2024 Geospatial Trends

Opportunities for data.europa.eu from emerging trends in the geospatial community: Geospatial digital twins

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The official portal for European data

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Executive summary

In this report, current trends regarding geospatial data and their relevance for data.europa.eu are explored. The aim of this annual exercise is to identify opportunities from emerging trends in the geospatial community and to explore how data.europa.eu can support and benefit from the new ways in which geospatial datasets are offered. This year the focus is on geospatial digital twins.

1. Introduction

The goal of data.europa.eu is to improve accessibility and promote the reuse of public-sector information. The portal provides access to open data from international, EU, national and regional sources. For the most part, this is done by collecting the metadata of public data made available across Europe. Metadata is harvested from both specialised geodata and generic open data catalogues and is made available on data.europa.eu (acting as a single point of access).

Geospatial data contains information on properties or conditions that are linked to a position on earth. Looking at the geospatial context – the where – of a phenomenon will often uncover interesting correlations or revelations. Facilitating the discovery of and access to open geospatial data sources is an important feature of data.europa.eu.

In the article 'Geospatial' ([1]), Sieber notes that, while efforts relating to open geospatial infrastructures predate the advent of open data, 'there are relatively weak links between the open geospatial and other open data communities. Stronger links could build critical capacity for spatial analysis within open data communities.' Data.europa.eu offers the opportunity to strengthen the links between open data and geospatial data communities and to promote the use of geospatial information within open data contexts.

As part of the data.europa.eu mission to support European countries in increasing their open data maturity and promoting reuse, the adoption of new trends for publishing geospatial data will be monitored and their relevance for data.europa.eu will be explored on a yearly basis. The focus of this exercise is to identify opportunities from emerging trends in the geospatial community and to explore how data.europa.eu can support and benefit from the new ways in which geospatial datasets are offered. The results are documented in this short report.

2. Trends

In this report, a trend is understood to be a recognisable tendency or direction of development, or, to quote the *Cambridge Dictionary*, a 'general development or change in a situation or in the way that people are behaving' ([2]).

The topic of geospatial digital twins was chosen to be discussed in this report as it seems especially relevant to data.europa.eu: on the one hand, data.europa.eu can help discover geospatial datasets to build digital twins; on the other hand, the specific needs for real-time and three-dimensional (3D) data in digital twin applications (apps) lead to new requirements regarding the discovery of additional types of data and the associated metadata.

([1]) Sieber, R., 'Geospatial', in: Davies, T., Walker, S., Rubinstein, M. and Perini, F. (eds), *The State of Open Data: Histories and horizons*, African Minds, Cape Town, 2019, pp. 137–150, https://library.oapen.org/handle/20.500.12657/24884.

([2]) https://dictionary.cambridge.org/dictionary/english/trend.

2.1. Webinar on geospatial trends

On 13 September 2024 a webinar was held on emerging trends in the geospatial community ([3]). The goal was to gather input from the participants on which trends, standards or ideas could be relevant for data.europa.eu.

At the beginning of the webinar, a brainstorming session on current trends regarding geospatial topics was conducted. The participants were asked what current trends regarding geospatial topics came to mind and what trends might affect the way we use geospatial data.

Figure 1 depicts a word cloud of the terms entered, where the size of the word is proportional to how frequently it was mentioned by the participants.

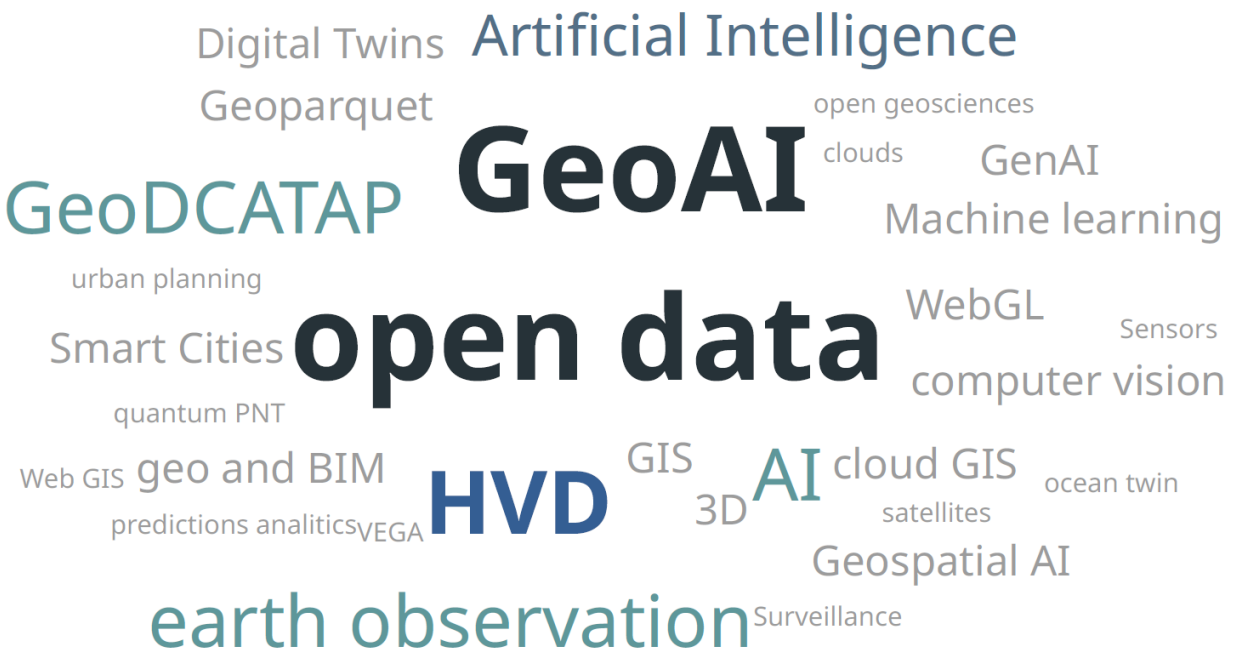

Figure 1: Trends named by participants in the webinar on 13 September 2024

While not a representative survey, these insights may be useful in providing input when choosing trends to focus on for next year's report.

Some of the responses named topics that have been covered in the previous years' webinars and reports: geospatial artificial intelligence (GeoAI), artificial intelligence (2023), smart cities (2022) and high-value datasets (HVDs) (2021). This shows that these topics are considered relevant by the participants.

This year, the webinar and the report focus on geospatial digital twins as a trend that may be of interest for the future of data.europa.eu. An introduction to the topic of geospatial digital twins was given, followed by a Q & A and an online activity to gather participants' views on how data.europa.eu might benefit from and support the establishment of geospatial digital twins.

([3]) Publications Office of the European Union, '"Emerging geospatial trends 2024 in the era of digital twins" data.europa.eu', YouTube website, 2024, https://www.youtube.com/watch?v=gkMX7picK8k.

2.2. Geospatial digital twins

A digital twin is a virtual representation of an intended or actual real-world object or system ([4]). The digital twin concept has been known by different names (e.g., virtual twin) and became especially popular for manufacturing industries in the 2010s and 2020s. A digital twin combines base data, planning and real-time data. It consists of models, simulations and analyses to emulate the behaviour of the object or system throughout its entire life cycle. The combination of visualisation, simulation and reasoning supports decision-making on various use cases. A **geospatial digital twin** follows the same general idea but focuses on a particular thematic aspect in a defined spatio-temporal subset of the real world.

A geospatial digital twin often utilises existing spatial data infrastructures to incorporate base data and thematic data. While spatial data infrastructures focus on serving data and interfaces, geospatial digital twins focus on the specific question and the underlying use cases. Geospatial digital twins address use cases that make use of data, some of which is already being published under EU directives such as the open data directive ([5]) or the Inspire directive ([6]), the latter having been a major driver for today's geospatial data infrastructures.

Geospatial digital twins mostly implement 3D visualisations to achieve a higher level of immersion for users. Often, 3D building and integrated meshes are used as a base layer. An integrated mesh ([7]) is 'a mesh surface with high resolution imagery textures representing the skin of the Earth, typically created from satellite, aerial or drone imagery' ([8]).

Figure 2 shows an information model for geospatial digital twins. Source systems provide access to the required data through standardised interfaces, allowing them to retrieve the data in different data streams. A data stream may be a standard Open Geospatial Consortium (OGC) service or a downloadable data package on an (open) data portal. The digital twin queries the data and transforms, processes and aggregates it based on the use cases determined in advance. The information is then provided to users – ideally following a user-centred design approach.

([4]) Wikipedia, 'Digital twin', 4 November 2024, https://en.wikipedia.org/wiki/Digital_twin.

([5]) Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information, OJ L 172, 26.6.2019, p. 56, http://data.europa.eu/eli/dir/2019/1024/oj.

([6]) Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an infrastructure for spatial information in the European Community (Inspire), OJ L 108, 25.4.2007, p. 1, http://data.europa.eu/eli/dir/2007/2/oj.

([7]) Open Geospatial Consortium (OGC), 'Integrated mesh scene layer (OGC version 1.3)', GitHub website, https://github.com/opengeospatial/ogc-i3s-community-standard/blob/main/docs/IntegratedMesh_ReadMe.adoc.

([8]) OGC, 'OGC Indexed 3D Scene Layer (I3S) and Scene Layer Package (*.slpk) Format community standard version 1.3', OGC website, 11 January 2023, https://docs.ogc.org/cs/17-014r9/17-014r9.html.

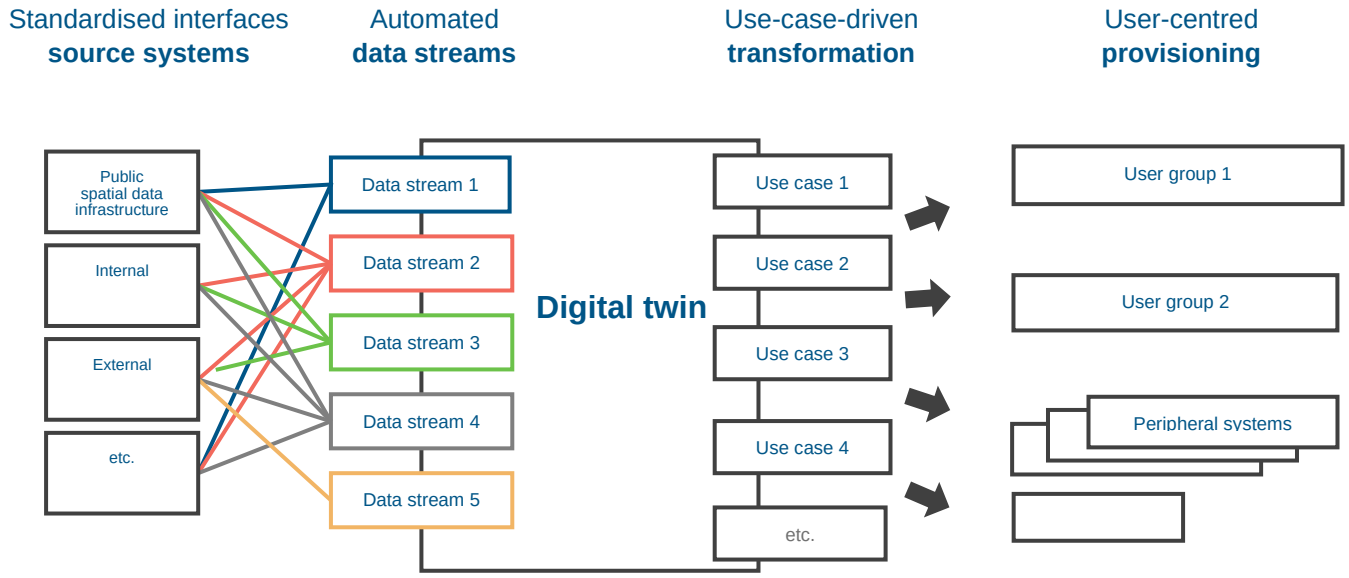

Figure 2: Information flow for geospatial digital twins
Source: **con terra.**

Use case: digital twin for disaster management

There are many use cases for geospatial digital twins – any question or task that will be easier to address when exploring a virtual representation or mirror of reality to better understand or model relationships between objects and processes. One tangible example is disaster management, because of the many different interlocking aspects.

The German state of North Rhine-Westphalia has very recently implemented a digital twin to facilitate the digitalisation of disaster management. It uses a lightweight 3D app that targets staff in charge of disaster response who do not have in-depth geographic information system expertise. Figure 3 shows a screenshot of the app. Besides 3D capabilities, the app provides analysis and simulation functions tailored to the needs of disaster managers. A scenario selection allows for quick and simplified access to relevant information layers based on disaster deployment keywords.

Figure 3: Digital twin for disaster management (screenshot)

Open data is an important source of data

Finding suitable data sources for geospatial digital twins is time-consuming. Open data catalogues can play a significant role in finding data and assessing whether it is suitable for the use case.
Disaster response officials need up-to-date information – ideally information that is easy to integrate under an open data licence. The data should be well structured, accurate and up to date, and available via an application programming interface (API). Some data sources used in the North Rhine-Westphalia digital twin for disaster management can be found at data.europa.eu: hospitals, schools and kindergartens are available as popular geospatial services / APIs (OGC API Features, OGC Web Map Service) and as downloads in comma-separated values format. Figure 4 shows screenshots of the descriptions of these data sources at data.europa.eu. An advantage of using data.europa.eu rather than a local geocatalogue is that the information is available in different languages, as the descriptions are machine translated for data.europa.eu.

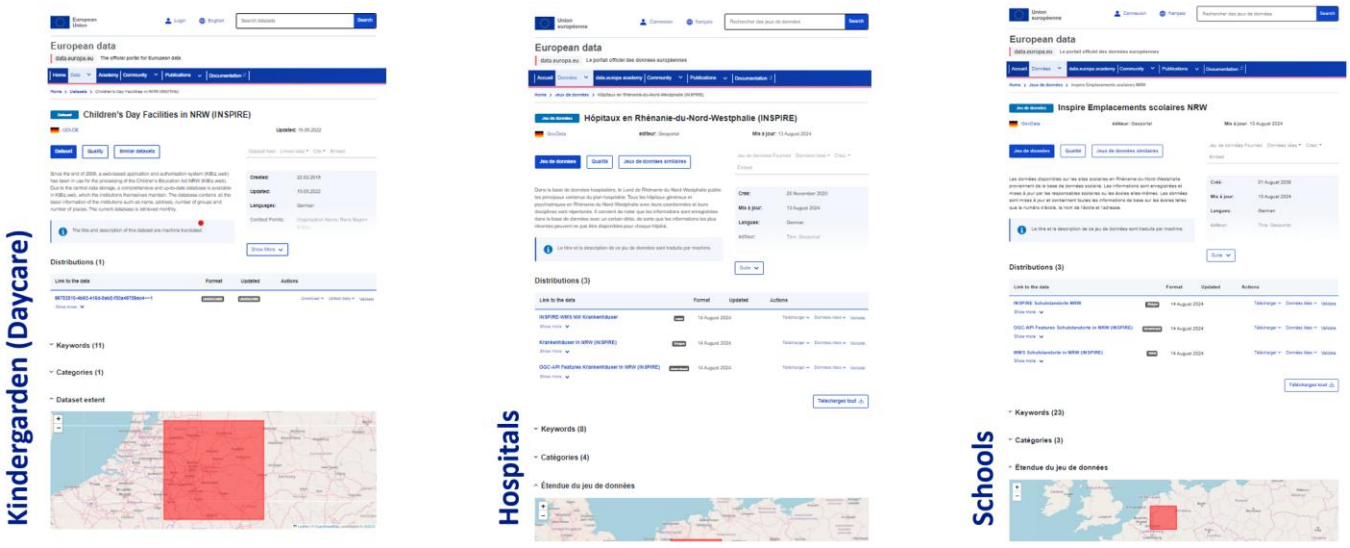

Figure 4: Finding open data on data.europa.eu
***Source:* con terra.**

Destination earth

Destination earth (**DestinE**) is a flagship initiative of the European Commission to create a digital twin of the earth. The goal is to develop 'a highly-accurate digital model of the Earth … to model, monitor and simulate natural phenomena, hazards and the related human activities' ([9]).

DestinE is implemented by the European Organisation for the Exploitation of Meteorological Satellites, the European Centre for Medium-Range Weather Forecasts and the European Space Agency.

Technologies and standards

The creation of geospatial digital twins relies heavily on the availability of the necessary data comprising more than just geographic base data (e.g. background maps, street networks or any kind of infrastructure data). To fulfil the aim of modelling the real world in the best possible manner, 3D and real-time data become especially relevant. 3D data helps to better represent the area covered by a digital twin, for example by integrating building models and point cloud data. While 3D data enables the realistic modelling of built environments and terrain, real-time data (e.g. traffic information, weather conditions) adds a new dimension of information. By including real-time data, digital twins not only represent a static view of the environment, but also offer dynamic insights into the current state of the environment, enabling an understanding of reality with minimal delay.

To integrate such additional types of data sources, it is important to consider the use of standards. This reduces integration efforts while also helping to increase the reusability of data sources. In the context of geospatial digital twins, OGC standards play a particularly important role.

There are various standards available to support the interoperable provision of 3D data. Besides the OGC CityGML (Geography Markup Language) standard that specifies a model and encoding for 3D city models, the OGC 3D Tiles ([10]) and OGC I3S – Indexed 3D Scene Layers ([11]) standards are particularly important in enabling the interoperable encoding and provision of 3D data.

([9]) Destination earth, Destination earth website, https://destination-earth.eu/.
([10]) https://www.ogc.org/standard/3DTiles/.
([11]) https://www.ogc.org/standard/i3s/.

The latter two are OGC community standards. This means that they are not directly maintained by the OGC but are instead de facto standards that are implemented by a significant number of members of the larger geospatial community. Thus, both standards already have a relevant acceptance in practical applications. The OGC 3D Tiles standard was submitted by Analytical Graphics Inc., the developer of the Cesium project, a widely used framework for enabling the visualisation of 3D geospatial data. The submitter of OGC I3S was Esri, which is especially known for the ArcGIS family of software products. The scope of these two standards is relatively similar, as they both support the encoding and sharing of 3D meshes, 3D building models and point cloud data. Differences exist, however, in the support for various coordinate reference systems. Consequently, we consider both standards as highly relevant for sharing 3D data that can serve as input for the creation of digital twins.

One further interesting development is the emerging OGC API – 3D GeoVolumes standard ([12]). Although this standard is still in development, it may become a relevant specification in the future as it aims to provide an approach for integrating different vendor-specific solutions for the delivery of 3D data into a common approach.

For the provision of real-time data, it is necessary to consider two types of use case, in particular. On the one hand, the streaming-based delivery of data aims at delivering new data (e.g. new sensor readings) with minimum latency to ensure that it is delivered to apps as soon as it is available. On the other hand, it is also necessary to access archives of historical real-time data to analyse trends and compare the current situation with data from the past.

For the real-time delivery of data, the message queuing telemetry transport (MQTT) ([13]) protocol is a de facto standard used by a large community. MQTT is a publish/subscribe protocol. This means the publishers (i.e. sensing devices) deliver their data to a broker as soon as it is available. Apps/users interested in receiving the latest data for a specific sensor or type of measurement (topics) can subscribe to the broker for these data streams. The broker takes care of delivering the data to all subscribers as soon as it has received new data from a publisher. This results in a highly efficient mechanism for distributing real-time data, which is especially popular within the internet-of-things community. Consequently, MQTT is a standard that can help to supply digital twins with live updates about the state of the environment represented by a specific digital twin.

Within the geospatial community, OGC SensorThings API ([14]) and OGC API – Connected Systems ([15]) are two standards that address the provision of real-time data. While the OGC SensorThings API is already established and supported by a significant number of data providers, the OGC API Connected Systems is still undergoing the standardisation process. Both standards aim at enabling interoperable access to sensor observation data (measurements). In both cases, access to historical data via a developer-friendly interface is supported, as is their combination with publish/subscribe protocols such as MQTT. One difference between the two specifications is in their architectural approach: while the OGC SensorThings API has been developed rather independently from other OGC interface standards, the OGC API – Connected Systems aims at an approach that is aligned with the larger OGC API family of standards. Furthermore, the OGC API – Connected Systems also covers an interoperable encoding of sensor metadata to better describe the measurement processes that have been used on the observation data offered. For the development of digital twins, we recommend considering both standards.

In summary, there are suitable standards available to support the provision of data needed to build digital twins. However, we see a need to promote the use of these standards in order to facilitate data reuse. Furthermore, it is

([12]) https://ogcapi.ogc.org/geovolumes/.
([13]) https://mqtt.org/.
([14]) https://www.ogc.org/standard/sensorthings/.
([15]) https://ogcapi.ogc.org/connectedsystems/.

necessary to investigate how to provide metadata for new types of data sources (e.g. describing the data streams offered by a MQTT broker). By addressing these challenges, we expect that data.europa.eu will become an even more valuable tool for discovering data for building digital twins.

3. Key points for attention from the 2023 report

As a result of our analysis in *Geospatial Trends 2023* ([16]), we listed some potential work items that would be useful in further advancing data.europa.eu. These key points for attention are described in this section.

([16]) Publications Office of the European Union, Britsch, C., Jirka, S. and Kügeler, A., *Geospatial Trends 2023: Opportunities for data.europa.eu from emerging trends in the geospatial community*, Publications Office of the European Union, Luxembourg, 2023, https://data.europa.eu/en/doc/geospatial-trends-2023-opportunities-dataeuropaeu-emerging-trends-geospatial-community.

3.1. Investigate the potential role of data.europa.eu in current geospatial artificial intelligence developments

Last year's report listed some possible steps to be considered in 2024. Topics for investigation are listed in Table 1.

Table 1: Investigate the potential role of data.europa.eu in current GeoAI developments

	Topics for investigation	Results
1	In what way can data.europa.eu support the use of GeoAI?	Data is crucial for any machine learning app, as existing (past) data is needed for the training of algorithms to give predictions based on new (current or future) data. Without an adequate amount of data, no algorithm will be able to learn enough interrelations in the data to give any prediction. Open data offers great potential to aid the success of GeoAI apps, and data.europa.eu can help identify useful data resources.
2	How can we create synergies between data.europa.eu and research data infrastructure projects, such as the European Open Science Cloud portal ([17]))?	The development of research data infrastructures is currently a highly dynamic process. In its involvement in relevant projects (e.g. research projects such as metrology for integrated marine management and knowledge-transfer network (MINKE) ([18]) or AquaINFRA ([19])), 52°North aims to promote the use of standards as a first step to facilitate the discovery and sharing of research data. We recommend further monitoring the development of research data infrastructures, in order to investigate which catalogues for findable, accessible, interoperable and reusable (FAIR) ([20]) research data might also be relevant for data.europa.eu as future metadata sources.

([17]) https://open-science-cloud.ec.europa.eu/.
([18]) https://minke.eu/.
([19]) https://aquainfra.eu/.
([20]) https://www.go-fair.org/fair-principles/.

3	How can we develop a list of data quality properties that are needed by thematic experts to discover and assess the suitability of using specific datasets for GeoAI apps?	The FAIR principles are a good start. These principles emphasise machine-actionability, which is necessary for GeoAI apps. While there may be some overlaps between thematic domains, it is mostly the thematic experts who will be able to name the data qualities they need to answer a specific question or solve a task. One way to address this would be to invite thematic experts to a workshop to discuss the data (and data quality) needed to solve a specific task using GeoAI. If this is done for different thematic domains, it would be possible to determine the overlap in the desired data quality properties.
4	How can we develop recommendations on how the necessary information about data quality and the contents of datasets can be efficiently encoded in the Data Catalogue Vocabulary Application Profile (DCAT-AP)? Based on this information, data scientists will be able to better use data.europa.eu to discover and evaluate datasets for their Geo-AI apps.	This work is still ongoing. There are currently European research projects such as MINKE that are trying to provide approaches to sharing metadata to better describe the processes under which the data has been generated (in the case of the MINKE project, for example, measurement processes are addressed). Currently the focus is on describing such information in specific metadata formats. This information will also be considered as part of DCAT-AP in the future.

3.2. Investigate ways to support finding and accessing high-value datasets

The 2022 and 2023 reports suggested investigating methods to support finding and accessing HVDs.
The concept of HVDs was introduced in the open data directive. The objective of this 2019 recasting of Directive 2003/98/EC (the public sector information directive, PSI) ([21]) was to strengthen the EU's data economy by increasing the amount of publicly funded data available for reuse. HVDs are meant to be used to create value-added services to benefit society, the environment and the economy. HVDs must be made available for reuse:

- with minimal legal restrictions,
- free of charge,
- in a machine-readable format,
- as a bulk download (where relevant),
- via suitable APIs.

On 20 January 2023, the Commission published an implementing regulation containing a list of HVDs and rules on their reuse ([22]). Member States are required to make these datasets available within 2 years from the date of the regulation's entry into force.

([21]) Directive 2003/98/EC of the European Parliament and of the Council of 17 November 2003 on the re-use of public sector information, OJ L 345, 31.12.2003, p. 90, http://data.europa.eu/eli/dir/2003/98/oj.

([22]) Commission Implementing Regulation (EU) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use, OJ L 19, 20.1.2023, p. 43, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2023.019.01.0043.01.ENG.

Topics for investigation are listed in Table 2.

Table 2: Investigate ways to support finding and accessing HVDs

	Topics for investigation	Results
1	How do the Member States publish and describe HVDs?	The way to annotate datasets as HVDs at the national level is governed by the DCAT-AP for High-Value Datasets (DCAT-AP HVD) technical specification ([23]). There is also a set of guidelines on HVD reporting and how to tag them ([24]).
2	What insights does the planned new feature of the Inspire Geoportal ([25]) for browsing/viewing geospatial HVDs offer to users? How many datasets can be discovered in this way? Can this approach help users locate geospatial HVDs from authoritative governmental sources?	In its annexes, the Inspire directive lists 34 data themes that fall within its scope. Annex I to the open data directive lists six thematic categories. The implementing regulation on HVDs references themes from the Inspire annexes in three of the six thematic categories. This mapping between Inspire and HVD themes is used for the new Inspire Geoportal to show which datasets are HVDs. This approach can help users locate geospatial HVDs from authoritative governmental sources. However, there is a fairly large number of datasets for each HVD theme in some countries and none in others: at the time of writing (October 2024), browsing for 'addresses' ([26]) leads to 60 sets of metadata for addresses in Germany and none in Bulgaria, Ireland, Greece, Hungary or Malta. This may make it difficult to identify the datasets needed for a specific use case.
3	What are users' expectations for data.europa.eu in regard to finding and accessing HVDs? Are there specific user expectations for data.europa.eu in regard to finding and accessing geospatial HVDs?	We recommend conducting an online user survey on these questions or including them in the next user survey.

([23]) Semantic Interoperability Community, 'DCAT-AP High Value Datasets', GitHub website, https://semiceu.github.io/DCAT-AP/releases/2.2.0-hvd/.

([24]) European Commission, 'Reporting guidelines for HVDs', GitLab website, https://dataeuropa.gitlab.io/data-provider-manual/hvd/Reporting_guidelines_for_HVDs/.

([25]) https://inspire-geoportal.ec.europa.eu/.

([26]) https://inspire-geoportal.ec.europa.eu/srv/eng/catalog.search#/overview?view=themeOverview&theme=ad.

4	Is there a need for data.europa.eu academy training in regard to HVDs, for example explaining the relationship between themes from the Inspire annexes and HVDs?	As this information is difficult to find and to understand if you are not an expert, this could be a good topic for additional training sessions.

3.3. Investigate how metadata from OGC API Records endpoints can be harvested efficiently

At the time of writing, the OGC API Records specification ([27]) was close to being adopted by the OGC. A currently mostly empty repository ([28]) has been created as a discussion space on possible good practices for Inspire catalogue services based on OGC API Records.

As the investigation should be carried out after the OGC API Records specification has been published, we will put this on the agenda for 2025. Topics for investigation are listed in Table 3.

Table 3: Investigate how metadata from OGC API Records endpoints can be harvested efficiently

	Topics for investigation	Results
1	When will the first OGC API Records catalogues be available for harvesting?	Unclear, as the OGC API Records specification is still being published. This should be revisited once the specification is finalised.
2	Will Inspire recommend that Member States switch from Catalogue Service for the Web to OGC API Records?	Unclear, as the OGC API Records is still being published. This should be revisited once the specification is finalised.
3	Are there benefits in adding OGC API Records to the endpoints supported by the geo-harvester?	Unclear, as the OGC API Records specification is still being published. This should be revisited once the specification is finalised.

4. Conclusions and key points

Geospatial data can play a key role in addressing global challenges such as environmental pollution, economic crises, the loss of biodiversity and climate change. New technological means change the way we work with data. This may lead to new opportunities and ideas to improve data.europa.eu.

As a result of our analysis, we see that the potential work items listed below would be particularly useful in further advancing data.europa.eu.

This report has been compiled to investigate and start a discussion on how current geospatial trends might affect user expectations for data.europa.eu and to find opportunities that arise from them. The ideas from the *Geospatial Trends 2023* report ([29]) were discussed against the background of current developments. Some of them remain open to being revisited, for example when relevant standards have been adopted. In addition to this, new key points of

([27]) https://ogcapi.ogc.org/records/.

([28]) https://github.com/INSPIRE-MIF/gp-ogc-api-records.

([29]) European Commission: Directorate-General for Communications Networks, Content and Technology, Britsch, C., Jirka, S. and Kügeler, A., *Geospatial Trends 2023: Opportunities for data.europa.eu from emerging trends in the geospatial community*, 2023, https://data.europa.eu/en/doc/geospatial-trends-2023-opportunities-dataeuropaeu-emerging-trends-geospatial-community.

attention to follow up on over the coming years were identified. These will be addressed in next year's report on geospatial trends.

Data sources for digital twins

Topics for investigation are listed in Table 4. They should be addressed in 2025.

Table 4: Investigate data sources for digital twins

	Topics for investigation
1	Are relevant types of data sources for use in geospatial digital twins already included in data.europa.eu?
2	To what extent is building information modelling data available as open data, and can examples already be found on data.europa.eu?
3	How are data resources for geospatial digital twins currently described, and are there more suitable ways to provide metadata about them?
4	How can geospatial digital twin initiatives be motivated to share their data as open data and to provide sufficient metadata to make it discoverable?
5	How can real-time data sources be described in DCAT-AP to facilitate their discovery to a suitable level of detail (e.g. describing data access services versus describing individual datasets)?

Investigate synergies with Destination Earth

Topics for investigation are listed in Table 5. They should be addressed in 2025.

Table 5: Investigate synergies with DestinE

	Topics for investigation
1	How can the discoverability of DestinE resources via data.europa.eu be ensured?
2	Should data.europa.eu and DestinE cooperate more closely?
3	Is there a need for data.europa.eu activities (e.g. a data story or academy training) with regard to DestinE?

Investigate consumption of real-time data sources via standards

Topics for investigation are listed in Table 6: Investigate consumption of real-time data sources via standards. They should be addressed in 2025.

Table 6: Investigate consumption of real-time data sources via standards

	Topics for investigation
1	How can real-time data delivered via the OGC API – Connected Systems be discovered and previewed in data.europa.eu?
2	How can real-time data delivered via the OGC Sensor Things API be discovered and previewed in data.europa.eu?
3	How can real-time data delivered via MQTT be discovered and previewed in data.europa.eu?

Investigate how metadata from OGC API Records endpoints can be harvested efficiently

The following tasks can be addressed after the specification for OGC API Records has been published (currently waiting for the adoption vote).
Topics for investigation are listed in Table 7.

Table 7: Investigate how metadata from OGC API Records endpoints can be harvested efficiently

	Topics for investigation
1	When will the first OGC API Records catalogues be available for harvesting?
2	Will Inspire recommend that Member States switch from Catalogue Service for the Web to OGC API Records?
3	Are there benefits in adding OGC API Records to the endpoints supported by the geo-harvester?

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