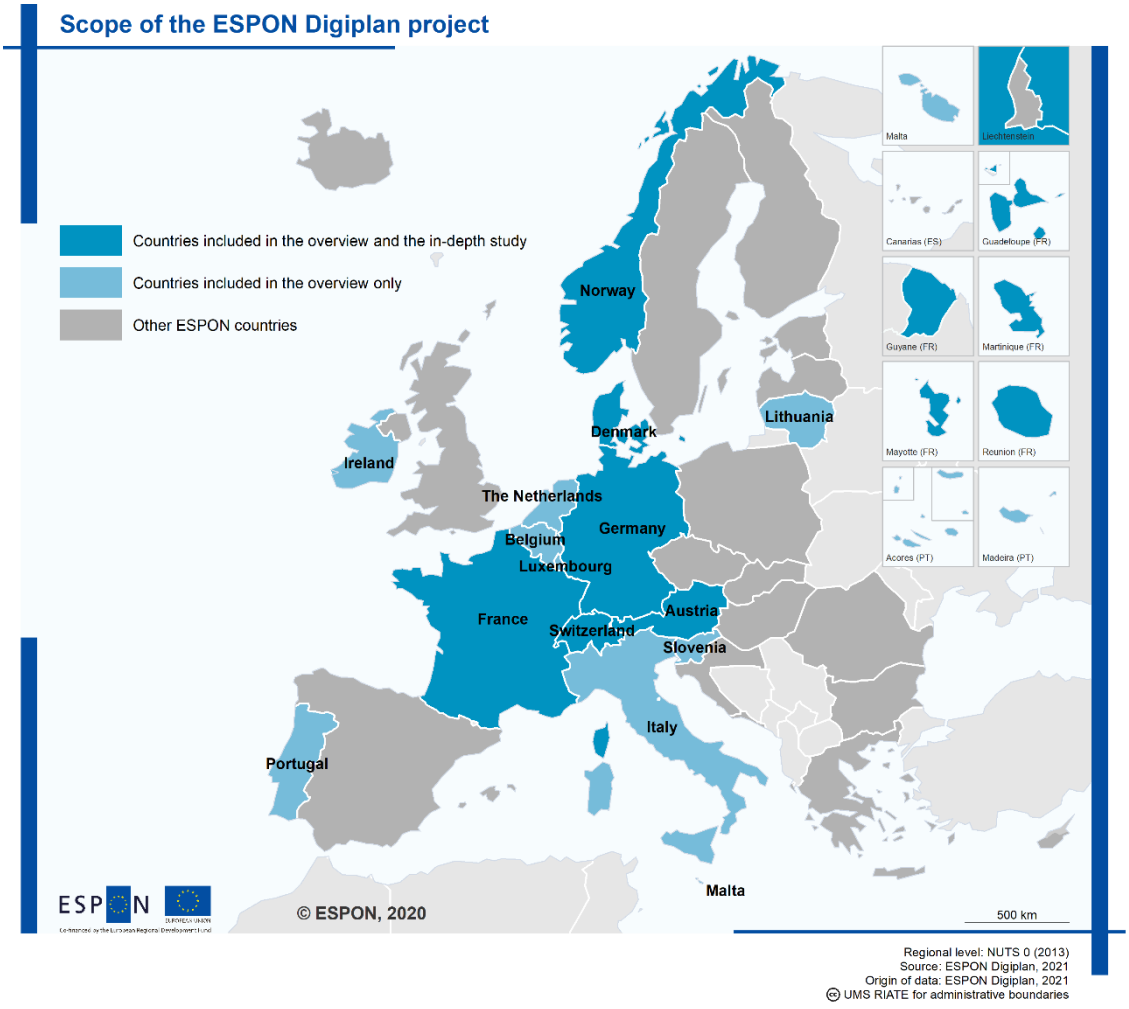
1 Introduction

1.1 Objective of DIGIPLAN

In the past decade, many European countries have taken significant steps to set up digital plan registers and digitise spatial planning processes. Digital plan data opens a range of new opportunities for getting insights into planning practice and the role of planning for spatial change over time. However, evidence on the potential of digital plan data and their actual use is lacking. At the same time, we can assume that the digitisation of plan data has an impact on planning practice.

The topic of digital plans and plan data is, therefore, twofold: (1) a provision/production side, e.g., how plans are digitally represented, and (2) a user/consumption side, e.g., how plan data is used and how it influences planning practice. Digital plans and plan data can, therefore, not be seen in isolation from planning practice. The digitisation is based on practice, because that is what it represents, and practice is influenced by digitisation, because it redefines, changes or introduces terms, standards, procedures, and relevance.

Map 1.1
Countries included in DIGIPLAN



In several cases, only parts of a country were studied, because the planning system had a federal structure or was regionally differentiated.

In DIGIPLAN, we studied digital plans and plan data across different planning systems in Europe. Although we touch upon different planning instruments in DIGIPLAN, our focus is on **municipal plans**, e.g. land use or zoning plans. Typically, there is a supervisory authority at the regional or national level and a desire to make plans and plan data accessible in a joint portal.

DIGIPLAN is a project developed in close cooperation with stakeholders. Stakeholders represent national planning agencies or ministries from Denmark (Danish Housing and Planning Authority), Norway (Ministry of Local Government and Modernisation) and Switzerland (Swiss Federal Office of Spatial Development). The stakeholders generally aim to gain greater knowledge on digitalisation in other ESPON countries in order to use this in connection with deliberations on future digitalization initiatives in the field of planning data.

We structured our analysis by asking three main questions:

- the scope of the digitisation of plan data – what has been digitised and why?
- the organisation and financing of the digitalisation – how is it digitised?
- the current and potential future uses of digital plan data – how is it/can it be used?

DIGIPLAN provides an overview and in depth, practice-oriented knowledge and recommendations on these matters, responding to stakeholders' knowledge needs. This final report presents our findings. The main highlights have already been listed in the executive summary. Chapter 1 defines key concepts and terms. Chapter 2 provides an overview of the digitisation of plans and plan data in 15 ESPON countries (Map 1.1). Chapter 3 summarises insights from the following 6 in-depth case studies: Switzerland, Norway, and Denmark (the three stakeholder countries), and Germany, France, and Austria. Chapter 4 cuts across the 6 cases and presents a broad overview by providing insights from five thematic papers (full length can be found in Annex 3) that explore key topics around digital plan data, while it also includes a brief discussion on indicator development and proposals for future research. Further details and background material can be found in the annexes (Table 1.1).

Table 1.1
Reports of the final delivery

Document	Content
Final report	Final report including executive summary
Synthesis report	Brief summary of main results
Annex 1	Five thematic practice papers
Annexes 2.1 – 2.15	Fact sheets on digital plans and plan data in 15 European countries
Annex 3	Digital plans and plan data in Austria
Annex 4	Digital plans and plan data in Denmark
Annex 5	Digital plans and plan data in France
Annex 6	Digital plans and plan data in Germany
Annex 7	Digital plans and plan data in Norway
Annex 8	Digital plans and plan data in Switzerland
Annex 9	Methodological background

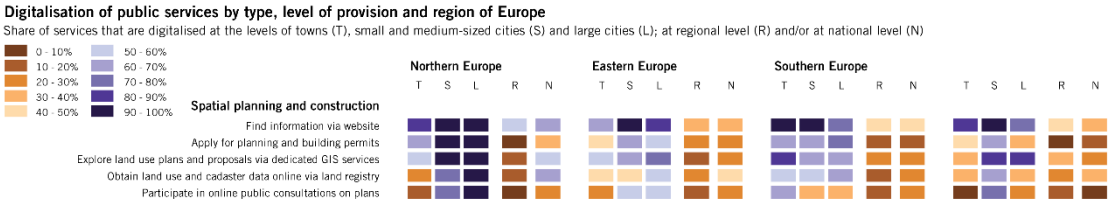
1.2 Conceptual background

1.2.1 Digitalisation of planning practice and planning systems

The digitalisation of workflows and datasets produced both in the private and public sectors has been gaining momentum (EC, 2017). This process is driven by ideas of efficiency, expressed for example in the concepts of “smart cities” and “digital governance”, ideas of participation, where key aims include the establishment of “open governments” and “open data”, and a hope for new economic growth based on this data (UN, 2017). National as well as international policies such as the EU’s INSPIRE directive from 2007 or the EU’s strategy for a digital single market are also driving digitalisation. Most recently, EU’s cohesion policy put the implementation of the Digital Single Market in focus, by supporting digitalisation in society and economy, improvements of digital infrastructure and investment in innovative technologies (EC, 2019) , Regarding spatial planning, the Aarhus Convention (UNECE, 1998) implemented more than 20 years ago introduced an overarching reason for improving public accessibility to planning information relevant to the state of the environment.

ESPON’s recent policy brief (2018) on the digital transition provides some hints on the current state of digitalisation in spatial planning. Many cities provide various services around planning, including exploring land use plans with GIS servers and obtaining data online via land registries. At the national level, however, the study finds that only a few services have been digitised (Figure 1.1). Nevertheless, as shown in our study, many countries have digital plan registers or are in the process of establishing them

Figure 1.1
Digitalisation of spatial planning and construction services in Europe



Source: ESPON (2018)

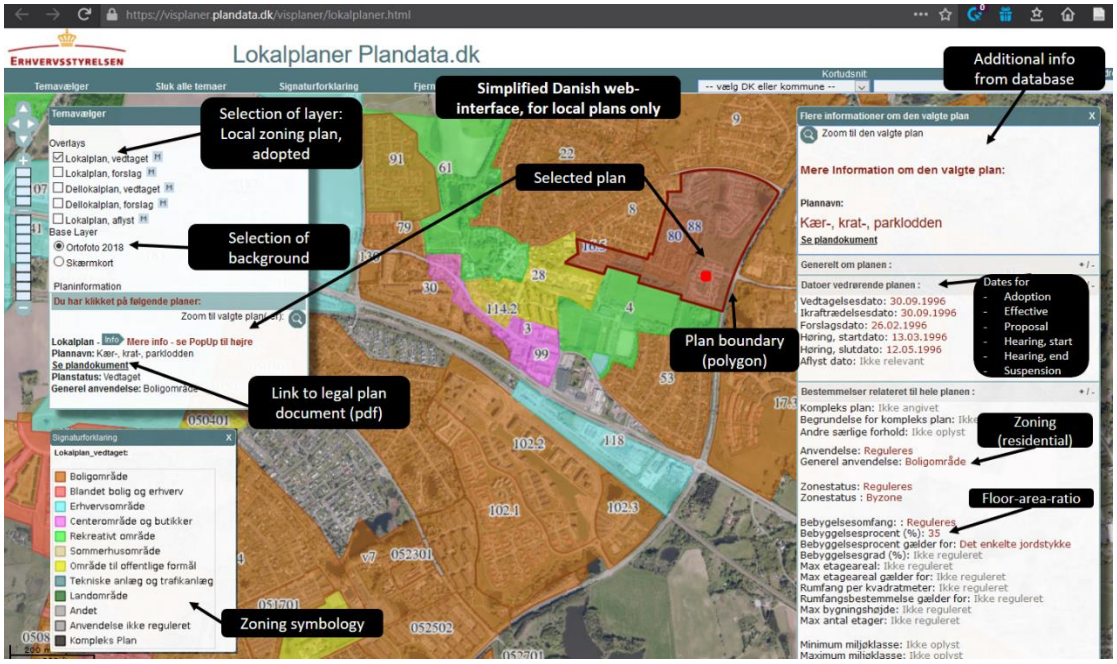
Comparative analysis requires an understanding of institutional spatial planning systems, more specifically, the functions that characterise planning, and the existence of instruments that allow the system to perform accordingly. Mazza (1996) differentiates between the following three types: 1) instruments that structure decision-making, endowing plans with a functional programme (strategy), 2) instruments for implementation and change (policy, design), and 3) juridical provisions (regulation, guidelines). ESPON COMPASS (ESPON COMPASS, 2018) provides a similar typology. In the widest sense, a spatial plan is the association of a spatial grid with norms and regulations for the allocation and use of rights (Mazza, 2010). This then raises the question of how digital information facilitates the allocation and use of rights in different national contexts, according to their institutional planning systems, the level of digitalisation of public services and plan data, and the culture of spatial planning practice.

The "owner" of the institutional planning system (often ministerial authorities) seems to be motivated by aggregating and communicating everything. This aspiration implies a potential conflict of interests regarding the performativity of the system. While digitisation may improve the efficiency of the production and consumption of data through planning activities, a plan is, nonetheless, an image; a symbolic form, subject to individual and collective decoding and interpretation (Gabellini, 1996).

The relationship between public sector digitisation agendas (or private developers’ agendas in some cases such as digital technology providers with public sector clients) and the creation of public awareness of spatial phenomena and processes may then be an issue of concern. The integration of geodata and plan data into common systems of information requires a significant degree of standardisation regarding data and the regulation of the information flow, possibly enhancing data accessibility at the expense of the cognitive and structuring role of plans. At stake is an appropriate representation of space in planning and decision-making

processes, and the balance between relevant and excessive information. An assessment of the balance between the efficiency of digital plan data and good spatial planning practices requires conceptual clarity on types of spatial information and the regulation of the relationship between citizenship and space.

Figure 1.2
Example of digital plan data in one of the Danish web-interfaces



Source: plandata.dk, own annotations

The digitalisation of planning has a number of likely but still unknown effects. It is likely, for example, that digitalisation, which itself entails a degree of geometrical, thematic, and technical standardisation of work-flows to be practically feasible, will lead to increased standardisation of how to plan, i.e., the standardisation of visions for future land use formulated by communities and institutions.

It is also likely that digitally facilitated processes of public participation as well as the presence of wider, online domains for dissemination- and accessibility-processes will lead to plans obtaining new performative roles. Plans may be used outside the expert community where it was produced, which in turn may influence how planners work.

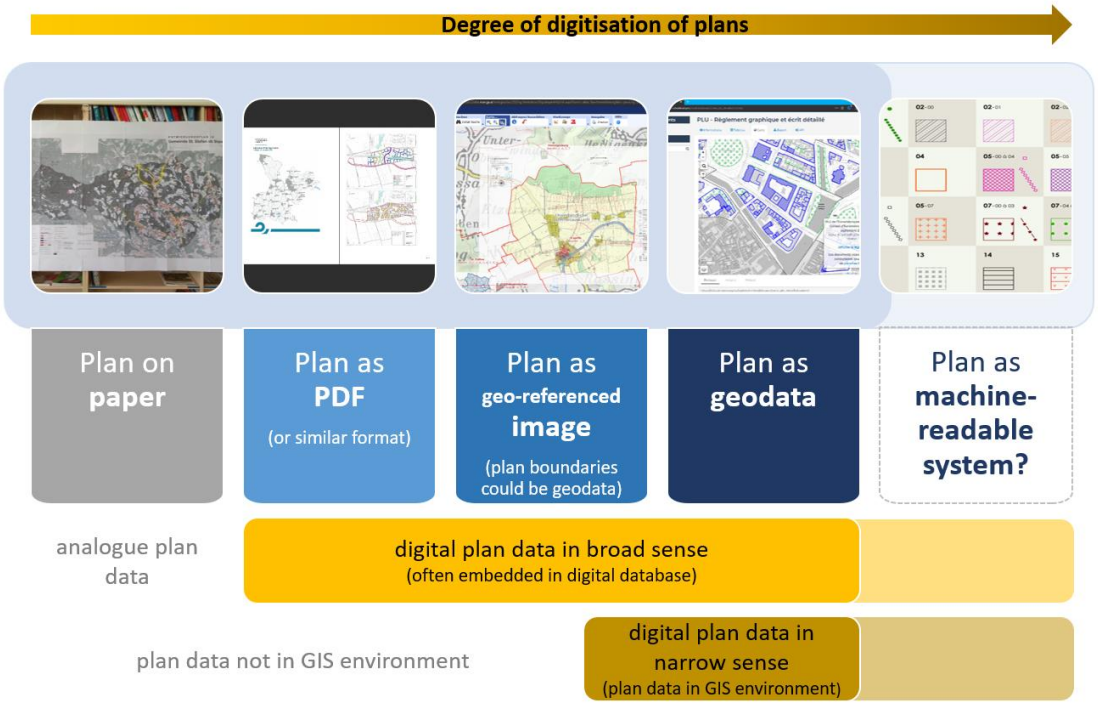
There has been an interest in using digital plan data in the context of Geodesign, which is defined as a set of concepts and methods used to involve all stakeholders and various professions in collaboratively design-ing and realising the optimal solution for spatial challenges in built and natural environments by utilising all available techniques and data in an integrated process (Steinitz, 2012). However, research in that respect has mainly focused on advanced planning support systems and has neglected the use of digital plan data in everyday planning (Hersperger and Fertner, 2021).

1.2.2 Digitisation of plans and plan data

The digitalisation of plan data as such is not new, but the systematic approach within a whole country and the development towards fully digital plans is. In a narrow sense, plan data can be defined as geodata that reflects planning regulations. Polygons that represent a discrete zoning map produced by the local planning authority are an example (see Figure 1.2). The data represents, e.g., specific usage rights or building re-strictions for a specific area, binding for more detailed plans or landowners directly. Plan data is different from planning data, which is data that provides input to the planning process (e.g., traffic data, land use modelling data).

At the other end of the scale, there are more visionary and strategic spatial plans, which often have fuzzy boundaries and only indicate intended spatial changes (ESPON COMPASS, 2018). Plan data must then be assessed as strategic representations of spatial development, often in the form of spatial grids or diagrammes that indicate potential courses of action, anticipating the making of zoning and regulation. Strategic spatial plans can also be digitised, either with very basic information or with more details, but not standardised across different plans. As planning becomes more strategic at all levels and planning tools become more adaptable, it is important to analyse the digitalisation of these types of plans, in particular. However, regulatory plans have not disappeared and are receiving renewed interest as a result of digitalisation. Both types of plan data can be provided at different spatial/policy scales, e.g., at the national, sub-national, and municipal/local level.

Figure 1.3
Degree of digitisation of plans

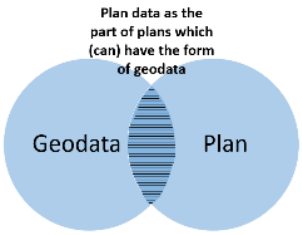
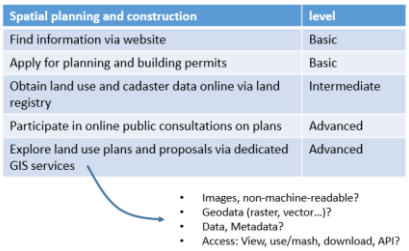
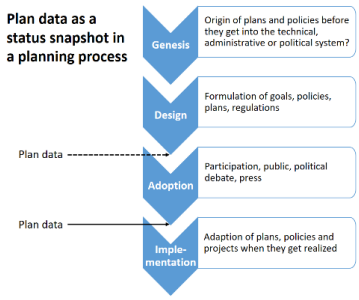
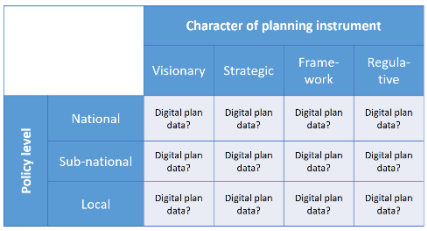


Note: The stage to the right, plans as machine-readable system, is greyed because we have not found any plan or plan data working like that yet, this was mentioned as a possible future in some cases.
Source: Authors

A central idea is that of the degree of digitisation of plan data. This may be related to technical (e.g., in a GIS environment or not) as well as legal issues (which version is binding?). Figure 1.3 illustrates this. Nevertheless, as our study shows, there is a range of different characteristics that may describe digital plans and plan data, not always along a continuum. We discuss this topic in more depth in section 4.2, although Table 1.2 highlights some of these aspects.

Knowing the purpose, intentions, and not least the history behind digitalisation is important to be able to interpret the data correctly. One of the big advantages of digital plan data, its flexibility of use, is also its greatest challenge as it can easily be taken out of context or used in inappropriate contexts. There are high demands regarding the data quality, but at the same time, the (future) requirements may be unclear when plans are digitised.

Table 1.2
Different perspectives on digital plan data

Digital plan data as a special form of geodata Digital plan data can be understood as a special form of geodata. It covers a specific area with some attributes. What is special about plan data is that it presents intentions and regulations, not a current state, although the difference in practice will be less clear. Furthermore, a plan also consists of many other elements which might not be geolocated other than, for example, covering the whole municipality (e.g., a certain goal or vision formulated in the plan).	
Degree of digitisation In practice, the digital version of, e.g., a zoning map may be a scanned image/not machine-readable or it may be raster or vector data (e.g., polygons) with metadata included. How the data can be accessed may vary, e.g., it may only be possible to view it, tools may be included, or users may be able to download it as geodata or access it via an API as well as openly/publicly or limited accessibility. Digital plans may exist in parallel with analogue plans, or alone, thereby constituting the legally binding form of a plan.	
Plan data in the planning process Planning involves a process, formal and informal. We can assume that standardised plan data is rather limited in relation to such a process, as it only represents a snapshot. In particular, the early phases of a plan process may not be represented in plan data. Other information may be digitised, but not in a standardised format. Using plan data must critically reflect this limitation of representation of the planning process. Planning phases based on Flyvbjerg (1992)	
Plan data from different plans and policy levels ESPON COMPASS (2018) illustrated the wide variety of plans and policy levels involved in spatial planning in Europe. Digital plan data, if it exists, will have very different format depending on the character of the planning instrument and the policy level.	
The aim of digitising plans The format and content of plan data is related to its aim. It may be framed against a general digitalisation agenda in the public sector with overall goals about efficiency, open governance and new growth based on data. It may also be part of more specific, planning-related goals such as allowing digital participation and hearings, digital planning permit processes and easier cooperation between departments or different authorities.	

To summarise and in order to provide a simple joint framework, we defined a number of key terms (Table 1.3). Geodata and plan data are different types of spatial information; "maps" and "plans" are produced and used on the basis of different concerns with space, yet they rely on each other and share data. Both regulate the relationship between citizenship and space. An essential difference between them resides in their concern with time and their allocation of rights to the use of space. In practice, geodata and plan data are combined through the information flow of increasingly integrated digital systems of data production and consumption.

Besides plan data, digitisation and digitalisation are two important terms. Digitisation as the actual conversion of analogue data to digital, while digitalisation includes the wider process and reaction to it in planning or society. However, in practice it is often difficult to see the difference, the terms are sometimes used interchangeably. Another important term is digital portals, sometimes also called platforms, which are the entry points to plan data. These may be part of a bigger system, e.g., one that supports the formal planning process, backed up by various databases. However, they may also just present data from other sources. An important feature of such portals is that they are accessible and intuitive, which means they can be used by non-experts. For example, "basic map navigation and data querying functionality is being expanded to incorporate advanced map-making and online data geoprocessing capabilities that enable deriving new data and insights." (González et al., 2020)

Table 1.3
Key terms

Term	Definition
Plan data	Reflecting planning intentions, regulations, and risks and opportunities typically as map or text. Allocation of rights to land use currently and in future.
Geodata	Digital information about geographic locations, stored in a format that can be used with a geographic information system (GIS)
Digital plan	A plan accessible digital (online), format can be different, but in a narrow sense all regulations are accessible as digital plan and process data
Digital plan data	Plan data in a GIS format, which means related to machine-readable geographic locations
Digital process data	Data from the planning process (e.g., plan status, date of effectiveness, author…)
Digitisation	Transform from analogue to digital format, often by applying standardisation and harmonisation of data and (re)defining regulations and visualisation rules for the digital format.
Digitalisation	Different ways in which society or planning reacts to/takes advantage of digitisation
Digital portal (or "platform")	Any electronic tool for communication to, e.g., visualise or edit plan data, support analyses, support hearing process, participation, interaction, and report errors. WebGIS is the most common user interface.
Base map	Plan data is normally mapped onto a base map, which in turn may be based on the land registry
Legal status of digital plan data	Is the digital plan / plan data legally binding?
Land registry (cadastre)	Land Registry provides property owners with a land title guaranteed by the government, as well as a title plan that indicates the property boundaries. Today usually available digital. Spatial plans on local level (e.g. land use plans) often have to relate to the land registry.
Planning process	Key steps of plan making (e.g., genesis-design-adoption-implementation), not necessarily in a linear sequence (workflow)
Spatial plan	Plans (and other tools) used to mediate and regulate spatial development, usually related to the legal planning framework and various planning authorities
Geodesign	Concepts, methods and digital systems used to involve in collaboratively designing and realising optimal solutions for spatial changes

Source: Authors

2 Overview of digital plan data across Europe

The aim of this up-to-date overview of the digitalisation of plan data in fifteen European countries is to identify the key similarities and differences in the digitalisation of plan data as well as current uses and potential future developments. This overview is the result of desk research and qualitative semi-structured interviews and should be seen as an explorative study on the digitalisation of plan data in Europe. The aim of the desk research is to provide background information on the planning system and the planning instruments to contribute to a better understanding of the context of the digitalisation of plan data (e.g., the main actors in spatial planning, type of planning instruments, etc.) before performing the interviews. The desk research facilitated more in-depth interviews. The questions that were prepared for the semi-structured interviews are available in Annex 1.

The qualitative exploration of the digitsation of plans and plan data in 15 European countries highlighted the following **key findings**:

- There has been an eagerness among spatial planning actors to provide harmonised and standardised plan data on a digital and open platform in the past 10 years.
- Digitisation has improved workflows and planning practices, thereby contributing to cost-reduction.
- The way in which countries have organised and published digital plan data differs, which reflects the diversity of spatial planning traditions and competences.
- Digital plan data that has been harmonised and standardised facilitates innovative practises.
- Foreseen future developments in the digitalisation of plan data may be affected by a reordering of priorities and possible budget restrictions as a result of the COVID-19 pandemic.

The qualitative exploration of European experiences regarding the digitalisation of plan data tackles several challenges. The **main challenges** identified are:

- DIGIPLAN does not provide in-depth information on the diversity of the spatial planning contexts in the fifteen selected countries and regions. Other publications provide such background knowledge; see, for instance, the study by the ESPON COMPASS project (Nadin et al., 2018).
- The varying extent of digitalisation in the fifteen selected countries. The interviews only provide a snapshot of the digitalisation and the use of plan data as of spring 2020, when the selected countries and regions were at different stages of their overall digitalisation strategy.
- Inputs from the interviews provide a clear overview and precious information for this study. However, it should be kept in mind that the collected information may not always provide an exhaustive picture of the context. Our results reflect an explorative approach of the digitalisation and the use of digital plan data in fifteen countries and regions across Europe.
- The nature of semi-structured interviews provides rather clear answers, which provides a good basis for a cross-case analysis. However, it can limit the level of detail. Furthermore, the fact that the interviewees had limited time for the interviews meant that it was not possible to explore every single question in depth. Indeed, semi-structured interviews do not allow a complete exploration of individual perspectives and circumstances, resulting in patchy information.
- The majority of the interviews were conducted and reported in English. However, English was not the native language of most the interviewees which may reduce preciseness of answers or hide nuances. Some interviews, if possible have been conducted in the local language, otherwise we tried to clarify things in follow-up communication.

The remainder of this section highlights the most common answers collected during the interviews. Detailed information for each selected country and region were summarised in factsheets, which can be found in Annex 2.

2.1 The digitisation of plan data

This section presents the results from the desk study and the interviews about the purpose, added value, most significant drivers, main obstacles, and the standards and methods of the digitalisation of plan data. Each sub-section provides a summary of the main patterns identified in the fifteen cases. Examples of specific cases are also included for illustrative purposes.

2.1.1 Two main purposes

The digitisation of plan data takes place within the contexts of digitalisation achievement and spatial planning traditions. However, the answers to the question "What is the main purpose behind the digitisation of plan data?" reveals clear similarities between the case studies. Overall, the main purpose of this process can be summarised as follows: to improve access to high quality and comparable plan data through a digital format on a single portal.

Two main purposes of digitisation were identified in the case studies. The most common one, which was mentioned in thirteen cases, is to ensure easy access to plan data with a high level of transparency to everyone. This was expressed in different ways in the interviews through notions such as open data, open governance, transparency, and easy access to data and metadata. For instance, transparency of governmental processes is the main purpose in the Netherlands. Ensuring transparency, including access to metadata, was clearly stated as one of the main purposes in Denmark, the region of Tyrol in Austria, and Switzerland[11]. In the case of Norway, the transparency of plan data is related to having an effective and democratic planning process with the potential for increased involvement of the public and sector authorities. Similarly, the investigation in Italy highlighted the use of digital plan data as a means for better knowledge base for decision making. In Portugal, easy access to digital plan data helps address the increasing demand for geographical and territorial information from administrations, government, universities, private companies, and the general public.

The other main purpose is a desire to create a nation-wide (or region-wide) digital portal that contains harmonised plan data or plan data of a better quality than the non-digital format. This was mentioned as one of the main purposes of the digitisation of plan data in ten of the fifteen cases[12]. For instance, the main purpose of the digitisation of plan data in Luxembourg is to increase the homogeneity and the quality of the plan data.

2.1.2 Added value

Being able to produce country or region-wide analyses, improved workflow and planning practices, and cost reduction are the most common benefits of the digitalisation of plan data mentioned by the interviewees.

Being able to produce country or region-wide analyses was explicitly mentioned as an added-value in eleven instances. It is closely linked to the main aim of digitalisation, i.e., to create a nation-wide digital user interface, containing standardised and harmonised plan data, which not only provides a larger coverage of plan data, but also harmonised plan data that can be used for different types of analyses for an entire country or region. In Ireland, such country-wide harmonised datasets allow the analysis of land use zoning data, which was not possible before digitalisation, when the quality of plan data varied greatly between local authorities. Similarly, the use of harmonised digital plan data in Malta allows the planning authority to analyse the number of urban developments proposed or implemented outside development zones within a specific period of time, or the footprint of certain types of areas and their changes over time. The standardisation of plan data in municipal plans was also mentioned as an added value of the digitalisation of plan data in Slovenia.

[11] See, for instance, www.geocat.ch Accessed on December 15th, 2020.

[12] The creation of a nation-wide digital portal was mentioned as one of the main drivers in Germany, Ireland, Lithuania and Slovenia. This information is reported in this sub-section on main purpose to make the overview clearer.

Improved workflow and planning practices were mentioned in ten instances. The improvement mostly concerns the municipal level. For instance, the digital submission of plans to the State is simpler for municipalities in Denmark than the previous analogue submission. Similarly, municipalities in Luxembourg do not have to manually extract plan data to prepare requested planning reports for parcels located on their municipal territory. Such reports can now be auto-generated through the country-wide geoportal, thereby reducing the workload of municipalities. The automation of planning permit processes also improves both the workflow and planning practices. Finally, the improvement of workflow was explicitly connected to cost reduction in five cases, due to faster processes (e.g., Bavaria in Germany), digital publications being cheaper and easier to store than paper publications (e.g. France), etc.

2.1.3 Main drivers

The following three main drivers of the digitalisation of plan data were identified: top-down process led by national/regional planning actors, the INSPIRE Directive, and the general digitalisation process and technological development.

The top-down processes led by national or regional planning actors correspond to either the active role of the Ministry or Authority responsible for spatial planning or new spatial planning laws. The pro-active role of the national or regional authority responsible for spatial planning was also a key driver in Wallonia (Belgium), Lithuania, Luxembourg, Norway, Portugal, Slovenia, and Switzerland. For instance, the Ministry of the Interior is the clear driving force in Luxembourg as was the Ministry of the Environment and Spatial Planning in Slovenia, which combined all the plan data provided by the municipalities. A top-down process also characterises the Danish case, with the difference being that it was the tax authority rather than the national planning authority that was the driving force behind a digitalised and harmonised dataset containing plan data. In Switzerland, it is the regional actors, the Cantons, which demand digital plan data from the municipalities. Furthermore, the legal requirements to publish plan data in a digital format were mentioned as one of the main drivers of this process in several instances, e.g., the region of Tyrol, where the 2011 spatial planning law was changed, stipulating that land-use plans be published online, which has been the case since 2013. In Bavaria, an amendment to the Building Code in 2017 required the municipalities to publish their land use plans on the state's central internet portal.

The INSPIRE Directive (INfrastructure for SPatial InfoRmation in Europe) is an initiative of the European Union the aim of which is to establish infrastructure for spatial information in Europe that is aimed at making geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development[13]. Even though the Directive does not mandate the digitalisation of data, it has been clearly connected to the digitalisation of plan data as the two processes run in parallel. The Directive contributed to making the authorities in charge of plan data think about the digitalisation of their data. INSPIRE was mentioned in eight cases (Bologna, France, Germany, Luxembourg, Switzerland, the Netherlands, Tyrol and Wallonia) as either one of the main drivers in the beginning of the digitalisation of plan data or at a later stage in the process.

The general digitalisation process and technological developments were also clearly stated as being key drivers in the digitalisation of plan data in the cases of Luxembourg, Malta and Switzerland. New possibilities thanks to new technologies producing better quality data, as well as more efficient integration of data into one system and communications between geographic information systems were mentioned in the case of Malta.

Other drivers were also mentioned, but for a more limited number of countries, e.g., improving the application process for building permits in Malta and Slovenia.

[13] The Directive provides guidelines for already digitised data. It came into force on May 15th, 2007 and will be implemented in stages, with full implementation required by 2021. https://inspire.ec.europa.eu/about-inspire/563 Accessed on December 9th, 2020.

2.1.4 Main obstacles

The three most common obstacles in the digitalisation of plan data mentioned by the interviewees are a lack of experience and technical expertise, low quality of the input data, and a lack of financial resources.

A lack of experience with the digitalisation of plan data and the required technical expertise was one of the main initial, and sometimes still ongoing, obstacles as it is often the case in new processes. This obstacle was mentioned in seven instances and concerns both public authorities and private consultancies. For instance, private actors in Luxembourg lacked knowledge on transforming plan data in the new GML/XSD model, which was stipulated by the ministerial regulation. A similar situation occurred in Switzerland. In France, this new process raised issues such as the privacy of data when creating new public-private partnerships.

The low quality of input data was mentioned in six cases, namely Bologna, Germany, Ireland, Lithuania, Malta, and Portugal. In these cases, digitalisation required: vectorising complete datasets, creation of new standards, poor resolution, incomplete information, mismatching data specifications, gathering plan data from various sources, submission of incorrect locations; all of which make the process time-consuming and resource intensive. Italy was also added here, not so much because of low quality, but because data in general is not available or is difficult to access.

A lack of financial resources was mentioned in seven interviews (Bavaria, France, Lithuania, Norway, Slovenia, the Netherlands and Wallonia). For several cases, this was mostly a problem in the initial phase of the overall digitalisation process, of which the plan data was part. The lack of financial resources at that time was mostly due to the fact that, initially, digitalisation was given rather low priority. In other cases, the lack reflects the limited financial resources allocated to municipalities. These limited resources also result in limited human resources such as in Slovenia, where a limited number of employees is one of the main reasons why about 15% of the municipalities have not yet adopted the new digital plan standard, which has been in place since 2008. Similarly, private consultancies making plans for local and regional authorities in the Netherlands reached their capacity limits due to the challenging timeframe of five years for digitising all 70,000 plans.

Other obstacles were mentioned such as the juridical situation as a barrier to legally binding digital plans in Austria and Denmark, or the collaborative nature of the digitalisation task between administrative levels in Switzerland.

2.1.5 Standards and methods

The majority of the methods used to enter the digital plan data are country-specific, with some degree of similarity with INSPIRE (e.g., Belgium/Wallonia and Germany/Baden-Wurttemberg). The digital plan data is usually entered by the data owner, which is often the planning authority in charge of the data (e.g., municipal, regional and national levels). Municipalities in several countries often rely on the expertise of external service providers to help them with the delivery of digital plan data (e.g., in Austria, France, Lithuania, Luxembourg, Norway, among others). In the case of the Netherlands, the external service provider prepares the plan data, whereas the planning authorities only have the responsibility of uploading the plan data on the digital portal. In fact, the authorities only have one person who has an electronic signature.

Standards are developed by different planning actors at the national level (e.g., national cadastral agency, federal planning council, ministry in charge on planning) and either apply to the production of digital plan data or its delivery. They can be transcribed into a law as, for instance, in all states in Austria (typically in a special directive defining map scales, categories, symbols, notifications, etc., to be used in the different plan types) or in the 2011 law for symbology in municipal planning in Luxembourg. An exception is Denmark, where there are no standards for symbols. A similar situation is found in Ireland, where there are no national standards for zoning uses; a generalised zone type transcribing local zoning classifications into national classification has been created instead.

Assessments of digital plan data are common. They mostly take the form of automated checks on submitted digital plan data to verify whether the symbology elements (e.g., geometries, no overlaps) conform with the standards. However, there is no automated assessment on the “quality” of the plan data (e.g., whether a specific parcel should be classified as an industrial zone). This remains the responsibility of the planners in

charge of the plan data, who have to do it manually, as was the case (or is still the case) for the publication of analogue plan data.

Table 2.1
Overview of digitalisation of plan data in fifteen countries

Country / region	Main purposes			Added value				Main drivers				Main obstacles			
	Easy and open access	One single portal	Other	National /regional wide analysis	Improved workflow and planning practices	Cost reduction	Other	INSPIRE Directive	Overall digitalisation process & techn. dev.	Top-down process	Other	Lack of experience	Low data quality	Lack of resources	Other
Austria (Tyrol)	■	■			■	■		■		■					■
Belgium (Wallonia)	■	■		■	■		■	■		■				■	
Denmark	■			■	■		■				■				■
France*	■			■	■	■	■	■		■		■		■	
Germany*	■				■	■	■	■		■		■	■	■	■
Ireland	■	■		■							■		■		
Italy (Bologna)			■		■		■	■			■		■		■
Lithuania		■		■						■		■	■	■	
Luxembourg	■	■		■	■			■	■	■		■			
Malta	■	■		■					■	■	■		■		
Norway*	■	■	■	■	■	■	■			■		■		■	
Portugal	■		■	■	■		■			■			■		
Slovenia	■	■		■						■	■	■		■	
Switzerland *	■	■		■	■		■	■	■	■					■
The Netherlands	■	■				■		■		■		■		■	■

* Interviews were conducted at several geographical levels in these countries. The table here indicates the information collected for the national level in unitary countries and regional level in federal countries. Note: the information included in this table was collected through semi-structured interviews and does only reflect the digitalisation of plan data for the digital portal(s) as communicated by the informant. The table does not aim to provide a complete overview of the digitalisation of plan data in each country; it rather presents results of an exploration based on specific digital plan data portals. Detailed information for each case can be found in the fact sheets (Annex 2).

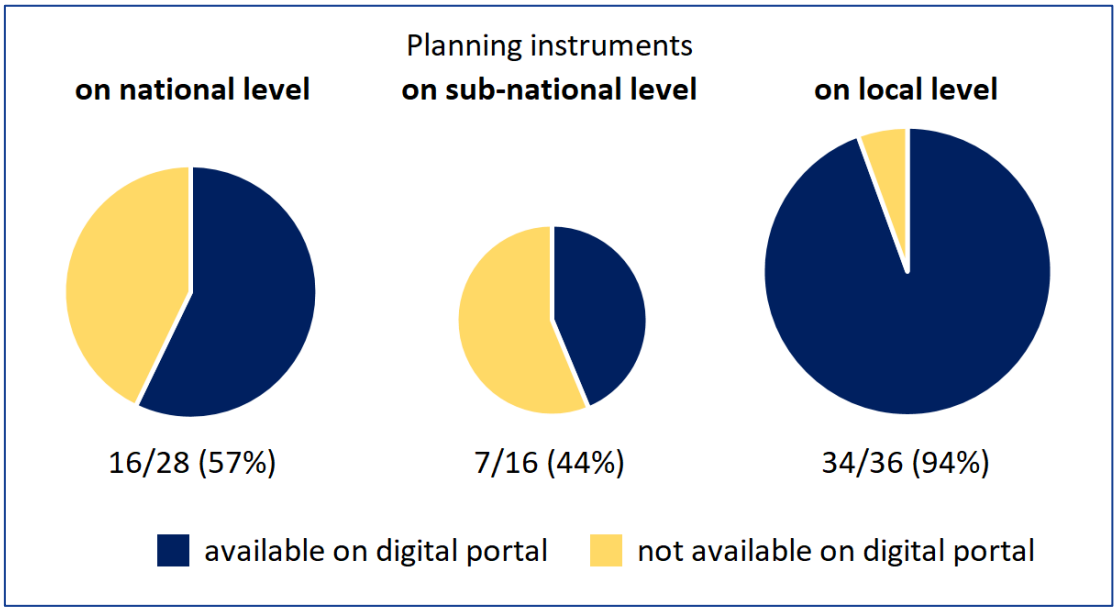
2.2 The uses of digital plan data

2.2.1 Types of digital plan data

In order to identify the types of digital plan data included in the geoportals, the interviewees were asked which planning instruments had been digitalised at the time of the interview. In addition, desk research was carried out to complement the information on what types of digital plan data are available in each case study. The analysis highlights how the type of digital plan data available in each country reflects the competences in planning of the different administrative levels in each country as well as the nature of the planning instrument. Digital plan data at the national level is available in all unitary countries[14] (with the exception of Ireland), while for federal countries[15], digital plan data is usually available at the sub-national level (e.g. Belgium) but not necessarily at the national level.

Table 2.2 lists the existing planning instruments in each investigated country or region and classifies them according to the administrative level at which they are implemented. The instruments written in black are available digitally, whereas those in grey and italics are not available on the state or regional portal. Different country profiles exist based on the availability of digital plan data. Out of the 15 countries analysed, two provide digital plan data at all levels (Portugal and the Netherlands), four provide digital plan data at the national and local level (Denmark, Luxembourg, Slovenia, and Switzerland), three provide digital plan data at the sub-national and local level (Austria, Belgium and Germany), one at the national level (Malta), and four at the local level (Ireland, Italy[16], Lithuania and Norway). Local planning instruments include municipal master plans, municipal land use plans, zoning plans and detailed plans that have a regulatory nature.

Figure 2.1
Share of planning instruments covered in the digital portals



The local level is the one that is the most digitised, achieving 94% across the investigated cases (Figure 2.1). This is followed by national planning instruments, of which most of those with a strategic or framework nature have been digitised, whereas the more visionary ones have not, resulting in 57% of planning instruments having been digitised at the national level. Finally, planning instruments at the sub-national level

[14] Denmark, France, Ireland, Italy, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Portugal, and Slovenia.

[15] Austria, Belgium, Germany, and Switzerland.

[16] Investigation reflects on the geoportal of the city of Bologna.

include regional and inter-municipal instruments, of which only 44% have been digitised, which means that they represent the instruments that have seen the lowest level of digitisation in this investigation. This relatively low share is partially due to the generally weak role regions play in planning in unitary countries and the limited number of federal states across the 15 countries investigated in this study, as well as their more strategic, or framework, character.

Table 2.2
Planning instruments by administrative level included in the investigated geoportals

Case	National level	Sub-national level	Local level
Austria (state portals)	*Austrian Spatial Development Concept* *Federal sectoral plans*	*State/regional development programs* State/regional development plans	Municipal land use plans Local development concepts *Local regulatory plans*
Belgium (Wallonia)	N/A	Sectoral plan Regional planning framework *Territorial development scheme* *Intermunicipal development schemes*	Communal development scheme Local orientation scheme Municipal planning framework
Denmark	National planning directives *National planning reports* *Summary of national interests*	N/A	Municipal strategies for planning Municipal plans Local plans
France	*Planning regulations* *Territorial planning directive* *Operation of national interest* Schemes of public services	*Regional scheme for spatial planning, sustainable development and equality* *Ile de France Region's master plan*	Scheme of territorial coherence Local land-use plan for several municipalities Local land-use plan Municipal map
Germany	-	State/regional development plans	Land use plans
Ireland	*National spatial strategy*	*Regional planning guidelines*	Development plans Local area plans
Italy (Bologna)	N/A	N/A	Strategic Plan Local Plan Operative spatial planning instruments
Lithuania	*Comprehensive plan of the Republic of Lithuania*	*Comprehensive plan of the County*	Comprehensive plan of the municipality Comprehensive plan of the locality Detailed plans
Luxembourg	Sectoral plans Land use plans	N/A	Municipal land use plans Partial land use plans

Case	National level	Sub-national level	Local level
Malta	Strategic plan for the Environment and Development Local plans (administrative boundaries only)	N/A	N/A
Norway	*National expectations for regional and municipal planning* National planning guidelines and provisions National zoning plans	*Regional plans*	Municipal plan strategies Municipal plans Detailed zoning plans
Portugal	Coastal areas spatial plans Nature protected areas spatial plans National spatial planning policy programme* Sectorial programmes and sectorial plans* *Estuary spatial plans*	Regional spatial plans Intermunicipal spatial plans	Municipal land use plans Area zoning plans Detailed zoning plans
Slovenia	*Spatial development strategy for Slovenia* National spatial plans	N/A	Municipal spatial plans Detailed municipal spatial plans Administrative acts
Switzerland (federal level)	Sectoral plans Concepts	*Cantonal comprehensive plans*	Building zones *Land use plans*
The Netherlands	Zoning plan	Zoning plans	Zoning plans
Number of digitised instruments	16 out of 28 (57%)	7 out of 16 (44%)	34 out of 36 (94%)

Planning instruments written in *italics* are not available in the plan data portals. * Only listed
Source: Authors.

2.2.2 Legal status of digital plan data

One important concern regarding the legal status of digital plan data is that, in most cases, the plan data available in the geoportal is only *de facto* legally binding but not *de jure*. This means that the digital plan data is not legally binding insofar as it is a representation of the actual plan data. Therefore, although the quality standards of the digital plan data can be high, the data cannot be used as legally binding documents.

In most of the cases examined, the legal status of the plan data included in the geoportal is not legally binding. The digital plan data stored in the geoportal is the representation of the physical plan. This is because the legally binding plan data is either in paper form, which is the case in Slovenia, Norway, France, Luxembourg, Switzerland, and all cases in Germany, or in a PDF format as in Denmark and Austria. In some cases, such as the Netherlands and Portugal, it is the digital plan data that is legally binding. As for analogue plan data, the legally binding digital plan data is approved by the authorities (e.g., public administration or local councils). In Portugal, for example, the digital plan data is drafted by the local council and then published on the Official Journal of Portugal, which is the main source for legislation in the country. Once it has been published there, the digital plan data becomes legally binding and it can be published in the geoportal.

In some cases, such as Austria, the rigidity of the legislation related to plan data becomes an obstacle insofar as it limits in many ways the manipulation of the data, including its digitisation. In Tyrol, the submission of plan data is fully digital, and the Tyrolean spatial information system fully supports the legal steps in the planning process, which is an added value of the digital plan data because it improves the data flow. However, there are barriers, which have their origin in the governing competences regarding the adoption and publication of plans. There is an ongoing debate in Tyrol about the legal status of geodata there because it is the responsibility of the municipalities to publish the legally binding plans, while the digital plan portal is administered by the state.

2.2.3 Types of users

There are three important aspects when it comes to the type of users of digital plan data in each of the case studies: the profiles of users, the monitoring of users, and the permissions given to use digital plan data. the following five groups of users were mentioned repeatedly in the questionnaires: planners, public authorities, researchers, companies, and individuals. Other groups mentioned are notaries, who use the plan data to check the existence of any pre-emptive rights, land registries, or architects, who need the plan data to list all the planning related rules for a parcel. These groups are mostly the same as those who use(d) analogue plan data before digitalisation was started. In most cases, digital plan data is publicly accessible, due to the EU's INSPIRE Directive, which is followed in most of the cases investigated in this analysis. However, planners and local or regional authorities remain the most common users in almost all cases. These actors, for example, may use the digital plan data to produce reports on planning permits, while the regional administration may use it to assess municipal and private plans. A related issue is data retrievability and how easy or transparent it is to access data. As an example, the INSPIRE portal[17] a rather complicated portal, where it can be difficult to find what you are looking for if you are not an expert. Other databases have well designed portals or have structured data in a way so they can be easily found over other services as search engines.

The results from the semi-structured interviews reveal that few of the case studies examined have a reliable way of monitoring who uses their digital plan data. For example, Denmark, Slovenia, Norway, Austria/Tyrol, Belgium/Wallonia, Bavaria, Baden-Württemberg, and the Swiss Federal Office for Spatial Development state that they lack a way of monitoring their users. Nonetheless, in some of these cases, they offered assumptions based on communications through the channels between users and the portal such as contact forms or emails, or even statistics. This is the case for Norway, where they can identify planners and architects, public authorities, and the public as users of their portal by analysing the statistics they collect for internal use. Bavaria and Baden-Württemberg also state that they do not monitor their users. However, they define their users based on their target groups, i.e., planners, the administration, or the public.

The monitoring of users may be related to the permissions given to users by the digital plan data managers. There are different models for regulating who can access the data. For instance, in France, different licenses are issued to users: anonymous, service provider, delegated, local authority, and local administrator. Anonymous users can see and collect data but cannot modify any of it. Service providers are professionals who can check the data and validate it. Delegated users are professionals who have been given permission to send planning documents on behalf of a local authority. Finally, the local administrator profile has control over the technical licenses. In St. Gallen (Switzerland) and Austria, a distinction is made between internal and external users. While internal users are those operating within the municipal administration, external users comprise planners or interested citizens.

2.2.4 Number of users

The measurement of digital plan data usage is an underdeveloped aspect mainly because few case studies collect information, but also because there are many ways to measure the use of a website. On the one

[17] https://inspire-geoportal.ec.europa.eu, accessed June 2021

hand, Denmark, Baden-Württemberg (Germany), ROPLAMO18 (Germany), Malta, Norway, Slovenia, and the Federal Office for Spatial Development of Switzerland do not collect statistics on the use of digital plan data. On the other hand, the case studies measure the use of digital plan data in different ways as showed in Table 2.3. The numbers reported cannot be used to make comparisons between the cases as the numbers of users depend, to a great extent, on the nature of the geoportal, the type of information included (e.g., only digital plan data, or any type of geodata), and the types of services provided by the geoportals. Wallonia (Belgium), Ireland, Luxembourg and Portugal report visitors' use of digital plan data, but their figures suggest a wide range from 500 monthly visitors in the case of Ireland to 44,500 monthly visitors in Belgium. Finally, RISBY19 (Bavaria, Germany), Lithuania, the Public Law Restrictions Cadastre (Switzerland), and St. Gallen (Switzerland) report digital plan data on request. While RISBY registers around 7,000 monthly requests, the city of St Gallen has 10,500, while the Public Law Restriction Cadastre has 23,000 and Lithuania has more than 330,000 monthly requests.

Table 2.3
Monitoring the use of digital plan data and geoportals

Counting system	Description	Total	Period	Geoportal
Map call	Each zoom corresponds to one map call	100,000	Daily	Tyrol/Austria
Visitors	Number of individual visitors	500 to 1,000	Monthly	Ireland
Page views	Number of pages viewed	4.8 million	Yearly (in 2019)	Wallonia
Spatial data request	Number of requests using spatial data for planning	2 million	Yearly	Lithuania

Source: Authors, based on expert interviews and desk research.

2.2.5 Examples of the evaluation of planning practices or innovative practices

Several case studies are examples of the evaluation of planning practices or innovative practices carried out by policymakers. In Ireland, for instance, evaluation was the initial aim behind the collection of plan data. The goal is to evaluate planning aims and carry out an analysis on land use zoning and whether the correct amount of land has been zoned or not. This evaluative practice turned out to be useful because it gave the planning authorities an overview of the status of land use at the local level at a time when the planning authorities needed to plan the development of residential areas. Luxembourg is also an example where digital plan data has been used to calculate the amount of land that can be built on, which may be of interest to ministries such as Home Affairs, Spatial Planning, or Housing, as well as the private sector. Portugal is an example where planning practices (territorial dynamics, spatial planning, and urban planning) are permanently assessed by the General Directorate for Territorial Planning. In addition, the Directorate is developing an online portal where indicators in time series and real time will be published and freely accessible to external evaluators. Switzerland, Slovenia, and Norway are examples of digital plan data being used, rather than evaluated, by policymakers who work with territorial development. For example, the City of St. Gallen (Switzerland) uses a 3D city model internally (stakeholders and city councillors) to help visualise plans and in participatory processes for building permits or large planning procedures. Furthermore, in the case of Switzerland, notaries often provide a cadastre excerpt to guarantee the legality of transactions carried out by real estate businesses when registering land.

Several examples of innovative practices were also identified in the countries. In Denmark, for example, where several major companies receive all plans, a major supermarket chain uses digital plan data as they

[18] ROPLAMO is the system used in Germany to monitor spatial-development plans.

[19] RISBY is the spatial information system in Bavaria.

are interested in where new residential and commercial areas will be developed. The supermarket chain has, therefore, subscribed to receive information on all new plans in Denmark. Something similar occurs in the Netherlands, where certain retail companies use the digitised data to explore potential locations for new stores. In France, an innovative use of digital plan data entails taking the temperature of the soil or measuring the amount of sunlight in specific locations in order to install solar panels. Also, in France, 3D simulations of the potential for construction in specific parcels have been prepared based on the maximum volume within the parcels. Similarly, in Luxembourg, the solar cadastral has an on-going programme the aim of which is to determine solar potential by using digital plan data, and more precisely by looking at information on roofs in the local plan (PAG) sub-section on the geoportal. In Malta also, digital plan data is used to create heat maps. In Ireland, small organisations use the planning application in the Irish geoportal to set up alert systems to inform them of when a planning application is happening somewhere. Finally, the Swiss canton of Geneva has launched a pilot project for 3D planning data (land use planning). The canton is also developing an algorithm that can automatically read the legal regulations (building regulations).

2.3 Foreseen developments

Foreseen developments were divided into short-term (2 years) and long-term (5 years) in the semi-structured interviews.

In the short-term, all countries, except for Austria (Tyrol) and Denmark, aim to implement reforms in several ways. Most of the actions aim to improve the existing data systems and/or improve how digital plan data is used. Regarding the improvement of existing data systems, the most common future developments include improving the collection of data (both by increasing the amount of plan data to be digitalised and by including more municipalities or regions in the geoportal), digitalisation, and adaptation to new requirements and standards. For example, Wallonia, France, Lithuania, Norway, and the Swiss City of St. Gallen aim to digitalise all their plan data that is still in paper format. In addition, Portugal aims to digitalise the special juridical regimes for the ecological and agricultural reserves, and the Swiss Federal Office for Spatial Development will digitalise the cantonal comprehensive plan at the federal level.

Cases where the aim is to expand the available data in the geoportals include Wallonia (Belgium), France, Luxembourg, and the Swiss Public Law Restriction Cadastre. Nonetheless, various types of plan data have not been included in the geoportal. While in Wallonia municipal and regional plans are to be included in the geoportal, the focus in France is on local urban plans and territorial coherence schemes.

Adaptation to new requirements and standards is a goal in Germany, Ireland, the Netherlands, and Slovenia. The motivations for these actions vary between the countries. For example, the German planning authorities aim to introduce the national data model XPlanung[20] by 2022 in their geoportals as a way to increase the efficiency of data exchange between the actors involved in spatial planning processes. In Ireland, the objective is to produce and make the data more easily available. In the Netherlands, the new standards will be designed to accommodate the new Environmental and Planning Act (Omgevingswet[21]), to be adopted in 2021, with which the government intends to combine and simplify the regulations for spatial projects. The aim is to make it easier to start up projects. For example, the construction of housing on former business parks, or the building of wind farms. Finally, Slovenia will implement ePlan with the objective of ensuring greater transparency and efficiency in spatial planning. ePlan will allow users to prepare, accept, and enforce spatial planning acts as well as to establish electronic procedures to obtain building permits.

Other ways to improve the existing data systems include the attempts in Wallonia to facilitate the entry of digital plan data or to make crowdsourcing and editing available through the geoportal. Another example is the Maltese initiative to launch a new base map that includes polygons, height readings, 3D models and spatial analysis. Similarly, Norway aims to provide 3D planning, to visualise plans in 3D, and to provide a snapshot of plan data to show what applies to a specific property.

In the long-term, most of the countries do not have specific plans. Austria, France, Germany (Stuttgart), Norway, Portugal, and Switzerland (FOSD) are the exceptions. Among these, the foreseen developments are varied but mirror, to some extent, the previously described foreseen developments in the short-term. For example, France aims to add smartness and structuration to its geoportal, link automated processes with simulation possibilities, and artificialise the land and measure the ecological impact. While the first goal may be considered an attempt to improve the existing data systems, the two latter goals point towards the operationalisation of digital plan data for analytical purposes. In a similar vein, Austria aims to automatically assess the impact analysis of their digital plans. Furthermore, foreseen developments in Switzerland (FOSD) are oriented towards the operationalisation of digital plan data. In this case, the goal is to implement the project Bundling Infrastructure, which supports the relief of the landscape due to an improved data basis with mergeable infrastructure. On the other hand, Germany, Norway, and Portugal look forward to improving their existing data systems. While Germany will focus on including plan data for all municipalities in the XPlanung format, Norway will integrate plan regulations and will increase the participation of non-traditional

[20] https://inspire.ec.europa.eu/sites/default/files/presentations/0945_20180919_xplanbox_torstenfriebe.pdf. Accessed on December 15th, 2020

[21] https://www.government.nl/topics/spatial-planning-and-infrastructure/revision-of-environment-planning-laws. Accessed on December 15th, 2020

users. Portugal will also include regulations on land use, policy instruments, and landscape management programmes.

Finally, as the interviews were conducted in spring 2020 amid the COVID-19 pandemic, many respondents acknowledged some uncertainty in the short and mid-term regarding future developments regarding the digitalisation of plan data.

3 In-sights from Austria, Denmark, France, Germany, Norway and Switzerland

3.1 Digital plans and plan data in Austria

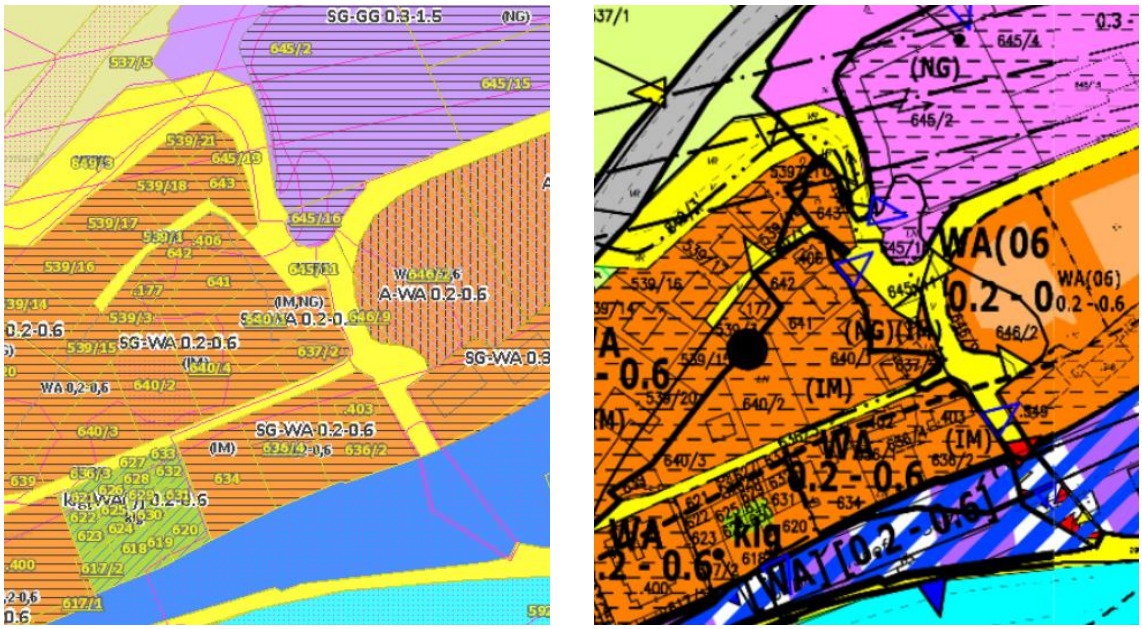
Scope of digital plan data

Austria is a federal republic with 9 federal states (Bundesland) and more than 2,000 municipalities. Legislation and implementation of spatial planning is performed by the nine states. Each state has its own spatial planning law, and plan regulations, therefore, differ. However, the difference is often in the detail, while the main pillars such as the type of plans and their content are very similar.

For spatial planning at the municipal level, there are 3 planning instruments in almost all federal states according to the respective spatial planning law: (1) The municipal development concept ("örtliches Entwicklungskonzept"), which is mainly a strategic instrument, (2) the zoning or land use plan ("Flächenwidmungsplan"), which is the central regulatory instrument and is subordinate to the municipal development concept (3) the local development plan ("Bebauungsplan"), which defines concrete structures and is subordinate to the zoning plan. The land use plan is digitised in some form in all states. It is usually drafted on a 1:5000 scale. Its basis map is the cadastre. Zones drawn on the plan must be correctly related to the cadastre. Uniform formal rules for notation, drawing and units used in the plan are defined in all the states' planning laws. In several states, the municipalities (or their planning consultancy) submit plans digitally to the state's planning authority, although sometimes an analogue version is also submitted (Gruber et al., 2018).

Each state has a geographic information system, typically a database with different layers of geodata with an internal and an external (public) access part. They all have a specific part dealing with plan data. All portals include the municipal land use plans. Other planning instruments from the different levels are occasionally included.

Figure 3.1
Same land use plan in state and municipal geoportal



Land use plan from a part of the city of Schladming – left: Geoportal of the state, right: Geoportal of the municipality; Source: Auer (2008), screenshot updated, accessed on 22nd December 2020 from https://gis.stmk.gv.at/atlas2/landesplanung.asp?typ=f and https://map.geoportal.at/PSC/synserver?project=Schladming_FWP

The digital land use plans should include all regulations, like the analogue plans. However, because the digital plans are not legally binding in most states, although they are considered to be very useful supplements), there can be differences in the visualisations, which can have a negative effect on readability and even interpretation. Figure 3.1 presents a comparison of a land use plan from Schladming, a city in Styria, in the Styrian geoportal and in the municipality's geoportal. Besides the differences in layout, some information is included in one but not in the other plan, while different notations are used for some areas. These differences might be related to the view settings, which can be changed in the Styrian geoportal. In any case, this can be confusing for users.

Organisation of digital plan data

Similar to the development in other countries, digital tools for plan making and administration have been used in the sector for many years. Indeed, several states started experimenting with digital plan data in the 1990s (Klotz and Marth, 2000). Lower Austria was one of the first to establish a standard for digital plans in 1996, which became adopted in 1999 (AT04). Nevertheless, implementation was not successful at that time. Many states adapted their planning laws during the 2000s and 2010s, requiring the submission of digital plans, often in parallel with printed plans. The changes to the laws were often followed by long transition periods and several follow-up adaptations. In Table 3.1, we identify three phases of the digitalisation of land use plans in Austria. In the 1990s, digital plan data, as well as geodata in general, became established in public administrations and online geodata platforms made their first appearances. In the 2000s, many states produced guidelines and changed the planning laws. Portals for internal as well as external use were developed. In the 2010s, digital plans were implemented in many states, although the process often involved long transition periods. Technology, data availability and digital processes were further improved.

Table 3.1
Phases and milestones in digital plans in the Austrian states

Time	Main activities	Examples
1990s	First experiments with digital plan data in administration, first WebGIS platforms online	1995: Pilot project using digital plan data for citizen communication (Vienna) 1998: tirisMaps online (Tyrol)
2000s	Development of guidelines, incentives, changes of planning laws, development of external (internet) and internal (intranet) portals	1999: Guideline for digital plans (Lower Austria) 2000-2004: Funding scheme for digitalisation (Lower Austria) 2004: Cooperation geoland.at is established (all states) 2008: Digital plans implemented in law (Upper Austria) 2011: Digital plans implemented in law (Tyrol)
2010s	Implementation (takeover of digital plans), transition period and adaptation of sector, continuous development (technical, planning process and planning law related), external access and use	2008-2017: Transition period (Upper Austria) 2010: Harmonised urban land use plan data available in geoland.at viewer across Austria 2012: Open Data Austria (data.gv.at) 2013-2019: Transition period (Tyrol) 2017: Full digital land use plan (Tyrol) 2017: ÖROK publishes first analysis based on land use plan data across Austria

Source: Authors

Digital plans and plan data have certainly increased the role of the federal states in planning. Federal states adapted their planning laws, requiring municipalities to deliver digital data. The data provides new opportunities for overview and insight (and control) for the states. Future automatic checks of some content of digital

plans (besides the technical checks which are already in place) have been discussed, or at least in the form of automatic information during submission. This potential has not been realised (yet), probably because of long transition periods, limited resources or different political priorities.

Municipalities also see the benefits of digital plan data, e.g., information regarding planning restrictions on a specific plot can be accessed quickly. The digitalisation of plans has not affected the smaller municipalities, as they are served by private planning consultancies. However, it has led to a market shakeout in the consultancy sector in Upper Austria as well as the increased role of a few software providers in some states. Long transition periods were allowed. In Vorarlberg, the state even took over the technical implementation of the land use plans.

The development and maintenance of the portals is financed by the states. The municipalities are the main data providers or pay planning consultancies to perform this task. To accelerate data provision, the state of Lower Austria provided a co-funding scheme for municipalities or consultancies for the transition to digital plans in the early 2000s. However, the scheme did not lead to the expected results and was stopped. In Upper Austria, the state provided the INSPIRE services in return for the data, which would otherwise have had to be performed by each municipality separately. Also, as an analogue and a digital version have to be submitted, both need to be approved by the state before the plan can be adopted.

Use of digital plan data

The Tyrolean system supports the formal planning process of the municipal land use plan. Participation processes are not facilitated, but formal objections, comments, etc., during the planning process are documented and integrated into the system. PDFs of current plan regulations can be generated in real time in the portal and constitute legally binding documents. Due to legislation that states that local planning is responsibility of the municipalities, official announcements of plans are still made by the municipalities. In Upper Austria, similar to, e.g., Burgenland, municipalities have to submit a digital as well as an analogue version. The digital version goes through a range of technical checks, while the analogue version is the basis for the contextual assessment. Only when the plan has been approved by both sides, can it be approved and saved on a special 'law' server. In Lower Austria, no digital plan data is submitted. Instead, the submitted analogue plans are scanned and georeferenced. Since 2007, building zone boundaries have been digitised, also to be used for INSPIRE. However, they do not play a role in the formal planning process.

For the states, digital plans and plan data have primarily increased efficiency (i.e., reduced the time needed for the same task) of workflows. Furthermore, in states where digital and analogue plans are handled in parallel and new tasks regarding comparison have had to be introduced, efficiency has improved. A very common way of using plan data is for the calculation of building land statistics ('Baulandbilanz'). Planning software solutions used by planners and municipalities often have basic analytical functions, e.g., calculating obligatory building land statistics for municipalities. However, with digital plan data, it is possible to do this at the state level as well. A recent report by the Environment Agency Austria (2019) found that 3 out of 6 states which were studied have already implemented such calculations. The states' joint portal "geoland.at" provides harmonised land use plan data from all 9 states. However, this is only for information purposes. ÖROK, the Austrian Spatial Planning Conference, uses the same data for general analysis on building land. The collection of this data is performed manually and a reference table to generalise land use categories from all 9 states into 5 categories is used. Excerpts on the valid zoning ("Widmungsauskunft") now and previously (historical data) are becoming more important, not least because of a change in the tax law that involved using different tax rates on sales price depending on how far back a zoning from 'green' land to built-up land was conducted.

3.2 Digital plans and plan data in Denmark

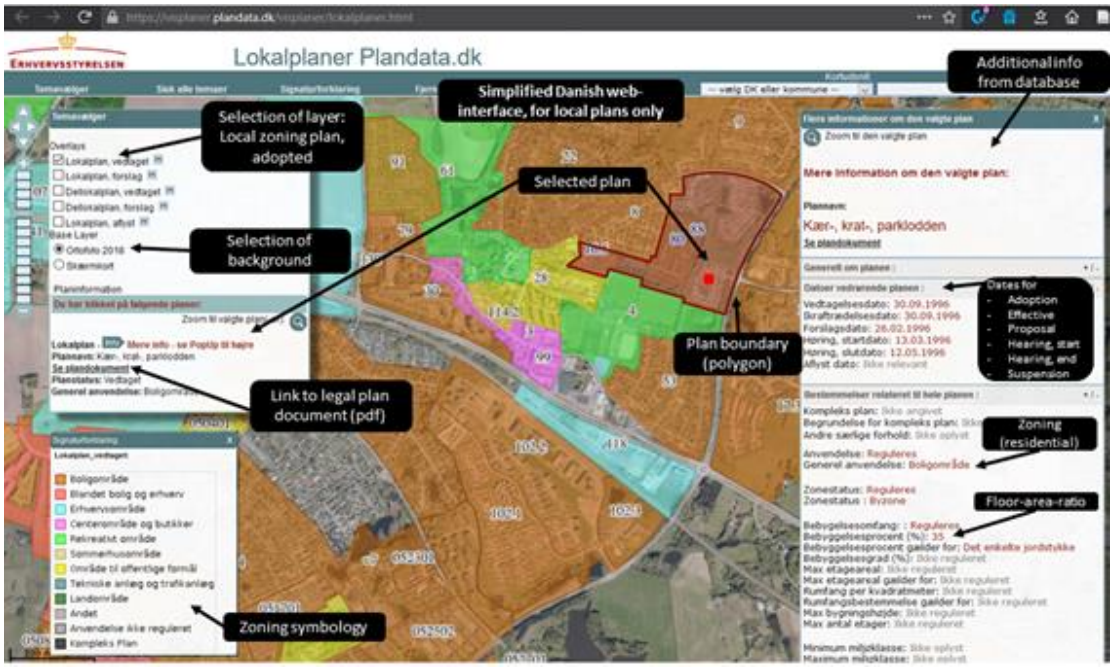
Scope of digital plan data

In Denmark, the 98 municipalities are the main planning authorities responsible for spatial planning at the local level through municipal and local plans. This is regulated by the Planning Act. The national authorities are responsible for national legislation and for spatial planning policies for specific topics, e.g., coastal protection, retail trade, test centres for windmills, etc.

All plans produced under the framework of the Planning Act have to be registered in the publicly available digital plan register "plandata.dk". Several platforms can be used to access the register, e.g.:

- http://kort.plandata.dk (all plan data: national, municipal and local)
- https://visplaner.plandata.dk/visplaner/lokalplaner.html (only local plans)
- http://kort.plandata.dk/searchlist/#/ (a search module for all municipal and local plans)

Figure 3.2
Platform for local plans on Plandata.dk



Source: https://visplaner.plandata.dk/visplaner/lokalplaner.html, annotations added by authors

It is via plandata.dk that official and legally binding planning documents, in the form of PDFs or links to legal texts by national planning directives, can be accessed. The geodata, which is available on plandata.dk, is used as cartographical representations of the plan elements; it is not legally binding. On plandata.dk, digital plan data from the national and local level is available. Digitalisation differs in the various planning instruments (e.g., due to the scale and character of the plan), which range from general strategic orientation to cartographical representation of binding and non-binding elements. In addition to plandata.dk, most municipalities have their own geoportals, where digital plan data for the municipality is displayed.

The nation-wide digitalisation of plan data has accelerated in the past 10 years due to new legislation and data systems. The most recent changes (since 2017) in legislation have been driven by the planned use of data by the tax authority for calculating property tax. This required the (re)digitalisation of all local development plans by the state to increase quality and ensure full coverage.

Organisation of digital plan data

The digitisation of plan data in Denmark started as a voluntary project. Several of the previous systems functioned on a voluntary basis and there was varying support for the systems from the municipalities. There were several voluntary collaborations and committees in different parts of the country, which worked on developing common models and guidelines for the use of digital plan data. However, in order to bring all the municipalities together under one public system, a legislative intervention was considered necessary. Today, all municipalities must publish their plans on plandata.dk.

The respective planning authorities are responsible for entering the plan data in plandata.dk. Municipalities continuously register plan data by publishing new plans and updating old plans. The municipalities are responsible for the quality, accuracy, and legality of the data for local and municipal plans. The Danish Business Authority is responsible for registering the plan data for the national plans and for ensuring their quality and accuracy.

The main actors involved in the digital plan data are:

- The Ministry of the Interior and Housing which is responsible for all national legislation and planning. (until January 2021, the Ministry of Industry, Business and Financial Affairs was responsible)
- The Danish Housing and Planning Authority, which is responsible for plandata.dk (until January 2021 the Danish Business Authority was responsible)
- The municipalities, which are responsible for local planning.
- Other public ministries/agencies (e.g., the Danish Tax Agency, the Nature Agency).

While the Danish Business Authority and the municipalities are responsible for the daily operation of the systems and the reporting of plan data, there is close collaboration between all actors on the development of future digitisation and use of plan data and improvement of plandata.dk.

In a recent expansion of plandata.dk, two issues regarding the digital plan data were data quality, especially regarding old plans and their digitalisation, and the fact that the development of plandata.dk was more focused on meeting the tax authority's demands rather than municipal planners' interests. However, the quality of the data has improved recently and planners and municipalities' needs have once more come into focus. This is thanks to a major update, which is financed by the tax authority and which allows to digitise and report plan data that is particularly useful to the municipalities in their planning and administration to plandata.dk

The Danish planning law focuses on the planning process and, thus, does not define any map symbols. This means the municipalities have different ways of defining regulations and intentions in their plans, which requires flexible definitions in the plan register. There are significant differences between the municipalities regarding their wants and needs for plandata.dk as well as the digitisation of plan data, just as there are large differences in how the municipalities use plan data. This complicates the development of the systems and future digitisation.

There is voluntary collaboration between the Danish Business Authority, municipalities and other stakeholders, e.g., public agencies and third-party developers, who together discuss, among other things, current deficiencies in the system as well as aspirations for the future digitisation of municipal and local plans. The collaboration has a visionary and future-driven focus.

Use of digital plan data

Plandata.dk ensures easy access to public plans, i.e., local, municipal and regional planning. In addition, plan data from other agencies and authorities is also displayed on plandata.dk. This applies to data from, e.g., the Agency for Culture and Palaces and the Danish Transport, Construction and Housing Authority. Furthermore, geodata for themes within, e.g., building and protection lines, nature protection and conservation, geology, etc. is also displayed. Anyone with an internet connection can access and download digital plan data and planning documents. The platform allows users to download plan data as PDFs or as geodata (directly from the portal or WMS/WFS). Only registered users have access to the plan registration modules

and only planning authorities (e.g., municipalities) can register users. The data is also registered in the Danish geodata metadatabase (https://www.geodata-info.dk), the Danish search service according to the INSPIRE directive

Despite the developments in the form of plandata.dk, the legally binding version of plans is still the PDF, not the geodata. However, even if plan data on plandata.dk becomes legally binding, the system is essentially for documentation and is a public information portal. It does not support the actual planning process, hearings, communication between actors, or implementation; all of which is handled by the municipalities themselves. However, plans are published on plandata.dk, which automatically sends notifications about mandatory and optional hearings when plans are in the process of being prepared or have been finally approved. The hearing process from this point on does not go through plandata.dk and hearing parties do not reply to plandata.dk. This is intentional as providing such a solution on behalf of the municipalities is not considered to be the state's task.

Several major private companies receive all plans, i.e., every time a new plan is created in the system, a message is automatically sent to the company. For example, a major supermarket chain is interested in the location of planned residential and commercial areas and has, therefore, subscribed to receive information on all new plans in Denmark. In addition, there may be plans involving other retail businesses of interest for them.

Although all municipalities must upload plan data to plandata.dk, there are still significant differences in the way in which the municipalities work with digital plan data and planning. The two main planning instruments at the municipal level, the municipal plan (a land use plan for the whole municipality prepared every 4 years) and the local plan (a development plan for a smaller area, which is project-driven); also imply different challenges for digitalisation. Parts of the municipal plan, the zoning regulations (da: kommuneplanrammer), are typically fully digital in many municipalities. The practice regarding local plans is more diverse. Several municipalities use digital software solutions that have been developed by third party consultants, with modules connected to plandata.dk. Even though various private companies offer solutions, many municipalities use simple word processing software and work with their own templates.

While the systems and plandata.dk are rather advanced, standardisation has not been actively pushed, resulting in diverse data quality. However, this may change with integration and new uses of the data, requiring certain data standards. In turn, digitalisation can alter planning. A major concern is the use of plan data for a new assessment of property values by the Danish Tax Authority. Plan data (e.g. allowed building densities) is disaggregated to single parcels. In plan, such allowances are often related to a bigger area or they are conditional to what is established by the neighbour.

In 2021, Denmark will have its first maritime spatial plan. It will become a legally binding digital map – the first of its kind in Denmark. The legally binding text and geography will be shown together, which will mean that users will not have to read the legal text first and subsequently orientate themselves on a separate map. In addition, the plan will have a specific digital hearing/participation element.

The municipalities are essentially interested in digital plan data and digital planning processes. However, with plandata.dk in its current form, municipalities must register their plans in a system that does not directly support the planning process, but rather collects information for various uses, e.g., the tax authority. Municipalities are concerned that the implementation of fully digital plans in such a system will limit their planning options and processes. For the municipalities, it is important that the digitalisation of plans and plan data does not limit the options for planning provided by rather wide framework of the planning act.

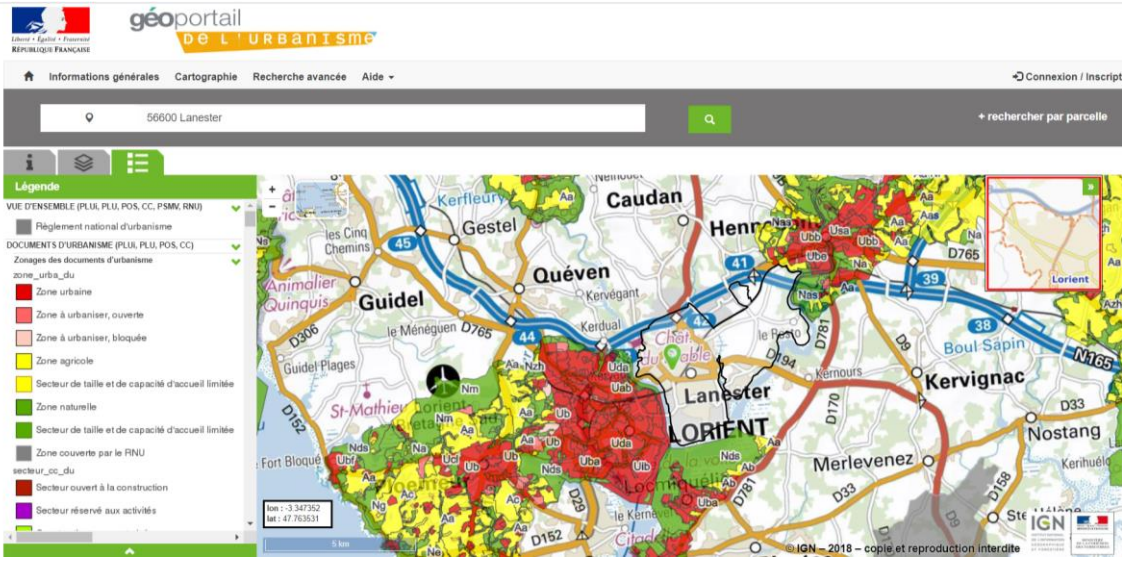
3.3 Digital plans and plan data in France

Scope of digital plan data

The public French geodata system is based on a main geoportal, allowing the global diffusion of geodata. Managed by the IGN (National Institute of Geographic and Forest Information). This main database is referencing every geodata available to the public, with many tools and possibilities of utilisation. This is illustrating what is called the *Etat Plateforme* (E-government), a deeper digitisation dynamic of all public services. From this main platform, users can access different dedicated sub-geoportals and applications. One of them is the Geoportail de l'urbanisme (GPU), dedicated to digital plan data from public authorities.

The GPU was established in 2013, a first version was online in 2016. It includes currently the main planning documents on municipal / inter-municipal level, including the PLU/PLUi and the SCoT. Coverage of available plans is continuously increasing. Out of about 25,000 municipalities that are expected to be covered by a local plan as a PLU[22], data for 16,000 municipalities (64 %) is available on the GPU by May 2021. This is about 64 % of those which are expected to have a local plan available. On the level of the SCoT, plan are available covering about 8,000 municipalities (35 %). The GPU has been established as the platform for plan data from public authorities, which third parties rely on as well as develop related digital products and services on.

Figure 3.3
Geoportail de l'urbanisme (GPU)



Source: https://www.geoportail-urbanisme.gouv.fr/, accessed 2 February 2021

All local / inter-municipal plans are covered by the GPU, on the national level only the scheme for collective services (e.g. noise zones from airports) is available on the GPU. The planning instruments not available have often a more general policy document character, without spatially specific regulations. However, some of it is available on more specific geoportals. E.g. specific data on environment and nature, which are part of the regional planning scheme, can be accessed on regional geodata portals. Certain specifications as detailed annexes and regulations to a local plan are not accessible over the GPU, but can often be accessed over local geoportals.

[22] Note that about 10,000 (25 %) of all 35,000 municipalities are not required to draw up a local plan, but are covered by the national urban planning regulations (RNU regime). This concerns mainly small, rural municipalities.

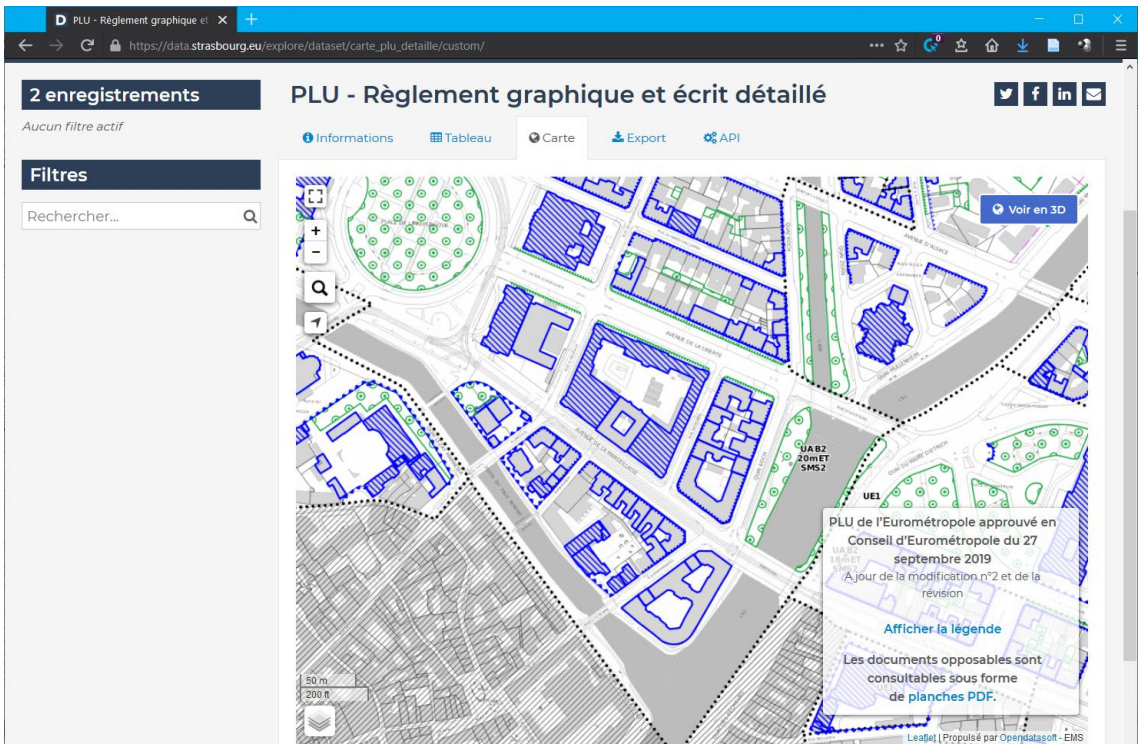
Organisation of digital plan data

The main actors in digital plan data are (1) on the national level incl. ministries, agencies and councils in the role of legislator defining the planning code and procedures for digitalisation, administrators of data infrastructure and designers of standards for plans, and (2) on the local level the municipalities as the main planning authority in terms of land use. Municipalities very often though cooperate to deliver joint plans for the local (PLUi) as well as the city-regional level (SCoT). Regions and other authorities can be important to provide regional geodata or infrastructure (databases, geoportals). Little by little, especially since the reduction of the number of French regions in 2016, France is starting to get something more clear in terms of national infrastructure. When it comes to platforms there is a national level, a regional level, and first of all the metropolitan areas have each one their platforms, and the districts have theirs.

Exchange of information between the plan data platforms were often hampered by the use of different standards. GPU is using the standard developed by the National Council for Geographic Information (CNIG), a multi-level government organization responsible to facilitating the use geodata. Since 2006, the CNIG has been developing and maintaining three standards for the digitsation of the different planning documents.

Municipalities or municipal cooperations are the main planning authorities on local level, responsible for major planning instruments as SCoT or PLU/PLUi. The state of digital plans and plan data on that level is very diverse. A rather advanced example is Eurometropol Strasbourg, which has a central data portal called “Open Data Strasbourg.eu”, created in 2019, but Strasbourg has a long history in working with geodata. Plan data is published over the central data portal. For the local plan, the PLU, all detailed graphical regulations can be viewed in the portal Figure 3.4. The legally binding documents are not the geodata, but the plan as PDF. The user interface provides a direct links to the PDF version of the plan. The two versions show the same information in the same way. Note that on the GPU, PLUs are visualised only in broad, harmonised zoning categories and not in the same detail as in that example. However, the PDF with the detailed plan can also be accessed over the GPU.

Figure 3.4
Urban plan of Strasbourg, geoportal



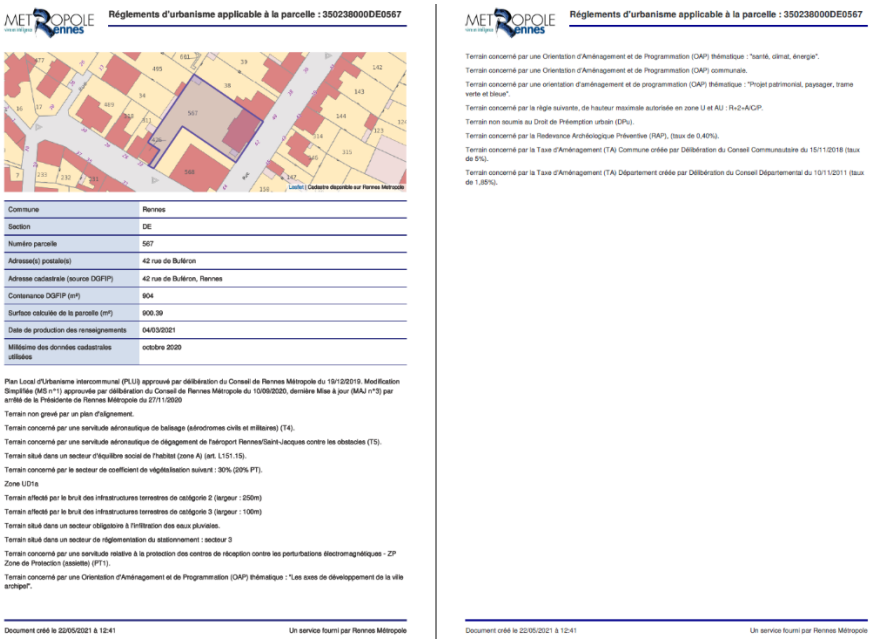
Source: Screenshot from https://data.strasbourg.eu/explore/dataset/carte_plu_detaille/custom, accessed May 2021

Use of digital plan data

The GPU became part of the formal planning process in 2020. Since, the planning law (Code de l'urbanisme) requires uploading of new plans to the national portal. Only planning authorities are able to publish over the GPU. The GPU also offers certain validation procedures. Plans for technical validation can also be uploaded by planning professionals.

Plans published in the GPU are though only adopted plans. Information on plans in the making or support for the planning process is not part of the GPU. The GPU only documents the currently effective plans. However, local authorities, especially the bigger ones, are also working with digital plans and plan data portals in public consultation. An example from Rennes Metropole provides further details how the status of digital plan data can be defined: Rennes Metropole's PLUi is available over its own geoportal[23]. The portal allows to produce individual fact sheets on regulations concerning a specific parcels, called "fiche" (Figure 3.5).

Figure 3.5
A retrievable "fiche" on the local planning regulations for a specific parcel in Rennes



Réglements d'urbanisme applicable à la parcelle : 350238000DE0567

Commune	Rennes
Section	DE
Numéro parcelle	567
Adresse(s) postale(s)	42 rue de Bulléron
Adresse cadastrale (source DGFIP)	42 rue de Bulléron, Rennes
Contenance DGFIP (m²)	904
Surface calculée de la parcelle (m²)	900.39
Date de production des renseignements	04/03/2021
Millésime des données cadastrales utilisées	octobre 2020

Plan Local d'Urbanisme intercommunal (PLUi) approuvé par délibération du Conseil de Rennes Métropole du 19/12/2019. Modification Simplifiée (MS n°1) approuvée par délibération du Conseil de Rennes Métropole du 10/09/2020, dernière Mise à jour (MAJ n°3) par arrêté de la Présidente de Rennes Métropole du 27/11/2020

Terrain non grevé par un plan d'alignement.

Terrain concerné par une servitude aéronautique de balisage (aérodromes civils et militaires) (T4).

Terrain concerné par une servitude aéronautique de dégagement de l'aéroport Rennes/Saint-Jacques contre les obstacles (T5).

Terrain situé dans un secteur d'équilibre social de l'habitat (zone A) (art. L151.15).

Terrain concerné par le secteur de coefficient de végétalisation suivant : 30% (20% PT).

Zone UD1s

Terrain affecté par le bruit des infrastructures terrestres de catégorie 2 (largeur : 250m)

Terrain affecté par le bruit des infrastructures terrestres de catégorie 3 (largeur : 100m)

Terrain situé dans un secteur obligatoire à l'infiltration des eaux pluviales.

Terrain situé dans un secteur de réglementation du stationnement : secteur 3

Terrain concerné par une servitude relative à la protection des centres de réception contre les perturbations électromagnétiques - ZP Zone de Protection (asselée) (PT1).

Terrain concerné par une Orientation d'Aménagement et de Programmation (OAP) thématique : "Les axes de développement de la ville archipel".

Document créé le 22/05/2021 à 12:41 — Un service fourni par Rennes Métropole

Réglements d'urbanisme applicable à la parcelle : 350238000DE0567

Terrain concerné par une Orientation d'Aménagement et de Programmation (OAP) thématique : "santé, climat, énergie".

Terrain concerné par une Orientation d'Aménagement et de Programmation (OAP) communale.

Terrain concerné par une orientation d'aménagement et de programmation (OAP) thématique : "Projet patrimonial, paysager, trame verte et bleue".

Terrain concerné par la règle suivante, de hauteur maximale autorisée en zone U et AU : R+2+A/C/P.

Terrain non soumis au Droit de Préemption urbain (DPu).

Terrain concerné par la Redevance Archéologique Préventive (RAP), (taux de 0,40%).

Terrain concerné par la Taxe d'Aménagement (TA) Commune créée par Délibération du Conseil Communautaire du 15/11/2018 (taux de 5%).

Terrain concerné par la Taxe d'Aménagement (TA) Département créée par Délibération du Conseil Départemental du 10/11/2011 (taux de 1,85%).

Document créé le 22/05/2021 à 12:41 — Un service fourni par Rennes Métropole

With its increasing coverage and the inclusion of more plan types, the GPU has become an important reference portal (Capart, 2019). The number of users of the GPU has increased continuously. Digital plan data in general is seen as a big advantage in terms of being accessible online to everybody, allowing to use the data for various purposes. But also the public authorities are using the data themselves, e.g. for analyses of land use or risk analysis combined with other data. However, at the portals and data providers themselves, very often, knowledge on data use is missing.

We can clearly see the main ambition standing out: to be an efficient public administration. The discussion on planning as such and if we get better plans (and better places) with digitisation seems sometimes subordinated to technical and administrative questions or, also, is digitisation not seen as having and influence on planning practice yet. However, the huge change in accessibility to plans and plan data – within a few years already half of all plans in France are online – might just need some more time to unfold its potential for informing planning itself.

[23] https://mviewer.sig.rennesmetropole.fr/?config=apps/PLUi/PLUi.xml#, accessed May 2021

3.4 Digital plans and plan data in Germany

Scope of digital plan data

Germany is a federal country with 16 states, 22 administrative districts (counties and county-free cities) and around 12,500 municipalities. The fundamental aspects of spatial planning are defined by the federal government. The states implement the spatial planning on a broad scale with the so-called 'state planning' (Landesplanung). At the local scale, the municipalities are responsible for planning, including land use plans (Flächennutzungspläne) and local building plans (Bebauungspläne).

A federal portal (geoportal.de, GDI-DE) contains geodata from all over Germany, including plan data from states or municipalities. The aim of the GDI-DE is to make geodata easier accessible. However, not all public geodata and plan data are currently accessible as there are sometimes problems with the naming of datasets or metadata. In addition to the national geoportal, many states offer state-wide portals for the publication of digital plan data, such as the geoportal of Baden-Württemberg. Some cities also use their own portal with display and download services, for example, Hamburg (Figure 3.6). Furthermore, several States use the MetaVer[24] portal to publish metadata of the digital datasets.

Figure 3.6
Full vector dataset of the land-use plans in Hamburg, showing the textual determinations for a specific plot (marked red)

Source: https://geoportal-hamburg.de/geo-online

During the 2000s, there were several e-government projects in Germany, also in the field of geodata. Surveys conducted in German municipalities identified a need to exchange standards for municipal land-use plans (Figure 3.6). Based on an amendment to the German constitution in 2010, the IT Planning Council was established. In 2017, this organisation decided to introduce XPlanung as an exchange format for plan data in Germany, which must be implemented by 2022. As a result, the coordination centre for XPlanung was established, which is responsible for the maintenance of the standards XPlanung and XBau. Within the framework of XPlanung, there are two approaches to the digitisation of plan data. On the one hand, there is

[24] https://metaver.de/portal/

full vector digitisation of plan data, while on the other hand, there is raster-ring, whereby the perimeter of a land-use plan is recorded and a scan of the original plan is attached.

Organisation of digital plan data

The German geodata infrastructure (GDI-DE) includes a steering committee with authorities representing the different administrative levels and a coordination office (Koordinierungsstelle). The coordination office is responsible for the development of the geodata infrastructure and for coordination between various authorities. The GDI-DE is jointly financed by the federal government and the states. The aim of the GDI-DE is to ensure that digital plan data can be used everywhere and that it is also integrated into the European geodata infrastructure.

In the case of spatial plan data, the technical specifications of the common standard are based on INSPIRE and XPlanung. The exchange of data between actors is facilitated by the XPlanung standard, as indicated by the illustration on the right in Figure 3.7. The technical organisation of the zoning plans is the responsibility of the coordination centre of XPlanung. The relevant regional authorities, however, are responsible for the implementation of technical specifications. The INSPIRE Directive has been legally implemented by the federal government and the states. As the states interpret the INSPIRE Directive slightly differently, the way in which the municipalities are affected in terms of the delivery of the land-use plans differs. Since the municipalities have sole responsibility for land-use planning, they are also responsible for financing the digitisation of their plan data. In some states, there are also funding programmes or support for the implementation of land-use planning in XPlanung within the spatial data infrastructure.

Figure 3.7
Exchange of data without a common standard (left) and with XPlanung (right)

Icons represent different stakeholders in planning, such as planning authorities, citizens, planning consultancies, real estate industry.
Source: http://www.xplanungwiki.de/index.php?title=Datei:Datenaustausch_kombiNeu.png

GeoRhena is responsible for cross-border cooperation between France, Germany and Switzerland in the Upper Rhine area. A geoportal has been in place since 2017, which is used to publish cross-border geodata in this region. A map presents the current status of planning in the area. Thus, planning authorities in the neighbouring countries can be informed or involved in planning processes. GeoRhena does not harmonise data and works with the lowest existing denominator of cross-border data. As a result, plan data often has components with different definitions or different recording intervals, which makes it difficult to present them in a common format. As a result, often only rough cross-border data exists, even though a effort was put into producing them.

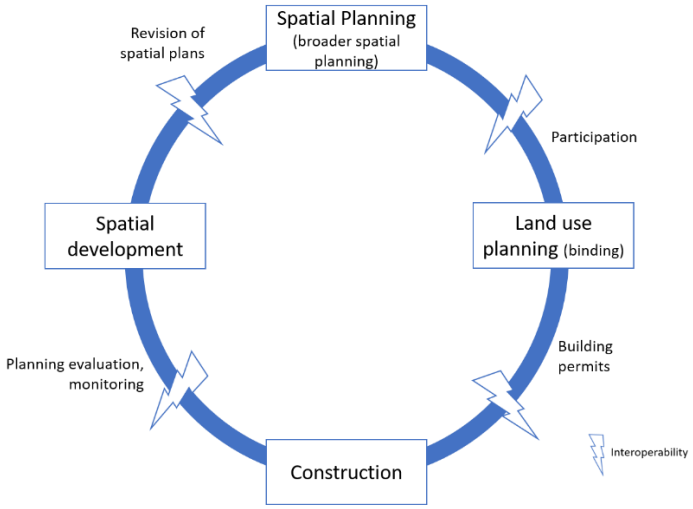
The use of digital plan data

The publication of digital plan data on the Internet increases the transparency of planning processes and facilitates participation. However, experience in Stuttgart indicates that the degree of participation has not

changed substantially with digitisation. Rather, the content of the planning project determines the degree of participation by private individuals. In Hamburg, it is difficult to assess whether the level of participation has changed as a result of digitisation.

The planning processes themselves have not changed in Stuttgart due to digitisation, as all individual process steps are required by law (Baugesetzbuch). In the planning processes, however, the medium has changed, from analogue to digital. In Hamburg and Freiburg, the ambition to establish digital process chains was mentioned. The XPlanung standard serves as a basis for the provision and use of interoperable digital plan data, so that it can be used from spatial planning to construction or for the evaluation of planning practice (Figure 3.8). Consistently implementing digitisation and achieving a complete process chain will take some time.

Figure 3.8
Digital process chain linking spatial planning, building permits, construction, monitoring, evaluation and plan revision



Source: Based on Krause et al. (2020)

In the interviews, it was mentioned that larger cities and municipalities tend to use XPlanung in a full vectorial approach, while small municipalities tend to use the raster ring method. This may be because small municipalities have a better overview of their area, which means they do not need automated evaluations using full vectorial data to the same extent. In large municipalities and cities, however, there is a greater need for evaluation options, which is only possible with the full vectorial approach. On the other hand, it was mentioned that the raster ring method is used for the digitisation of old plan data, while the full vectorial method is used to produce new digital plans. Either way, the coordination centre of XPlanung recommends that all municipalities digitise and capture their plan data in full vectorial form.

3.5 Digital plans and plan data in Norway

Scope of digital plan data

Geonorge is the national website for map data and other geographic information in Norway. Geonorge is a part of the Norway Digital cooperation and is developed and run by the Norwegian Map Authority. The purpose of this portal is to document available data in different sectors and make it available for viewing and downloading. The portal contains a map viewer, but this is designed so as to view some of the different data sets contained on the portal. It is not meant for end-users in a planning- or building permit process. The national geographic infrastructure in Norway is decentralized. Many authorities produce geodata and make it available on Geonorge. Not necessarily physically, but as a link to their own portals. In this way, Geonorge functions more like a register which shows available data and where to find it. The slogan for Geonorge is "Everything in one place". The idea behind this infrastructure, the portal and its standards, is in part to follow international standards, which means that the data should be able to be read by simple off-the-shelf (NO: hyllevare) software. Geonorge supports many APIs which makes it possible to use the data contained in Geonorge without physically visiting the website and downloading data. This means that many different tailored end-user solutions can be developed on top of this.

The Norwegian spatial governance system is structured by two main regulatory principles: frame management, where one level of governance sets the frames for lower levels, and subsidiarity, with a strong delegation of strategic and regulatory authority to municipalities. This makes the municipalities the main planning authority, with substantial authority on land-use, while the national level has a guiding, legislative and overseeing role. The regional level also plays a part in providing regional plans that play a guiding and coordinating role for the municipalities. The Planning and Building Act regulates the Norwegian planning system. This means that many of the digital services are at the municipal level, while the infrastructure and metadata is at the national level.

The local-level planning instruments are municipal master-plans, areal zoning regulations and detailed regulations. These all consist of a map and a variying set of other documents, mostly text. Plan data that form the map of all these instruments are most often made available on Geonorge, if the municipality participates in the infrastructure. The municipal portals make all documents available, both plan data and related documents, while only some data, such as plan outlines, land-use plan ID and land-use plan name is contained on Geonorge. For this reason, the municipal portals are much more used in most processes where plan data is needed. As seen above, planning processes for all the municipal planning instruments have the option to be fully digital. Most processes still fall short however, seeing as the option for digital signatures is seldom used.

Table 3.2
Planning instruments available in digital portals

Level	Planning instruments	Included in Geonorge	Included in municipal portal(s)
National	National expectations for regional and municipal planning	No	No
	State planning guidelines	Yes*	No
Regional	Regional plan (goals and strategies)	No	No
	Regional land-use plans	No	No
Local	Municipal master plan	Yes**	Yes
	Area zoning plan	Yes**	Yes
	Detailed zoning plan	Yes**	Yes

* Most state planning guidelines are written documents. Those who do contain geodata are available on the portal.
** Not all municipalities have all plan data available on Geonorge, some have none.

Organisation of digital plan data

The period since the current Planning and Building Act of 2008 was introduced is characterised by the harmonisation of the planning system with the national geographic infrastructure. They are now consolidated through further norms and regulations, experimentation and implementation of new technologies, and support systems for planning, taking digital plan data further into practice. In 2009 the Map and Plan Regulation (MPR2009) was updated accordingly, giving detailed description of requirements for public maps, geodata, plan data and municipal plan registers. Also in 2009 national product specifications for land-use plans and digital plan registers (NPAD) were introduced. This is currently the most important standard for plan data. Specifications include in depth information on how land-use plans are to be produced, based on drafting conventions with a finite set of symbols providing standardised legends for plans. All this was in place in 2010 when the INSPIRE-directive was implemented in Norwegian law. In 2015 Geonorge was established as national geoportal.

The infrastructure is funded through the Norway Digital network. The participants in the network fund it based on the different actors' use and contribution of data. As participants in the network, the actors all have access to the data produced within the organization. For some datasets a fee is charged for access by actors outside this network. It is up to the data owner to decide whether to charge and how much. Norway Digital is the strategic network which manage this over time, and the national geodata coordinator (Norwegian Map Authority) develops the national geodata strategy, which sets out goals and actions for the further development of the national geographic infrastructure.

The municipalities can charge for the downloading of plan data if they wish. Many do this, and this is a way to fund the municipalities use and production of geodata and plan data.

There are two types of plan registers (Kartverket, 2020):

- **Plan register with plan overview**. A simple document overview (list) of adopted land-use plans in document-form.
- **Digital plan registers**. A database with complete and systematic information on adopted land-use plans.

Of these two types, the Norwegian Map Authority recommends that municipalities establishes a digital plan register, due to its advantages regarding efficiency and accessibility (Kartverket, 2020). Digital plan registers must be in accordance with the National Product specification for Land-use plans and Digital plan registers (NPAD) (Kommunal- og Moderniseringsdepartementet, 2018). There's no requirements that older land use plans adopted before 2010 (implementation of the Map- and Planning Regulation), should be digitised and included in the plan register.

The digital plan register must contain information on adopted land-use plans and other regulations that has an impact on allowed land-use. This means that also dispensations from land-use plans need to be included. The plan register must show the plan situation for individual properties and contain land-use map, regulations, decisions and other information regarding the use of a property.

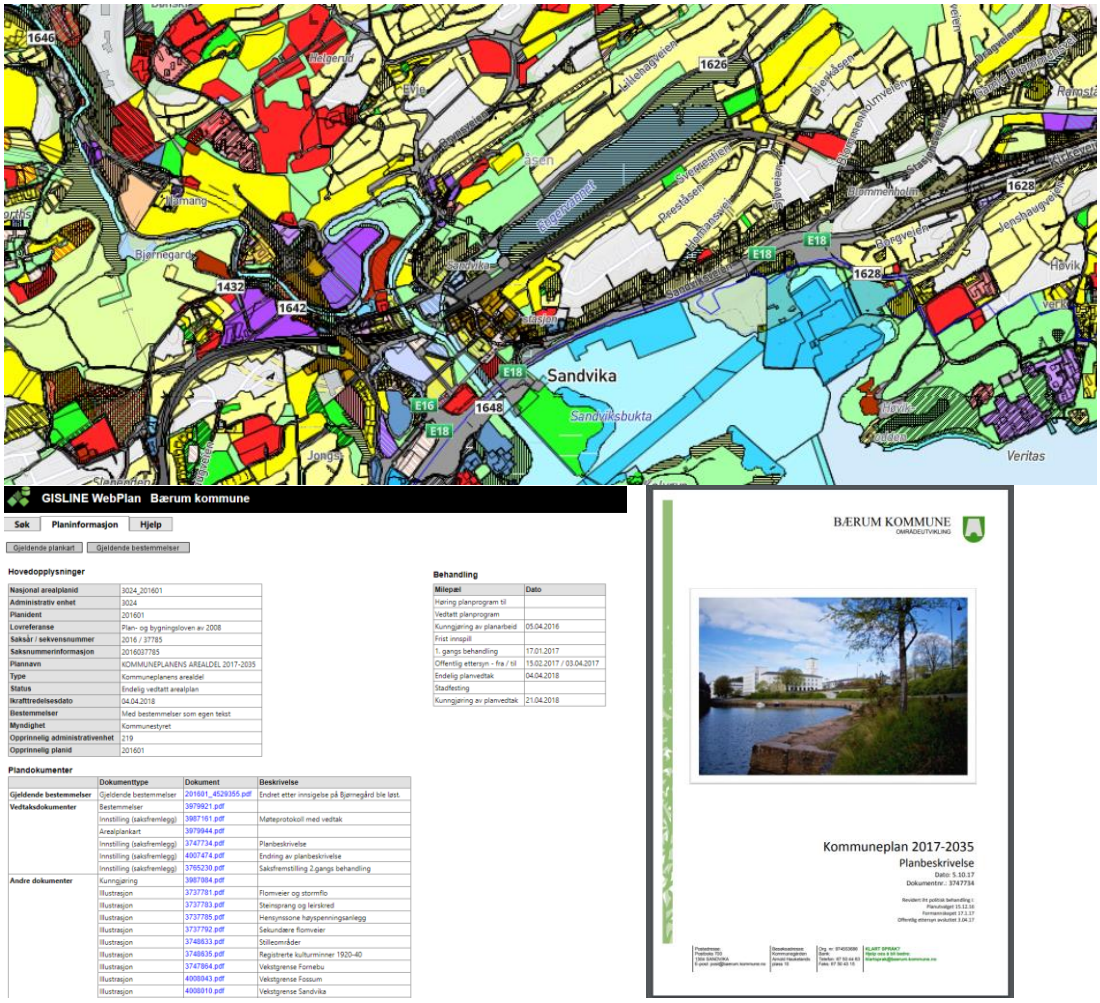
Use of digital plan data

The introduction of digital plan data into the practice of spatial planning has made information more accessible, allowing stakeholders and citizens to get larger amounts of information about their environment, foreseeable changes, and opportunities for initiatives and development. At the same time production of digital plan data requires resources, instruments and competences that has a certain threshold. As a consequence the actor or the person who use the tools acquires considerable influence over the process.

Many characteristics of recent evolutions of digital plan data and services that are based on it reflect an expectancy: that geodata, plan data and building data may be able to flow seamlessly between producers and consumers, automatically building up and constantly updated bank of data that can be used for planning purposes. The experience of municipalities who treat incoming plan data and building information cannot confirm that this is yet the case; in some cases quite the contrary. For plan data to be reliable it often has to be reconstructed from a proposal, even when standards are followed, to the standards the municipality needs in order to use them for its own purposes. This problem of transference is demanding in terms of resources and competence, and it is costly. There is also a difference between actors who may share data, as the ones that are part of the Norway Digital network, and end users who may find themselves outside of a paywall, but who might rely on the availability of digital plan data to exercise their tasks (cf. Figure 3.2).

The reverse problem can also be reported, that consultancies provide resource and competence demanding data, which is uploaded to an authority in public proceedings, losing control as data owner over further editing and commercial uses.

Figure 3.9
Plan data in the register of Bærum municipality



Screenshots of plan data from the current municipal land use plan of Bærum municipality: (top) plan data at the municipal map portal; (bottom left) the municipal plan register showing the main components of the plan document as well as milestones in the process of approval, (bottom right) frontpage of the overall municipal land-use plan document
Source: https://webhotel3.gisline.no/Webplan_3024/gl_planarkiv.aspx?planid=2016031

Equal treatment from one municipality is certainly been improved since standards and availability of digital plan data is implemented by all municipalities. Also the principle of knowledge based management is strengthened by today's dataflow in the field of spatial planning: more spatial and environmental information is available, and it is more precise and more frequently updated. The fact that it requires specific expertise has changed the types of competences required for a planning consultancy or authority to function, and the academic composition and work cultures of professional environments. Data engineers may be involved in the construction of plans as a distinct competence, a newcomer in professional planning environments, generating new barriers of information, at least for a period until these professionals acquire more knowledge about other aspects of practical spatial planning that well be new to them for the time being. Different competencies have distinct concerns, demanding great efforts from each other for collaboration to function well.

3.6 Digital plans and plan data in Switzerland

Scope of digital plan data

Switzerland consists of the federal government, 26 cantons and about 2,200 municipalities. The federal government is responsible for the Federal Spatial Planning Act as a legal framework as well as the national plan data. The cantons implement the law by preparing cantonal structure plans. At the local level, municipalities have sole responsibility for their land use planning within the boundaries provided by the cantonal structure plans.

There are various portals with information on geodata, metadata or services for downloading digital plan data in Switzerland (Table 3.3). In addition, there are cantonal geoportals, where cantonal and sometimes also local plan data is published (e.g., Canton Thurgau in table). The municipalities sometimes also use their own portal, but this can be handled very differently.

Table 3.3
Important portals associated with geodata and digital plan data in Switzerland

Name Portal	Description	Link to portal
map.geo.admin.ch	National geoportal with data viewer	https://map.geo.admin.ch/
PLR Cadastre	Cadastre of Public Law Restrictions on Landownership	https://www.cadastre.ch/en/oereb.html
ThurGIS	Canton of Thurgau, example of a cantonal geoportal	https://map.geo.tg.ch
geocat.ch	Meta-Search-Engine for Geodata of Switzerland	https://www.geocat.ch/geonetwork/srv/ger/catalog.search#/home
geodienste.ch	Aggregation-portal for cantonal data	https://geodienste.ch/
open data swiss	Portal for open government data in Switzerland	https://opendata.swiss/de/

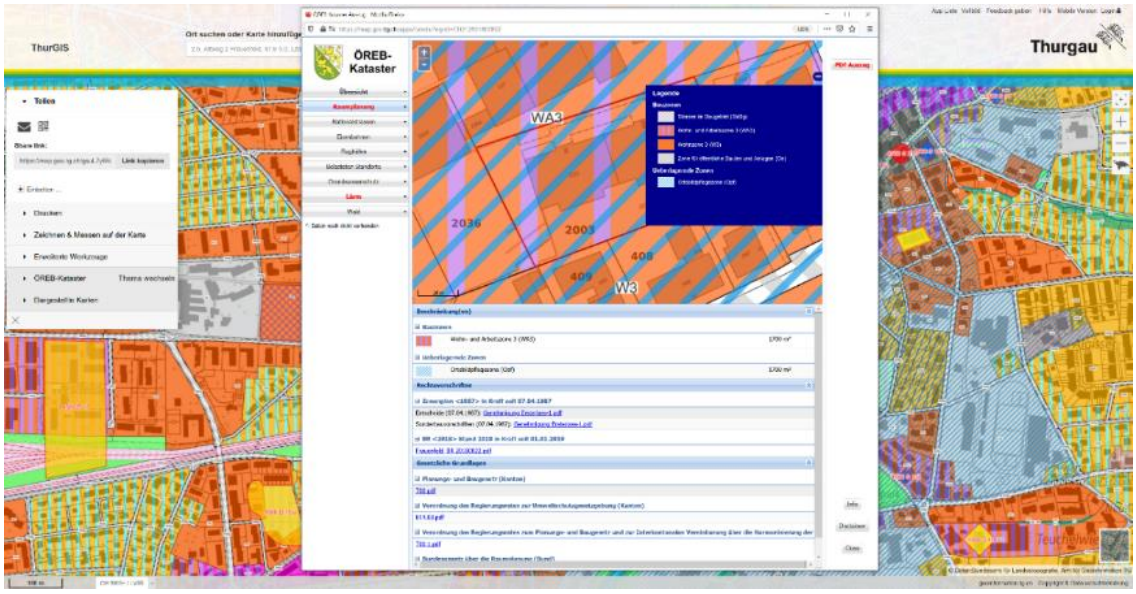
Source: Authors

Digitisation in spatial planning in Switzerland has taken place continuously through implementation by the corresponding authorities. A major milestone occurred with the Geoinformation Act of 2007, which legally anchored and initiated the cadastre for the public-law restriction on landownership (PLR-cadastre). It also introduced the federal minimal geodata models, which aim to achieve nationwide comparable geodata and plan data.

The purpose of the PLR-cadastre is to provide the public with up-to-date and reliable information on public-law restrictions on ownership. The implementation of the PLR-cadastre is anchored in the Geoinformation Act, passed in 2007 and in force since October 2008. The cantons are responsible for maintaining the cadastre in their region, which is why the information is published on cantonal geoportals (Figure 3.10). An extract from the PLR-cadastre for a particular property can, therefore, be obtained from these cantonal portals. Framework models have been developed for the digitisation of various themes for the implementation of the PLR, which are intended to harmonise the themes across cantons. Of the (actual) 17 themes in the PLR-cadastre, one major theme is municipal land use planning. By the end of 2019, all cantons should have implemented the PLR-cadastre and made it available. There has been a delay in some cantons but the task will soon be completed.

Digitisation in spatial planning varies from canton to canton due to the federal structure. In the case study, the digitisation of plan data in Switzerland is illustrated on the basis of the cantons of Thurgau, Basel-Stadt and Neuchâtel. The canton of Thurgau had already developed a cantonal model for land use planning before the Geoinformation Act. The canton encouraged the municipalities, which are responsible for land use planning, to digitise the plan data. This was then implemented by about 80% of the municipalities. In the meantime, the land use plans of all Thurgau municipalities can be found in the PLR-cadastre. The canton ensures that the information from the cantonal model is transferred to the federal minimal geodata model. It turns out that the public authorities have been perceived as a strong leading player in the standardisation of geodata. The digitisation of plan data required standardisation and minimal geodata models.

Figure 3.10
PLR-cadastre in the canton of Thurgau.



The public law restrictions on ownership of the specific parcel are shown in the middle window. The current status of the PLR cadastre can be viewed here: https://www.cadastre.ch/en/oereb/result.html

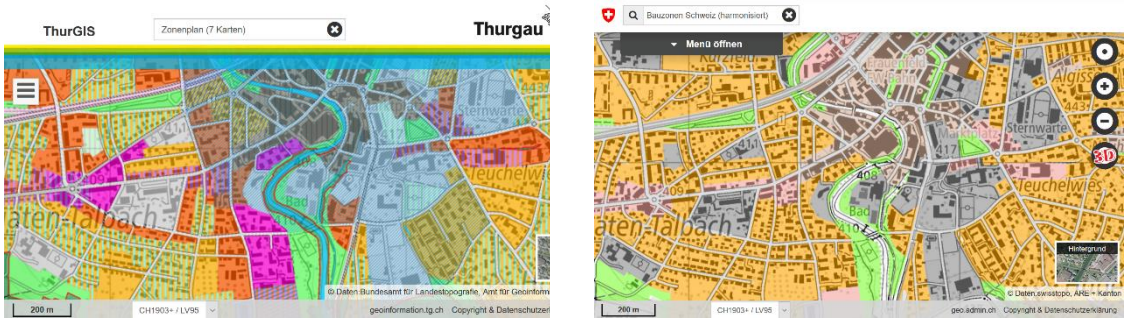
Organisation of digital plan data

The PLR cadastre represents the public-law restrictions on ownership, such as those resulting from land use planning. However, planning processes for land use planning are not controlled by the PLR cadastre, but take place in the traditional form. Nevertheless, the PLR-cadastre is different as the information is presented in layers that correspond to the respective legal basis, in contrast to a comprehensive plan. The cantons are responsible for the management and organisation of the legal texts in the context of the PLR-cadastre, which is based on the Geoinformation Act, the Data Act and various other laws that are relevant for the content (e.g., planning law, forestry law, water protection law). There are discrepancies between these specialised laws and data laws. The various laws concerning a parcel are displayed in the PLR cadastre. So far, however, it is only possible to display the entire legal basis and not only the applicable legal texts for a parcel.

A major point of discussion is the legally binding nature of the digital plan data. Land-use planning is regulated by cantonal legislation, which is why the cantons determine the legal status of digital plan data.

A federal minimal geodata model was established for land use planning. The cantons are required to provide the federal government with the relevant data so that a harmonised data set can be published on the national geoportal (Figure 3.11). A model is currently being discussed and developed for a nationwide dataset for cantonal structure plans.

Figure 3.11
Section of land use plan of Frauenfeld in cantonal (left) and national geoportal (right)



Left: Cantonal geoportal with the cantonal model of land use planning and detailed zones.
Right: National geoportal with harmonised building zones from the federal minimal geodata model of land use planning.

The municipalities are responsible for land use planning within the framework of cantonal legislation. For this reason, they usually finance data production and digitisation, such as in the canton of Thurgau. In contrast, the first digitisation of land use planning in the canton of Neuchâtel was carried out and financed by the canton. The cantons are responsible for the development and financing of cantonal structure plans. In the canton of Thurgau, the digitisation and digital preparation of the cantonal structure plans was carried out independently from other cantons. It turned out that there is no link between the digitisation of PLR topics and the cantonal structure plans. This is due to the fact that the PLRs are parcel-specific and binding on owners, whereas the cantonal structure plans are not parcel-specific and only binding on the authorities.

Several experts mentioned that the relationship between the various authorities and the public has not changed much as a result of digitisation. However, by publishing plan data, the cantons become more visible to the population and, thus, increase their presence.

Furthermore, as the plan data is mostly publicly accessible, especially the land use plan within the PLR-cadastre, everyone within the authorities and outside has the same information basis.

Use of digital plan data

Digital plan data is used in several steps of the formal planning process in Switzerland. However, in the cantons of Thurgau and Basel-Stadt, the planning process has only marginally changed due to the digitisation of plan data. In order to achieve the planned increase in efficiency with the digitisation of plan data, a project is currently in progress in the canton of Thurgau. This project aims to optimise processes, increase transparency of planning processes, but also make digital plan data (geodata) legally binding.

Cooperation within the authorities became closer in the canton of Thurgau due to digitisation. Due to the common tasks, there was a greater need to interact with each other and, in some cases, to resolve disagreements. Thanks to digitisation, the data is more accessible and easier to exchange, which can facilitate cooperation. On the other hand, easier access can result in less communication, which was reported in the canton of Basel-Stadt. Since everybody can access the plans from their computer, fewer meetings take place to discuss cantonal structure plans. The PLR-cadastre is a joint task of the federal government and the cantons, which required intensive cooperation. There are annual meetings and information events, during which the national and cantonal authorities meet to discuss current issues related to the PLR-cadastre.

It was shown that awareness of the added value of digitisation in spatial planning and digital plan data is a major motivation for the implementation of digitisation. Nevertheless, ensuring the national implementation of a cadastre of public ownership restrictions or federal minimal geodata models requires national approaches. Thus, the legal basis for the PLR cadastre was the crucial factor in its implementation.

4 Cross-cutting themes

4.1 Thematic practice papers

In five thematic practice papers we discuss some of the key issues regarding digital plans and plan data. The papers are based on our empirical case work and the themes were discussed with the DIGIPLAN stakeholders during the project. The full versions are available in Annex 1. In the following, we summarize some of the key points of them.

What is digital plan data?

The digitisation of plan data is not new. It began to emerge with the availability of GIS software with graphical user interfaces in the 1990s and innovative towns and individuals, who began to explore its potential. However, in the latest development, digital plan data has become embedded within established planning practices. Increasingly, systematic approaches across whole countries are applied. Digital plans are becoming mainstream in planning processes and plan data has been integrated with other sectors and is now used beyond the traditional planning sphere, becoming part of a wider 'integrated digital governance'.

Although plans and plan data have been standardised and harmonised within planning systems, a look across Europe reveals a wide variety of situations and approaches. This results in different forms and formats of digital plans and plan data, which we discuss in this paper. In the first section, we define important terms, followed by a quick overview of plan data that is available in national/regional plan data portals, based on the DIGIPLAN cases. We then discuss the key features and phases of digitisation and the impact of digital plan data on planning practice.

What are drivers for the digitisation of plan data and what is its purpose?

Across Europe, municipalities, regions and countries have started digitising plan data. This digitisation process, defined throughout this paper as the transformation of data from an analogue to a digital for-mat, has reached different stages, depending on, amongst others, the amount of resources allocated to it, its start date and the level of competence in spatial planning of the involved public authorities.

With these differences in mind, this thematic paper starts by discussing the main purposes and drivers behind the digitisation of plan data, which were identified by a qualitative survey conducted at different administrative levels across Europe. The paper then focuses on two best practices, which were made possible by having access to plan data in a digital format. The first is metadata sheets, which illustrates the advantages of a high level of transparency and easy access to plan data based on the case of Wallonia (Belgium). The second best practice is planning excerpts, which help to reduce the workload and costs and speeds up the planning process based on the case of Luxembourg.

Who can access digital plan data and does it change involvement?

Digital plan data is accessed through digital portals, where WebGIS is the most common user interface. There is a broad range of digital portals, regarding both the thematic scope, interactivity as well as accessibility. The platforms range from basic to advanced, though most platforms in the case studies have an intermediate level of digitalisation, which e.g. can allow the user to make simple operations based on the available plan data or there can be options to download the digital plan data in different formats. The level of digitalisation of a platform is not always clear-cut and the interactivity of the platforms can span across multiple levels. While user monitoring of the platforms is not widespread the users mentioned range from planners, public authorities, researchers, companies, and individuals.

The most common purpose of the digital plan data is to provide planning data with easy access and high level of transparency to everyone. There are considerable potentials regarding accessible digital plan data. By having a digital plan portal, the plan data can be visualized, it is possible to support hearing processes,

and increase participation. In addition, digital plan data can be accessed much easier and faster than analogue plan data, with the additional benefit that there can be more transparency in regard of the existing planning documents. While digital plan data often have been a significant improvement for trained or expert users, some portals can be very complex and confusing for non-experts. Digital plan portals with a user-friendly interface with intuitive commands and graphic visualization is therefore necessary to facilitate high accessibility. The use of digital data is increasing and the use will certainly change in the future as digital plan data and processes are developed and refined. The transition to more digital plan data and processes can however take time, both regarding planning authorities integration with digital data as well as citizen involvement and participation.

Are digital plans and plan data legally binding?

While in most countries, detailed digital plan data is available over publicly accessible geoportals, it is not usually legally binding. Instead, it is only a representation of the actual plan (data). The legally binding plan is often still the paper version; sometimes the version that is available at the municipal office. In Denmark, the centrally saved PDF version of a plan is legally binding, although some plan data is also published as geodata. In the Netherlands and Portugal, the geodata is also legally binding.

However, today, formal plans are mainly produced digitally, which means plan data, whether it be legally binding or not, is often available at very high quality. This high quality, along with high accessibility (see Thematic Paper on Accessibility), means digital plans and plan data are *de facto* legally binding. The digital plans and plan data are used in practice as if they were the legally binding plan.

There are several advantages having legally binding digital plans, which though go along with a general digitalisation of the plan processes. Implemented with a central portal and data infrastructure will mean there will be a clear entry point for accessing plan data. This does not exclude the possibility of embedding plan data in other portals, but where to find legally binding data from all planning authorities will be clear. At the same time, it will provide security for users and also a clear responsibility for keeping the data up-to-date.

A major advantage is also an increase in transparency and accessibility to the plan process as when the process becomes digital, comments, objections, changes, etc., will be documented. Finally, the 'legalisation' of digital plans might lead to similar processes and data structures, which in turn will increase accessibility across the planning system.

Challenging can be judicial limitations. They may be related to the general judicial system (how can spatial data be integrated in laws) as well as to the planning process, e.g. regarding by whom and how they should be published. Depending on the planning system, standardisation, which may be necessary when digitising plans, may be incompatible with requirements for legally binding plans. This may also be a challenge when older plans following old standards are integrated and digitised.

The fuzziness of many plans or the direct relation to a specific scale needs to be considered prior to the digitisation process. For example, a general more strategic plan could be zoomed in to parcel scale, which might be undesirable. Finally, accessibility is important for legally binding information. What systems need to be in place to ensure that plans are accessible? Moreover, is it possible to view the full extent of a plan and an appropriate scale, and therefore understand its implications, on a screen?

Future technical development and possibilities

The digitisation of plan data and planning processes began years ago and is now in fully underway. In many places, plan data is recorded as geodata with defined standards and is managed in dedicated infrastructure. There is no doubt that the future will bring further technical developments that will lead to new opportunities in the field of digital planning data and digital planning processes. The aim of this thematic paper is to inspire practitioners with ideas on future technical developments. Thus, the thematic paper shows a snapshot of potential future digital developments in terms of work processes and collaboration between actors. It also highlights advanced and innovative technologies and approaches in the digitisation of plan data from the case studies examined.

Overall, developments are envisaged towards establishing continuous digital process chains. The aim of a digital process chain is to use the same digital and interoperable plan data throughout the process from planning to construction and monitoring. A digital process chain prevents the loss of information between the individual process steps, improves the efficiency of processes and allows plan data to be reused. Furthermore, digital plan data and planning processes offer many options for transparent planning practice. However, the challenge lies in the complex implementation of digital process chains and the different speeds we observe in the development of digital processes and planning processes. Technological innovations based on digitisation offer new possibilities for a broad range of applications. Especially three-dimensional representations are promising since they make it easier to visualise and discuss planning. For optimal usability and comparability of data, the development of common standards is essential.

4.2 Comparative indicators based on digital plan data

Indicators can reflect the digitalisation process, show the diversity of planning in the cases, or function as inputs to the evaluation of planning practice. However, as seen in the case studies, the digitalisation of plans and plan data varies greatly. Besides the question of data availability, the meaningful use of indicators requires in-depth knowledge of the planning system and that the indicators themselves are clearly defined. We differentiate between the following two types of indicator:

1. Indicators that assess the extent of digitisation of plans and plan data. This could be based on actual plan data or more qualitative information.
2. Indicators measuring the planning activities, based on actual digital plan data. This means using the actual geodata to get insights into plans.

Indicators describing the extent of digitisation of plans and plan data

Our project has shown the wide diversity of approaches to and characteristics of digital plans and plan data. It is not possible to have one simple indicator that captures the extent of digitalisation. Nevertheless, we identified a range of topics from our study, which can be used as qualitative indicators. The indicators are useful as a very simple checklist to assess the current extent of digitalisation.

The proposed indicators in Table 4.1 are not necessarily located on a continuum (i.e., more or less digital), but rather depict some choices within a particular planning system. In the thematic paper "What is digital plan data?" we discuss some of these. Some topics are added here, for example education/skills/communication, related to the wider embeddedness and acceptance of digital plans and plan data in society. Other topics describe more technical features of plan data.

Table 4.1
Proposal for indicators describing the extent of digitisation of plans and plan data

Topic	Different characteristics
Standards	• Mainly technical, rather inclusive standards (from a planning point of view) • More strict digital plan standards across administrations
Data collection method	• Central scanning and digitising of analogue plans • Plan data (file) exchange by e-mail • Specific data upload, incl. automatic technical checks • Data creation directly in a geoportal (e.g., by drawing and snapping or choosing existing parcels)
Data format	• Scans (raster images) of plans • PDF with plans as images • Raster ring method data (boundaries of a plan as vector, the remainder as a georeferenced image) • Vector data of some or all features of a plan
Time dimension	• Current regulation • Information on plans in progress, plans under revisions • Historical plan data
Accessibility	• Distinction of accessibility for different user groups (e.g., internal/external) • Viewing only • Analysis or manipulation functions • Restricted download of data • Free download • Metadata listings, participation in open data initiatives

Topic	Different characteristics
Geographical coverage	• None (only data model) • pilot cases • transition towards completeness (e.g., covering all municipalities)
Relationship to analogue data	• Digital plan data represents some aspects of the analogue plans • Parallel systems exist (common in the transition period) • There is no analogue plan data, but prints and excerpts are possible.
Legal status	• Only for information purposes • De facto binding (e.g. because they are widely used in formal planning processes) • Legally binding PDF • Legally binding plan data • Both analogue and digital plans are binding
E-participation	• Information about plan proposals sent automatically to stakeholders (e.g., authorities, NGOs, property owners) • Electronic submission of comments • Map-based commenting • Integration of other participation tools in plan portals (online debating, discussions, wikis, integration of social media, etc.)
Collaboration / organisation	• Stand-alone approaches by interested authorities • Voluntary collaborations • Digitisation and data exchange required by law • Length of transition periods
Education / skills / commu-nication	• Parallel test systems (sandboxes) for (future) professionals • Complexity of systems (and user interfaces) - the necessity of certain skills to handle digital plans and plan data (for planners and non-planners) • Collaboration for the development of digital plans and plan data • Regular communication and debates on the digitalisation of plans and plan data

Note: The table is similar to a table in the Thematic Practice Paper 'What is digital plan data?', but includes additional topics.

Indicators measuring the planning activities, based on digital plan data

Much digital plan data is of such good quality that it makes sense to use it to obtain insights into what is being planned, where, how and when. The data may be input to a range of indicators on spatial planning or related to fields such as housing, transport, environmental protection, etc. What is distinctive about plan data is that it includes future intentions and policy decisions, while land use data only depicts the current situation. However, both are relevant and whether plan data is preferred depends on the questions being asked.

A typical question is how many **building reserves** exist. That means, of all the land that is zoned as building land, how much of it has already been built on, and how much is zoned but has not been built on yet, in which case it is a potential location for future construction. Besides plan data, information from building registers is necessary for that calculation. Also, the complexity of such an indicator could range from a simple calculation of plots that have not been built on yet, to a detailed calculation of, e.g., how much floor space (floor-area-ratio) has been designated by the respective plan compared to the floor space that already exists, thereby indicating potential for densification. However, the latter requires very high quality data and unambiguous plan regulations.

To get a simple overview of what we plan, **efficiency ratios based on the zoned building land** can be used. Such data is not available for all case countries, e.g. in Germany no country-wide database exists yet, but, as example, Table 4.2 shows data from Austria (ÖROK, 2020) and Switzerland (ARE, 2017). The table

shows that Austria has, compared to Switzerland, a much higher average of square metres building land per person. This can indicate a different planning practice in the countries, but it might be as well caused by differences in the planning system, the digitalisation and the definition of categories (e.g. if transport or summer house areas are included or not). Within countries the context would be similar, still, planning practice and even regulations (as e.g. in Austria) can be different. However, there we can see a familiar pattern, with cities and urban regions as Vienna and Zürich being more dense and therefore below the national average in m2 building land per inhabitant.

Table 4.2
Zoned building land in Austria and Switzerland, per NUTS2 region

NUTS2	Name	Zoned building land (ha)	m^2 per inh.	Index (difference from national average)
AT	Austria (2019)	318.927	360	100
AT11	Burgenland	22.595	770	214
AT12	Niederösterreich	89.879	536	149
AT13	Wien	14.845	78	22
AT21	Kärnten	29.057	518	144
AT22	Steiermark	54.479	438	122
AT31	Oberösterreich	61.143	413	115
AT32	Salzburg	14.333	258	72
AT33	Tirol	21.188	281	78
AT34	Vorarlberg	11.408	289	80
CH	Switzerland (2017)	232.038	276	100
CH01	Région lémanique	48.181	299	108
CH02	Espace Mittelland	54.960	296	107
CH03	Nordwestschweiz	29.777	261	95
CH04	Zürich	30.420	204	74
CH05	Ostschweiz	38.300	329	120
CH06	Zentralschweiz	19.255	241	87
CH07	Ticino	11.145	315	114

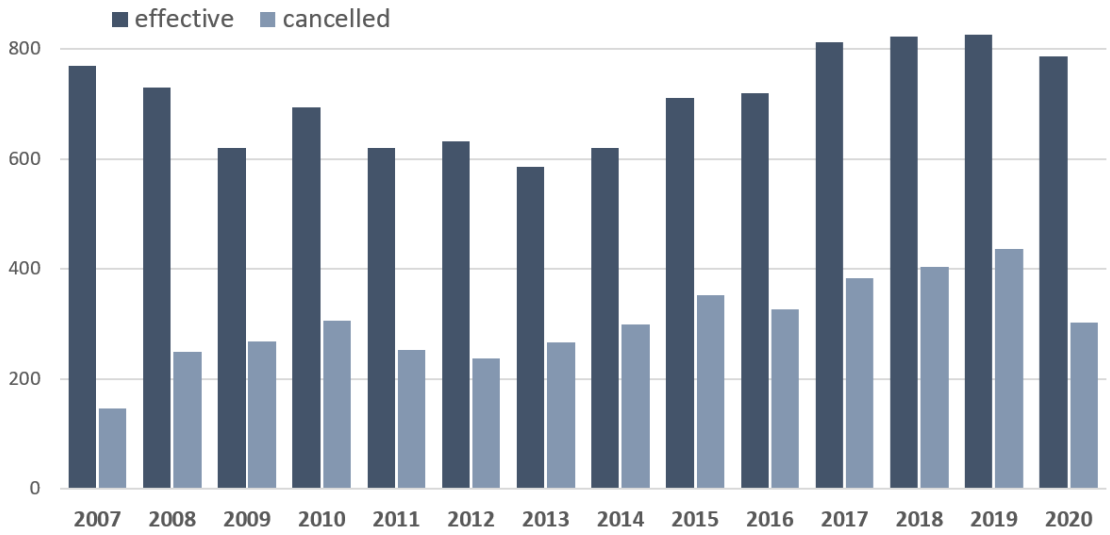
Source: Austria: “Widmungen für bauliche Nutzung“ (ÖROK, 2020), Switzerland: “Bauzonen” (ARE, 2017). Population data was derived from Eurostat for the respective years.

However, even here a comparison needs to include different context, not least geographical settings and historical land use patterns. For the topic of slowing down or even reducing of land consumption[25] this is anyway relevant, especially when time-series can be used (which is available in a few cases) to show the trend of development and potential policy effects.

[25] See for example SDG Indicator 11.3.1, Ratio of land consumption rate to population growth rate, https://landportal.org/node/52272 - although based on actual land use, data on planned land use would add further details.

Time-series data (or metadata referring to e.g. adoption date of a plan) would also allow to look at **new planned areas** separately. As example, Figure 4.1 shows the number of local plans becoming effective or cancelled in Denmark since 2007. Every year between 600 and 800 new local plans became effective. After the economic crisis in 2008, the number of plans decreased, but increased again since 2013. In 2020 we can see a drop in plans cancelled. Plans usually get cancelled when a new plan is done for the same area. We do not know the reason for this drop, but, as the number of local plans becoming effective did not change much, it could indicate that more local plans were done on 'greenfield land', i.e. land which was not built on before. An analysis of **size and use** of the new planned areas, for example, as well as looking more detailed into how plans are changed or updated could provide insights into general **dynamics of planning practice**.

Figure 4.1
Number of Local plans in Denmark becoming effective or cancelled since 2007



Source: Own calculation, data from plandata.dk, accessed 30 January 2021

4.3 Proposals for future research

The DIGIPLAN provides only a snapshot of the state and process in selected countries. The following proposals for future research builds on that snapshot and the knowledge. We clustered it in five topics:

- The transition to digital plans
- The impact of digitalisation on planning
- Digital technologies used in digital planning everyday practice
- Insights from other cases in Europe and beyond
- Using digital plan data to provide evidence on how we plan and use land

The transition to digital plans

DIGIPLAN has provided a first overview of digitalisation of plans and plan data. Even though we have touched upon the following questions, a wider review could provide valuable learning points:

- How are **existing/traditional planning instruments adapted to a digital format**? Do we loose certain content or information when digitising, or what new possibilities emerge for these planning instruments?
- How do **digital plans** look that have been developed from scratch for a digital format?
- What **types** of different digital formats can we find along a range?

Regulatory plans, e.g. municipal land use plans, are those digitised in almost all DIGIPLAN cases. Other plan types (visionary, strategic) are not digitised in the same way.

- What is the differences in terms of digitalisation in regards to more **strategic vs. regulatory** plans?
- **How** to deal with digitalisation of strategic plans and planning? Can visionary (and strategic) planning instruments be digitised? (e.g. issue of scale, possibilities to add schematic representations of visionary/strategic planning intentions)
- How does planning system, plan types etc. correlate with digitisation grades and paths?

Furthermore, a structured analysis on digitalisation of planning in relations to different geographies could add some additional perspectives

- Are there differences in the digitalisation of plans between **urban and rural** areas (e.g. lack of resource in smaller municipalities)?
- Is it possible to have digital plan data for **cross-border / trans-national** areas (including MSP and lake areas)?

The impact of digitalisation on planning

DIGIPLAN has provided some insights on how planning changes under digitalisation from the in-depth case studies. However, the interviews also showed significant developments foreseen in the coming years. The structural impact on planning should be closely followed, not least within a wider digitalisation agenda:

- How does digitalisation impact the planning process? What about participatory processes?
- How does digitalisation impact the plan (outcome)?
- Will monitoring and quantitative planning evaluation increase, and how to support that?
- Who gains and who loses? Is there a change in power relations? The relation between digitalisation and competences in planning
- How can planning systems / laws anticipate and foster or prevent changes?
- What is the cost of not to digitise?

The technologies used in digital planning everyday practice

Planning practice is digital, however, knowledge on the technologies and software used is missing. As Davis writes, "there are significant gaps in the literature on urban management-centric software. […] software products are widely used nationally, yet it appears that no descriptive or qualitative research has been conducted to examine the role of these software types within planning or development processes." (Davis, 2019, p. 46).

- How digital is planning practice on the ground – how much is automated?
  - Which software and standards are used in everyday planning practice to manage digital plans and plan data – and how does this structure the planning process?
  - Which tools are planners using, how much do we rely on external information (non-authorative) and what is the quality of that? (e.g. from Google, OpenStreetMap)
  - What role does broad data accessibility, e.g. through search engines, play for its use?
  - What are the reasons for not making use of the potential digital plans and technologies offer? Is there an educational gap? Is the technology or data compatible with practice?
- How do we interact with planning content in a digital age – what are the user interfaces (physical: screen, map table, VR/AR, web…)
- What potential have new technologies as 3D, digital geotwins etc. for digital planning practice?

Learning from other cases in Europe and other places in the world

As written in the New Urban Agenda's implementation plan: "The use of digital platforms and tools, including geospatial information systems, will be encouraged to improve long-term integrated urban and territorial planning and design, land administration and management, and access to urban and metropolitan services." (UN, 2017, paragraph 156). We have seen some advanced practices in our cases, but it is also clear that digitisation of planning happens around the world and there is a lot to learn from, even if planning systems, settlement structures and governance cultures are different.

- How embedded are digital practices in public governance and in planning?
- What different roles do private companies have (e.g. in Slovakia and Poland, a digital plan portals is provided by private consultancies)?
- How is plan data integrated with other government data and with technological development (e.g. in Korea or other highly digitised countries in Asia)?
- What can we learn about the integration of digital participation, the transparency in digital planning processes of the use of open, non-governmental / non-authorative or citizen-generated data from other cases?

Using digital plan data to provide evidence on how we plan and use land

Finally, digital plan data constitute a unique resource to learn about planning. Methods, indicators and data needs to be explored. They can be used to answer some of the questions above, but we highlight that topic separately, because plan data can provide structured evidence on planning.

- What is the quality of plan data and which methods can be applied to them, to explore the content of plans?
- What methods and data can be used to provide a more harmonised picture across different planning systems / regions / countries?
  - Can "Open Data in Europe" (European Data Portal) or INSPIRE (Annex III: Planned land use) be used in this respect?
- Which indicators could be based on plan data (see section 4.2), providing a better picture of how we use and plan to use land?

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