Working with INSPIRE View and Download Services

OER4SDI

Open Educational Resources for Spatial Data Infrastructures

In this technical tutorial, we will explore how to work with INSPIRE view and download services. Learning objectives are:

- Understanding the characteristics of INSPIRE view and download services.
- Gaining practical experience in working with these resources.

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1. Overview

INSPIRE stands for “Infrastructure for Spatial Information in Europe”. The European INSPIRE legislation requires public sector institutions in the member states to provide access to spatial data via so-called **view services** and **download services**.
INSPIRE also provides technical recommendations on how these services can be implemented on the basis of international standards such as classic OGC Web Map Services (WMS) and OGC Web Feature Services (WFS) or the newer OGC API type of services.

In this technical tutorial, we will explore how to work with INSPIRE view and download services. Learning objectives are:

- Understanding the characteristics of INSPIRE view and download services.
- Gaining practical experience in working with these resources.

The tutorial is structured as follows:

This tutorial is designed for students and professionals who want to improve their understanding of SII (Spatial Information Infrastructures). We assume that you have some basic knowledge of spatial data, metadata, OGC web services and QGIS. In this case, you will need about 90 minutes to work through this tutorial.

This tutorial has been developed in the context of the OER4SDI project at the Institute for Geoinformatics, University of Münster. Authors are Hamidreza Behbood and Albert Remke. The latest version of this tutorial is always available on GitHub. We hope you will use GitHub issues to provide feedback and suggest improvements.

The OER4SDI project has been recommended by the Digital University NRW and is funded by the Ministry of Culture and Science NRW.”.

2. Background on INSPIRE

2.1 INSPIRE in a Nutshell

What is the motivation behind INSPIRE and what are the main objectives?

Europe is an association of 27 member states that pursue common political and economic objectives, for example, in the areas of climate, nature, and environmental protection. The development and implementation of EU-wide environmental policies is dependent on data on the current state of and changes to nature and the environment. Such data exists in the Member States, but the data differs greatly in its type and quality as well as in the legal and technical requirements for its use.

This is where INSPIRE comes into play. The objective of INSPIRE is to create a European Spatial Information Infrastructure that improves the availability and usability of public sector spatial data that are relevant to European environmental policies.

How does INSPIRE try to improve the availability and usability of spatial data?

The core idea of INSPIRE is to obligate public institutions to make geodata and metadata on specific data themes discoverable, online accessible, interoperable, and easily reusable. Data and data services are interoperable if they can be combined with other data and services without requiring significant adaptation efforts.

To achieve this, INSPIRE requires data providers to:

- Describe their data and data services using **metadata** specified by INSPIRE.
- Provide their data for specific themes harmonized with **data models** specified by INSPIRE.
- Make their data available via online **data services** specified by INSPIRE.

- Provide a central **contact point** at the national level through which all metadata and data offerings can be found and accessed.

What is the role of the INSPIRE legal framework?

INSPIRE uses a set of legal instruments (the legal framework) to make all this happen:

- The **INSPIRE Framework Directive**[1] is a European law that requires the member states to implement INSPIRE by providing access to certain spatial data via discovery, view, and download services. This framework directive had to be transposed into national laws to become effective.
- The INSPIRE Framework Directive is complemented by the **INSPIRE Implementing Rules**[2]. These are directly binding European laws that define, in more detail, what has to be implemented and when. The implementing rules contain, for example, provisions on the data elements that have to be provided and on the functionality (operations) and service level (response time, availability) of data and metadata services.
- **INSPIRE Technical Guidance documents**[3] are non-binding recommendations that define again in further detail, **how** the datasets and services **can** be implemented. Here you find detailed data, metadata, and API specifications that refer to international standards, including those of ISO, W3C, and OGC.

So, the INSPIRE regulations (directive and implementing rules) define exactly **what** must be offered, **when,** and in **what quality**. The non-binding technical guidelines recommend **how** these data and metadata offerings can be implemented.

What are the technical components of INSPIRE?

From a technical point of view, INSPIRE consists of **data** and of **data services** that make these data available via APIs, e.g., map services for viewing or feature services for downloading data. Data and data services are described by **metadata**, which are made available for discovering those resources via catalog services and **portal applications** such as the European Inspire Geoportal[4] or the geoportal of the national spatial data infrastructure in Germany[5].

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[1] 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, pp. 1-14), Online resource: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l28195

[2] European Commission (2024): Inspire Knowledge Base, implementing rules, website: https://knowledge-base.inspire.ec.europa.eu/legislation/implementing-rules_en (last access 2024-9-02)

[3] European Commission (2024): Inspire Knowledge Base, technical guidance, website: https://knowledge-base.inspire.ec.europa.eu/legislation/technical-guidelines_en (last access 2024-09-02)

[4] Inspire geoportal: https://inspire-geoportal.ec.europa.eu/ (last access 2024-09-02)

[5] National geoportal in Germany: https://geoportal.de/ (last access (2024-09-02)

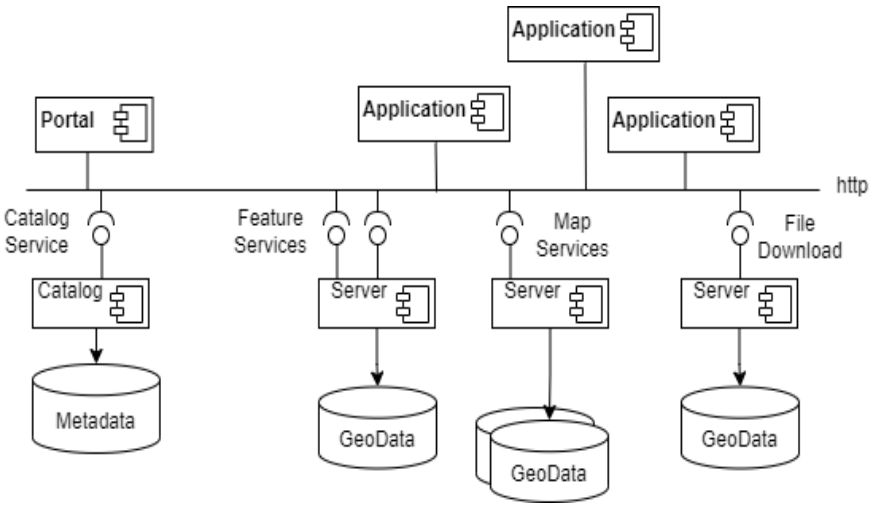

Fig. 1: INSPIRE Components (simplified view)

INSPIRE defines 34 data themes for which data, data services and metadata must be made available in such a way that they are interoperable and can be easily found, viewed and downloaded for further **applications**.

INSPIRE uses the term "**Network Services"** for services that facilitate the discovery, view, download, and transformation of data assets.

All resources of the INSPIRE data infrastructure are interconnected via the components and protocols of the **Internet and the World Wide Web**.

While the provision and use of data, data services, metadata and applications is the responsibility of data providers and data users, the provision of catalog services and portals is a cross-cutting task performed by institutions responsible for the overall operation of the INSPIRE infrastructure on a european, national or regional level. These tasks may also include the provision of documentation and registries supporting online access to schema definitions and vocabularies.

How is INSPIRE organized?

The European Commission is responsible for the coordination of INSPIRE at the European level. This is carried out by the INSPIRE Coordination Team, which also includes representatives of the Joint Research Center (JRC) and the European Environment Agency (EEA). Further committees (IC, MIG) also involve experts and representatives of the member states in the development and maintenance of INSPIRE.

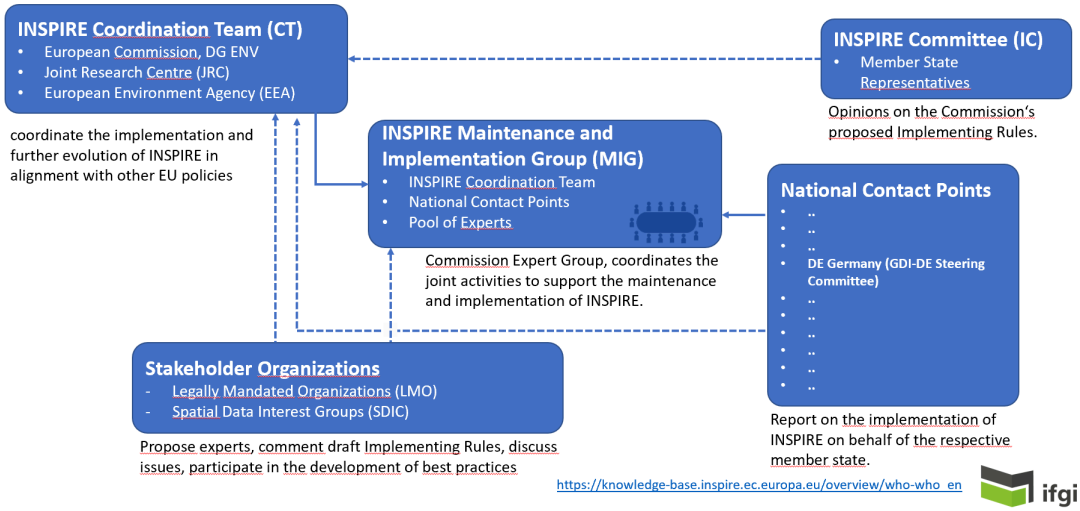

Fig. 2: INSPIRE organizational structure

Each Member State is responsible for implementing the INSPIRE directive within its territory. They have to transpose the INSPIRE directive into national legislation and develop policies to support its implementation. They designate a National Contact Point (NCP) to coordinate the implementation process and interact with the European Commission.

Public authorities within each Member State are responsible for creating, maintaining, and providing access to spatial data sets and services that fall under the INSPIRE data themes. They ensure that the necessary network services (e.g. discovery, view, download) are established and publish metadata on these resources in the national geoportal.

In member states such as Germany, which is itself a federation of **federal states**, the individual federal states are obliged by federal legislation to implement INSPIRE in their territory. This includes transposing the national INSPIRE legislation into the state legislation, providing a contact point and implementing the data and metadata services by public authorities.

INSPIRE - history and state of play

In 2007, the European Parliament and the Council adopted the INSPIRE Directive which created the obligation for both the European Commission and the member states to implement INSPIRE.

Until 2013, the implementation work focused mainly on creating the necessary legal and technical framework, including the transposition of the Directive into national law and the development of implementing rules and guidelines. During this phase, Member States had to identify datasets that fall within the scope of INSPIRE, provide metadata, view and download services for the existing data. Up to this point they were not obliged to meet already all interoperability requirements for spatial datasets and services.

By 2020, all datasets and services had to be compliant with the implementing rules and harmonized with rules on the interoperability of datasets and data services. Today more than 125 thousand datasets are discoverable via the european geoportal, many of them are as well provided as viewable and downloadable resources by public authorities.

Although many resources are made available in accordance with INSPIRE rules, the complexity of rules, specifications, organizational arrangements and workflows within this vast ecosystem of contributors is a big challenge for all involved. In fact, many users are not satisfied with the results of this huge undertaking, which started more than two decades ago, and question the cost-benefit ratio of INSPIRE[6]. The further development of INSPIRE, which is coordinated by the INSPIRE Maintenance and Implementation Group, therefore focuses in particular on adapting current main-stream technologies and simplifying the technical requirements for implementers. Another core objective is to improve the availability and usability of high-priority pan-European datasets.

2.2 INSPIRE data themes

INSPIRE primarily addresses data provided by public sector organizations. The focus is on 34 explicitly named data themes, including: Geographic Reference Systems, Administrative Units, Land Use, Transport Networks, Hydrography, Soil, Population, Demography, Natural Habitats and Biotopes, Protected Areas.

Annex I	Annex II	Annex III	
1. Coordinate reference systems	1. Elevation	1. Statistical units	11. Area management/ restriction/ regulation zones and reporting units
2. Geographical grid systems	2. Land cover	2. Buildings	12. Natural risk zones
3. Geographical names	3. Orthoimagery	3. Soil	13. Atmospheric conditions
4. Administrative units	4. Geology	4. Land use	14. Meteorological geographical features
5. Addresses		5. Human health and safety	15. Oceanographic geographical features
6. Cadastral parcels		6. Utility and governmental services	16. Sea regions
7. Transport networks		7. Environmental monitoring facilities	17. Bio-geographical regions
8. Hydrography		8. Production and industrial facilities	18. Habitats and biotopes
9. Protected sites		9. Agricultural and aquaculture facilities	19. Species distribution
		10. Population distribution — demography	20. Energy resources
			21. Mineral resources

Fig. 3: INSPIRE data themes as listed in Annex I-III of the INSPIRE Directive

[6] European Commission (2022): Evaluation of DIRECTIVE 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), Part 1/2. COMMISSION STAFF WORKING DOCUMENT SWD(2022) 196. Online resource: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12427-Sharing-geospatial-data-on-the-environment-evaluation-INSPIRE-Directive-_en (last access 2024-09-02)

The data themes are listed in Annexes I-III of the INSPIRE Directive. Annex I themes were to be implemented with the highest priority, followed by the themes in Annex II and later Annex III.

INSPIRE specifies a data model for each of the data themes. The abstract data model with its feature types and attributes is specified in the Implementing Rules. More detailed recommendations on the implementation and on the encodings are provided with the INSPIRE data specifications, complemented by UML diagrams and XML Schema Definitions for each of the data themes.

Let's look at one example: One of the Annex-I data themes is "Protected Sites". The legally binding provisions on the data model for Protected Sites can be found in the **Implementing Rules on the Interoperability of Spatial Data Sets and Services**, Annex II, Section 9.[7] Here you find the abstract definitions of required object types, attributes and data types.

9.1.1 *Protected Site (ProtectedSite)*

An area designated or managed within a framework of international, Union and Member States' legislation to achieve specific conservation objectives.

Attributes of the spatial object type ProtectedSite

Attribute	Definition	Type	Voidability
geometry	The geometry defining the boundary of the Protected Site.	GM_Object	
inspireID	External object identifier of the spatial object.	Identifier	
legalFoundationDate	The date that the protected site was legally created. This is the date that the real world object was created, not the date that its representation in an information system was created.	DateTime	voidable
legalFoundationDocument	A URL or text citation referencing the legal act that created the Protected Site.	CI_Citation	voidable
siteDesignation	The designation (type) of Protected Site.	DesignationType	voidable
siteName	The name of the Protected Site.	GeographicalName	voidable
siteProtectionClassification	The classification of the protected site based on the purpose for protection.	ProtectionClassificationValue	voidable

Fig. 4: Implementing Rules on the interoperability of data sets and services, Annex II, Section 9.1.1

[7] COMMISSION REGULATION (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services. Online resource: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:323:0011:0102:EN:PDF (last access 2024-07-09)

Most of the attributes are voidable, which means, values for these attributes are required but there might be cases where they can not be provided. Please note: Data types such as GM_Object, Identifier or DesignationType are complex data structures that are defined in other parts of the Implementing Rules.

The Protected Sites **Data Specification**[8] is a 128 pages technical guidance document that describes in detail what the basic ideas and use cases were that drove the design of the data model. It refers to the requirements of the binding implementing rules and adds recommendations on how to lay out the data structure and the encodings that can be used for data transfer. The Data Specification is complemented by UML models[9] and XML Schema definitions[10] for a set of application schemas (simple, full, Natura200) that all comply with the requirements of the implementing rules but add some information which is recommended for certain use cases.

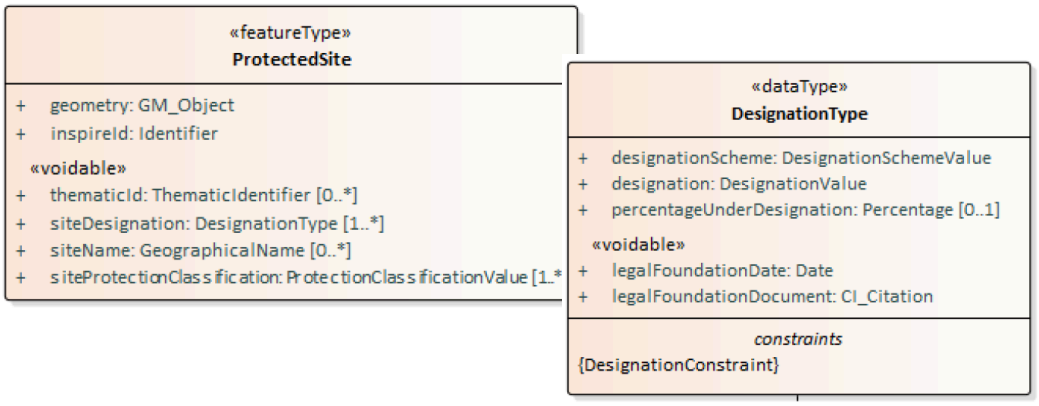

Fig. 5: Excerpt from the UML data model Protected Sites - Simple

Though the data specification is just a non-binding technical guidance document, most implementers try to follow the guidance of the data specification document to achieve the interoperability goals.

[8] INSPIRE Technical Guidance documents: Protected Sites Data Specification. Online resource: https://github.com/INSPIRE-MIF/technical-guidelines/blob/main/data/ps/dataspecification_ps.pdf (last access 2024-07-10)

[9] INSPIRE Technical Guidance: UML models of the Protected Sites Simple Application Schema. Online resource: https://inspire-mif.github.io/uml-models/approved/html/ , see: > Themes > Annex I > ProtectedSites > Application Schema Protected Sites > Protected Sites Simple (last access 2024-07-10)

[10] INSPIRE Technical Guidance: XML Schema Definitions (XSD) for the Protected Sites GML Application Schema. Online resource: https://inspire.ec.europa.eu/schemas/index.html, see > ps > 4.0 > protectedSites.xsd (last access 2024-07-10)

2.3 INSPIRE View Services

The INSPIRE Directive requires the provision of view services for the datasets that fall within the scope of INSPIRE. These services should make it possible to display, zoom, pan and overlay map views of spatial data sets and to display content and meta-information.

The Implementing Rules on network services[11] define more detailed requirements on the provision of view services, such as

- Abstract definitions of service operations and their parameters
- Metadata to be provided for the service instance and its layers
- Support for multiple languages
- Support for certain coordinate reference systems
- Supporting a common default layout
- Quality criteria such as response times, capacity for handling simultaneous requests, service availability

The **technical guidelines for the implementation of view services**[12] recommend implementing view services either as an INSPIRE profile of the ISO 19128 - Web Map Service (WMS) international standard, which itself is based on the OGC WMS standard or as an INSPIRE profile of the OGC Web Map Tile Service (WMTS). "INSPIRE profile" means that the implementations must adhere to the mandatory requirements of the base standard but may add INSPIRE specific requirements.

For example, the response of an INSPIRE-compliant WMS to a GetCapabilities request must not only contain the usual metadata required by the WMS standard, but must also provide all the metadata that INSPIRE has defined for visualization services. This can be implemented either through additional metadata elements or through a reference to an external metadata document.

The problem with such extensions is that it is not enough for application software to support the technical standard defined by ISO and OGC; the supplementary requirements must also be supported. This means that INSPIRE-specific adaptations are required, which are often not available in standard software. In the practical part of this tutorial, we will take a look at how standard software such as QGIS deal with these INSPIRE-specific requirements.

The version history of the INSPIRE Guidance document on view services begins in 2009, at a time when OGC WMS and WMTS were successful state-of-the-art standards for visualization services. Today, other mainstream standards such as RESTful interfaces, Open API and OGC API Maps are

[11] Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services. Online resource: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A32009R0976&from=EN (last access 2024-07-10)

[12] Online resource: https://github.com/INSPIRE-MIF/technical-guidelines/blob/main/services/view-wms/ViewServices.pdf (last access 2024-07-10)

gaining popularity, and it is anticipated that updated technical guidelines will reflect these developments in the future.

2.4 INSPIRE Download Services

The INSPIRE Directive also requires the provision of download services for the datasets that fall within the scope of INSPIRE. These download services can be implemented to provide access to a pre-configured copy of a dataset or to allow interactive selection and access to arbitrary subsets of the dataset. The more detailed requirements on the download services are defined in the implementing rules on network services[13]:

- Abstract definitions of service operations and their parameters
- Metadata to be provided for the service instance and the datasets offered for downloading
- Support for multiple languages
- Support for certain coordinate reference systems
- Quality criteria such as response times, capacity for handling simultaneous requests, service availability

The **technical guidance** for the implementation of INSPIRE Download Services[14] recommends implementing Download Services either as Atom Feeds or as OGC Web Feature Services (WFS). While Atom Feeds can only be used to provide metadata and download links for predefined datasets, the Web Feature Service supports both user-defined and predefined queries that result in any subset of the underlying spatial dataset.

As mentioned in section 1.2, binding requirements on the data that are offered by the download service are defined in the implementing rules on the interoperability of datasets and services[15]. The data specification documents recommend concrete application schemas (defined in UML) and XML encodings (GML).

Today there are also technical trends for download services that have not yet been taken into account in the technical guidance documents. For example, it is foreseeable that JSON-based encodings and RESTful interfaces such as the OGC API Features specifications will play a stronger role in the future.

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[13] Commission Regulation (EU) No 1088/2010 of 23 November 2010 amending Regulation (EC) No 976/2009 as regards download services and transformation services (europa.eu). Online resource: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A32010R1088&from=EN (last access 2024-07-10)d

[14] Technical guidance for the implementation of INSPIRE Download Services. Online resource: https://github.com/INSPIRE-MIF/technical-guidelines/blob/main/services/download-atom-wfs/DownloadServices.pdf (last access 2024-07-10)

[15] COMMISSION REGULATION (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services. Online resource: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:323:0011:0102:EN:PDF (last access 2024-07-09)

3. Practical example of using INSPIRE view and download services

In this practical example we want to see how we can use INSPIRE data using INSPIRE view and download services. We will pay attention to the special features of INSPIRE services with respect to the general standards of ISO and OGC.

Task 2-A

> **Please try to reproduce the use case and workflow described below step by step with your computer and software environment.**

Let's assume we are working on a European project to investigate the suitability of areas for the construction of new wind farms in the border region of Germany and the Netherlands. One piece of information we are interested in is the location and extent of protected areas - i.e. areas that are not suitable for the installation of wind turbines. In our exercise, we focus on

a) "FFH" protected areas, designated under the European Union's Flora, Fauna and Habitats Directive (92/43/EEC), which aims to conserve natural habitats and wild species across Europe, and

b) "BirdsDirective" protected areas, designated under the European Birds Directive (2009/147/EC).

Protected sites of these two categories together form the Natura 2000 network, which is a key element of the EU's biodiversity strategy. Wind turbines are not allowed in these areas**.**

We'll use QGIS for our practical exercise. If QGIS (version QGIS 3.34.9 'Prizren' or later) is not already installed on your computer please go to the official website (https://www.qgis.org/) and download the latest version.

As a first step, we define the area of interest of our project. We use the coordinate reference system ETRS89 UTM Zone 32 (EPSG:25832) for our exercise.

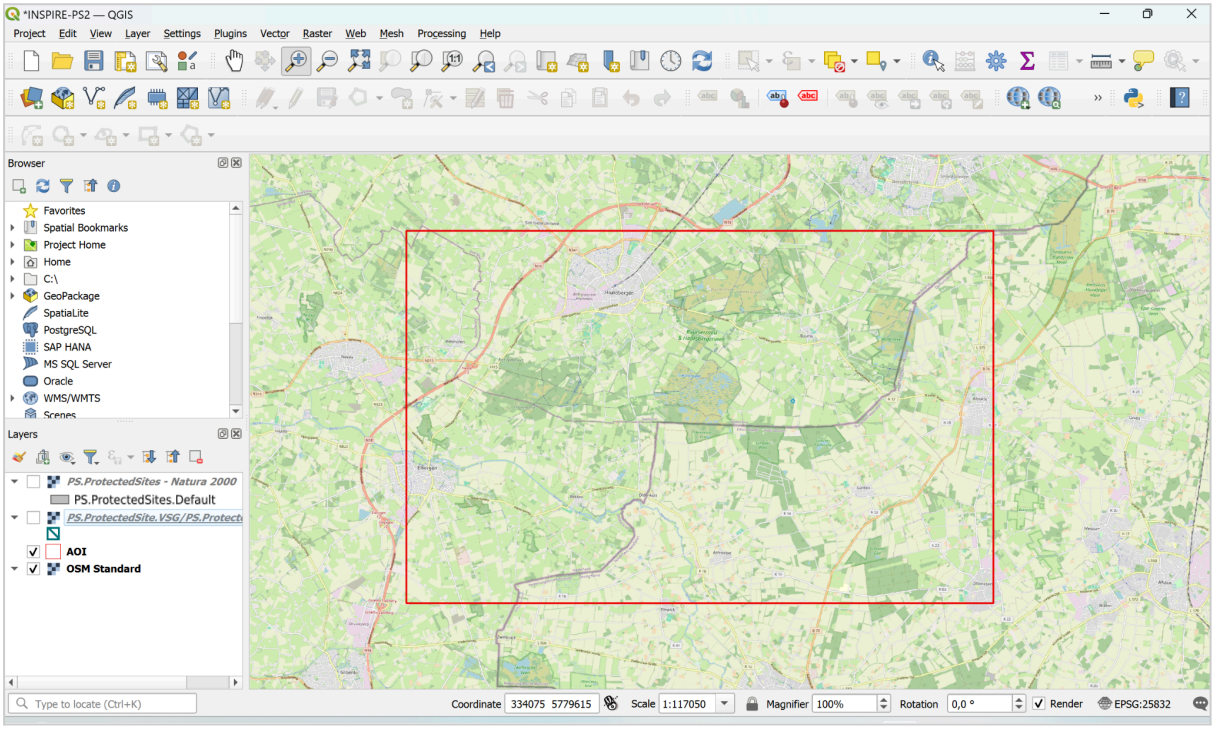

Fig. 6: Area of interest for investigating the suitability for wind farms

At this point, you are welcome to reuse the geometry of the area of interest that we have stored in the data directory of our GitHub repository: https://github.com/oer4sdi/OER-InspireViewAndDownloadServices.

3.1 Finding Data on Protected Sites

We use the INSPIRE Geoportal[16] to search for INSPIRE datasets on protected sites in The Netherlands and Germany. Look for INSPIRE **Thematic data**, **Data Themes** and select "**Protected Sites**" to get an overview of the member states data offerings for this topic. Select "National coverage" to filter datasets with a national coverage.

- For **The Netherlands** we find a number of datasets. We chose the dataset "Natura 2000 (INSPIRE geharmoniseered)" which should contain data on FFH and BirdsDirective protected sites. The sub-title "INSPIRE geharmoniseered" indicates that the dataset can be expected to conform to the implementing rules of INSPIRE.

[16] INSPIRE Geoportal, online resource: https://inspire-geoportal.ec.europa.eu/

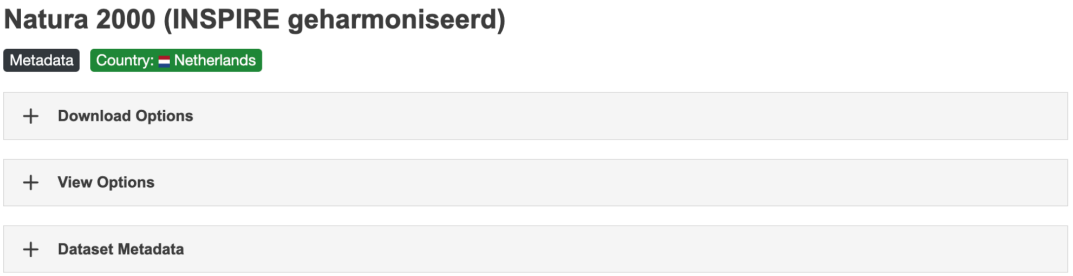

Fig. 7: INSPIRE geoportal: Natura 2000 dataset (INSPIRE harmonized)

The details page of this resource provides us with **dataset metadata** such as an abstract, a unique identifier (280ed37a-b8d2-4ac5-8567-04d84fad3a41), contact points, etc.

But the web page doesn't display all information that is available on this resource. Select the link “Download Metadata” to get access to the full metadata record with many more details. For example, you will find the information that the dataset is maintained in the coordinate reference system EPSG:28992 and that it is provided in a GML-based distribution format that complies with the INSPIRE technical guideline for protected areas, together with the path to the schema definition “../protectedSites.xsd” (see figure 8)..

```
<gmd:distributionFormat>
  <gmd:MD_Format>
    <gmd:name>
      <gmx:Anchor
      xlink:href="https://inspire.ec.europa.eu/schemas/ps/4.0/ProtectedSites.xsd">Protected
      Sites Simple GML Application Scheme</gmx:Anchor>
    </gmd:name>
    <gmd:version>
      <gco:CharacterString>GML, version 3.2.1</gco:CharacterString>
    </gmd:version>
    <gmd:specification>
      <gmx:Anchor xlink:href="https://inspire.ec.europa.eu/id/document/tg/ps">Data
      Specification on Protected Sites – Technical Guidelines</gmx:Anchor>
    </gmd:specification>
  </gmd:MD_Format>
</gmd:distributionFormat>
```

Fig. 8: Dataset Metadata - information on a distribution format

The “**View Options**” section of the website provides information about view services associated with the dataset. The website uses the view service itself to show us a map preview of the dataset.

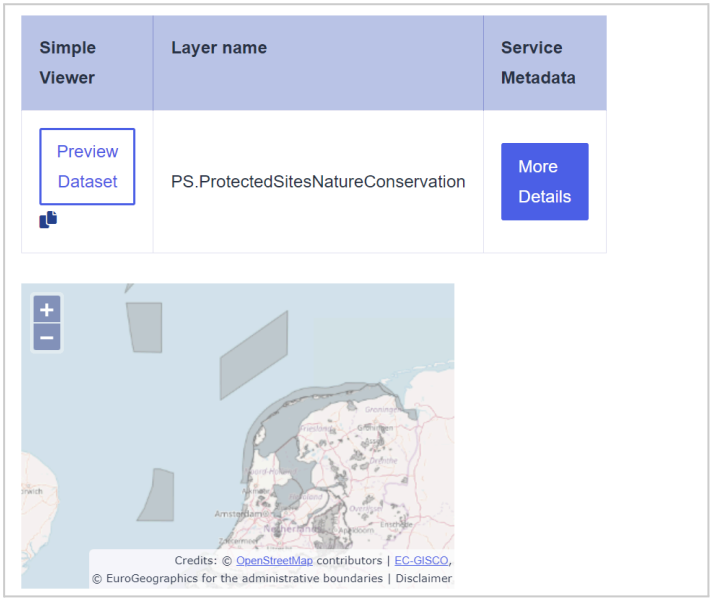

Fig. 9: Map preview of the dataset “Natura 2000”

Select “More Details” and “Download Metadata” to obtain the full set of metadata for the view service. The service metadata record indicates that the view service is implemented as an OGC Web Map Service that conforms to the Technical Guidelines for INSPIRE View Services v3.1. It also contains a link to the endpoint of the WMS service that we will use later to work with the view service.

```
<gmd:transferOptions>
  <gmd:MD_DigitalTransferOptions>
    <gmd:onLine>
      <gmd:CI_OnlineResource>
        <gmd:linkage>
          <gmd:URL>https://service.pdok.nl/rvo/beschermdegebieden/natura2000/wms/v1_
          0?request=getcapabilities&service=wms</gmd:URL>
        </gmd:linkage>
        <gmd:protocol>
          <gmx:Anchor
          xlink:href="http://www.opengis.net/def/serviceType/ogc/wms">OGC:WMS</gmx:Anc
          hor>
        </gmd:protocol>
        <gmd:description>
          <gmx:Anchor
          xlink:href="http://inspire.ec.europa.eu/metadata-codelist/OnLineDescriptionCode/acc
          essPoint">accessPoint</gmx:Anchor>
        </gmd:description>
      </gmd:CI_OnlineResource>
    </gmd:onLine>
  </gmd:MD_DigitalTransferOptions>
</gmd:transferOptions>
```

Fig. 10: View Service Metadata with a link to the WMS service endpoint

The metadata of the view service also contains a link to the data set that it visualizes. Here it refers to our data set with the unique ID “280ed37a-b8d2...”. The attribute xlink:href contains a link to the original metadata set of this dataset registered in the metadata catalog “Nationaalgeoregister” in the Netherlands.

```
<srv:operatesOn uuidref="280ed37a-b8d2-4ac5-8567-04d84fad3a41"
xlink:href="https://www.nationaalgeoregister.nl/geonetwork/srv/dut/csw?service=CSW&reques
t=GetRecordById&version=2.0.2&outputSchema=http://www.isotc211.org/2005/gmd&element
SetName=full&id=280ed37a-b8d2-4ac5-8567-04d84fad3a41#MD_DataIdentification"/>
```

Fig. 11: View Service Metadata with a link to the dataset that it operates on

Now let us look at the **download options**. The Link “Get Dataset” invokes the download of the predefined GML formatted Natura 2000 dataset. Please select “More Details” followed by “Download Metadata” to look up the download service metadata. The download service claims to be conformant to the “Technical Guidance for the implementation of INSPIRE download Services”. It implements the download services as an **ATOM** feed with links to web accessible predefined datasets.

```
<gmd:transferOptions>
  <gmd:MD_DigitalTransferOptions>
    <gmd:onLine xmlns:xs="http://www.w3.org/2001/XMLSchema">
      <gmd:CI_OnlineResource>
        <gmd:linkage>
          <gmd:URL>https://service.pdok.nl/rvo/beschermdegebieden/natura2000/atom/ind
          ex.xml</gmd:URL>
        </gmd:linkage>
        <gmd:protocol>
          <gmx:Anchor xlink:href="https://tools.ietf.org/html/rfc4287">INSPIRE
          Atom</gmx:Anchor>
        </gmd:protocol>
        <gmd:description>
          <gmx:Anchor
          xlink:href="http://inspire.ec.europa.eu/metadata-codelist/OnLineDescriptionCode/acc
          essPoint">accessPoint</gmx:Anchor>
        </gmd:description>
      </gmd:CI_OnlineResource>
    </gmd:onLine>
  </gmd:MD_DigitalTransferOptions>
```

Fig. 12: INSPIRE Atom Feed as access point to the download service

Now either use the “Get Dataset” option offered in the INSPIRE geoportal or follow the link to the Atom Feed offered in the metadata of the service to download the GML dataset on

Natura 2000 protected areas from the Netherlands. We will use this data later on in our exercise.

- For **Germany** only two datasets on protected sites with national coverage are offered

  We select "INSPIRE Schutzgebiete in Deutschland" since the other dataset with ATKIS DLM250 data is optimized for a small target scale of 1/1.250.000 which does not fit our needs.

  We select "Download Metadata" and learn from the metadata record that the data conforms to the INSPIRE implementing rules, that it is based on the coordinate reference system EPSG:4258 (ETRS89), and that it is available in a GML based distribution format.

  As part of the dataset metadata we find as well the information that two transferOptions exist, a WebMap Service endpoint (WMS URL) which is apparently a view service implementation and a Web Feature Service endpoint (WFS), which seems to be the download service. The INSPIRE Geoportal doesn't present these two data services as View and Download options which might be due to the fact that no detailed metadata on these services are available. However, we can use both services as view and download services for our purpose.

```
<gmd:transferOptions>
  <gmd:MD_DigitalTransferOptions>
    <gmd:onLine>
      <gmd:CI_OnlineResource>
        <gmd:linkage>
          <gmd:URL>https://geodienste.bfn.de/ogc/wms/INSPIRE_PS_DE?REQUEST=GetCapabilities&SERVICE=WMS&VERSION=1.3.0</gmd:URL>
        </gmd:linkage>
        <gmd:function>
          <CI_OnLineFunctionCode xmlns="http://www.isotc211.org/2005/gmd"
          codeList="http://standards.iso.org/iso/19139/resources/gmxCodelists.xml#CI_OnLineFunctionCode" codeListValue="information"/>
        </gmd:function>
      </gmd:CI_OnlineResource>
    </gmd:onLine>
  </gmd:MD_DigitalTransferOptions>
</gmd:transferOptions>

<gmd:transferOptions>
  <gmd:MD_DigitalTransferOptions>
    <gmd:onLine>
      <gmd:CI_OnlineResource>
        <gmd:linkage>
          <gmd:URL>https://geodienste.bfn.de/ogc/wfs/INSPIRE_PS_DE?REQUEST=GetCapabilities&SERVICE=WFS&VERSION=2.0.0</gmd:URL>
        </gmd:linkage>
        <gmd:function>
          <CI_OnLineFunctionCode xmlns="http://www.isotc211.org/2005/gmd"
```

```
            codeList="http://standards.iso.org/iso/19139/resources/gmxCodelists.xml#CI_OnLineF
            unctionCode" codeListValue="download"/>
          </gmd:function>
        </gmd:CI_OnlineResource>
      </gmd:onLine>
    </gmd:MD_DigitalTransferOptions>
</gmd:transferOptions>
```

Fig. 13: Dataset metadata on Protected Sites in Germany, Service endpoints for view and download services

3.2 Creating a map of Protected Sites using INSPIRE View Services

Now that we've identified datasets that serve our needs, let's check if it is possible to create a seamless map on protected sites that covers the cross border region of our area of interest.

We start with the view service for protected sites from The Netherlands. In QGIS we edit a new WMS server connection, name it "NL Natura 2000", copy-paste the URL of the WMS (see figure 10) and connect to the map service.

QGIS requests the capabilities of the WMS and displays the available WMS laýers. We select the layer that is rendered in the default style, set the requested CRS to EPSG:25832 and add it to our project.

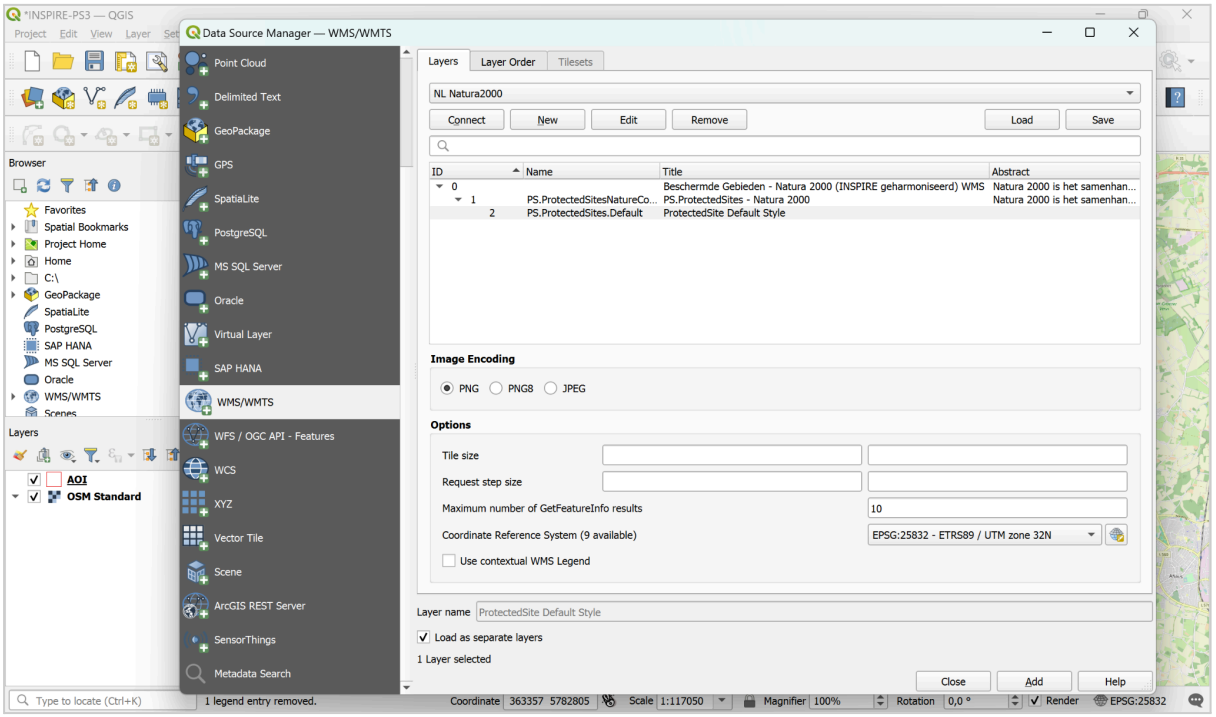

Fig. 14: Adding the view service on protected sites (Natura 2000) from The Netherlands

The protected sites are nicely displayed in our map and we can use the GetFeatureInfo function to get further information about the individual sites (see figure 15).

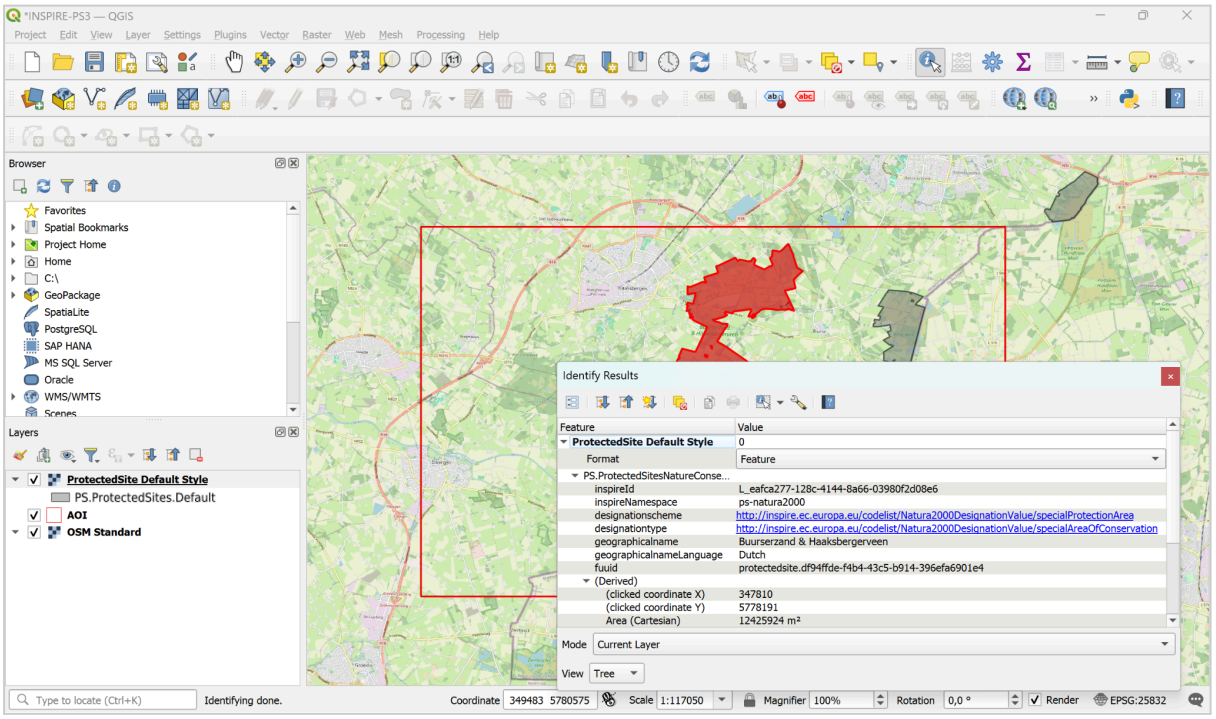

Fig. 15: Inspecting the view service and feature information from selected protected areas

In the same way, we can add the visualization of the German data set on protected areas. We use the URL of the MapService to connect to the MapServer. From the list of layers we select the layers PS.ProtectedSite.FFH and PS.ProtectedSite.VSG (birds protection area), which are the NATURA 2000 protected areas in Germany.

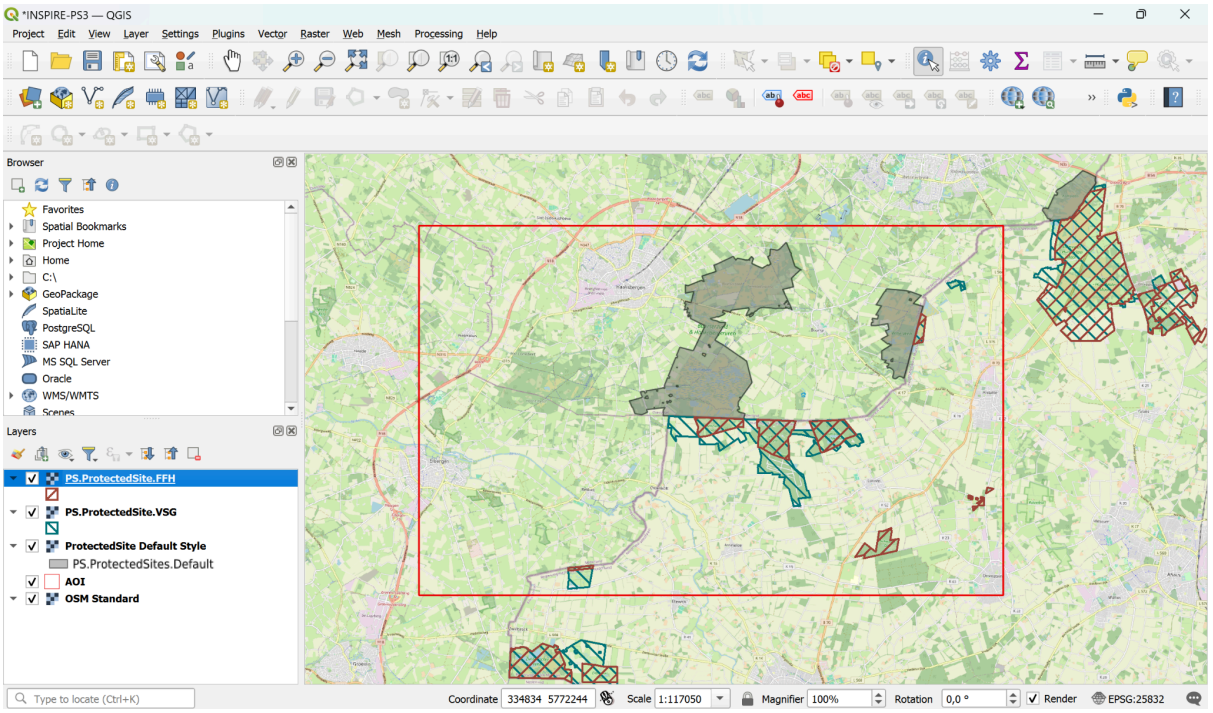

Fig. 16: NL-DE Cross border map of Protected sites (FFH, BirdsDirective)

The resulting interactive map displays seamlessly all protected sites with a Natura2000 designation. The protected sites are rendered in different styles which reflect their origin. Unfortunately it is not possible to adjust the predefined rendering of the map services.

3.3 Accessing Data on Protected Sites using INSPIRE Download Services

The next trial is about merging data from both sources to create a seamless homogeneous dataset that can be used for data analysis and visualization.

For this purpose we start again with the dataset from The Netherlands. Use the GML file that you already downloaded via the INSPIRE Geoportal (see section 2.1).

In QGIS use the data source manager to add the GML file as a vector layer to your project.

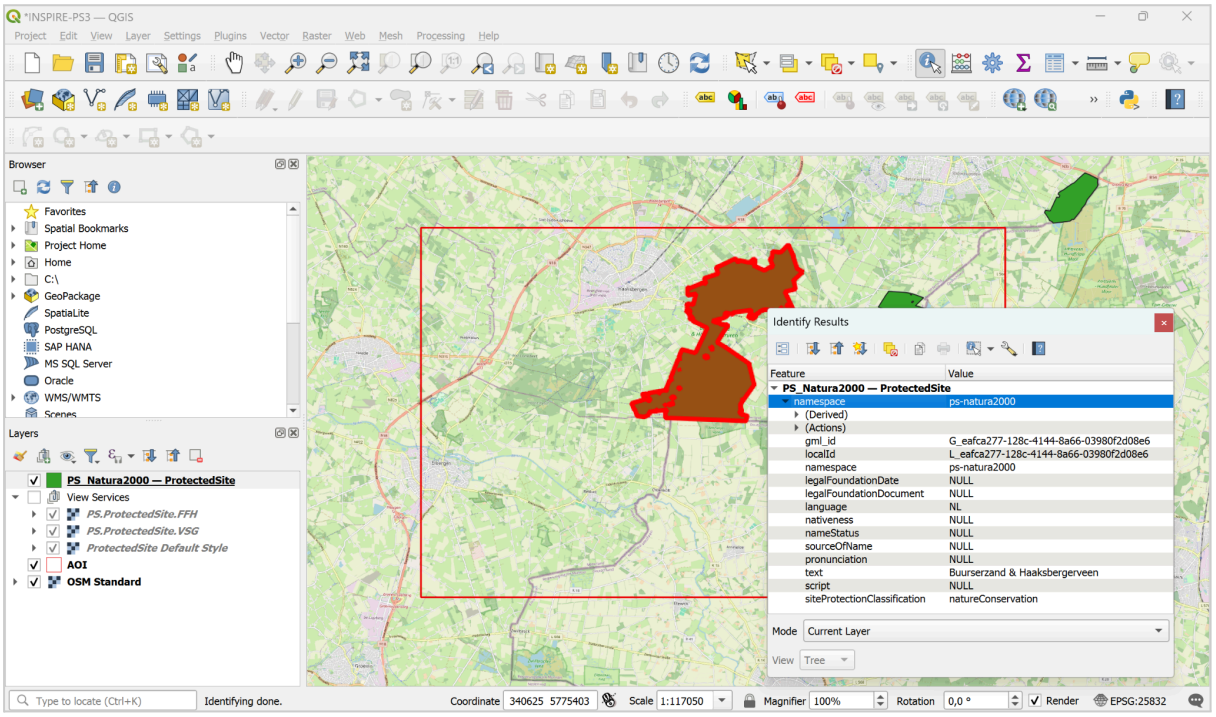

Fig. 17: Integration of data on Natura 2000 sites in the Netherlands from the downloaded GML file

As for the attribute data, we need to be aware that QGIS has some problems importing complex structured GML data. It tries to map the nested structure of GML attribute data to a linear table where each row of attribute values is in a 1:1 relation to the feature it describes. Furthermore most of the data types are mapped to strings and not all attribute values of the GML data source are mapped at all. I.e., we have to consider a significant loss of information. Figure 18 shows the GML data of the feature G_eafca277-128c-4144-8a66-03980f2d08e6. The elements that are highlighted in green can be found in the QGIS dataset (compare attribute data in Figure 17 and Figure 18).

```
<ps:ProtectedSite gml:id="G_eafca277-128c-4144-8a66-03980f2d08e6">
        <ps:geometry> … </ps:geometry>
        <ps:inspireID>
                <base:Identifier>
                        <base:localId>L_eafca277-128c-4144-8a66-03980f2d08e6</base:localId>
                        <base:namespace>ps-natura2000</base:namespace>
                </base:Identifier>
        </ps:inspireID>
        <ps:legalFoundationDate xsi:nil="true"/>
        <ps:legalFoundationDocument xsi:nil="true"/>
        <ps:siteDesignation>
                <ps:DesignationType>
                        <ps:designationScheme xlink:href=
"http://inspire.ec.europa.eu/codelist/Natura2000DesignationValue/specialProtectionArea"/>
                        <ps:designation xlink:href=
"http://inspire.ec.europa.eu/codelist/Natura2000DesignationValue/specialAreaOfConservation"/>
```

```
            </ps:DesignationType>
        </ps:siteDesignation>
        <ps:siteName>
            <gn:GeographicalName>
                <gn:language>NL</gn:language>
                <gn:nativeness nilReason="unknown" xsi:nil="true"/>
                <gn:nameStatus nilReason="unknown" xsi:nil="true"/>
                <gn:sourceOfName xsi:nil="true"/>
                <gn:pronunciation xsi:nil="true"/>
                <gn:spelling>
                    <gn:SpellingOfName>
                        <gn:text>Buurserzand &amp;amp; Haaksbergerveen</gn:text>
                        <gn:script xsi:nil="true"/>
                    </gn:SpellingOfName>
                </gn:spelling>
            </gn:GeographicalName>
        </ps:siteName>
        <ps:siteProtectionClassification>natureConservation</ps:siteProtectionClassification>
</ps:ProtectedSite>
```

Fig. 18: NL-Natura200 GML dataset, green: data elements that have been mapped to QGIS

As you can see, the attribute names in QGIS have lost their context, which was well defined in the original dataset (e.g. “inspireID/identifier/localID” was mapped to “localId”). The designation information got lost completely. However, in our case the attribute data is not that important, since we are mainly interested in the geometry of the Natura 2000 protected sites.

Use the processing tool “Vector selection” / “Extract by location” to extract and store all features that intersect with our area of interest as a layer “NL-ProtectedSites-Natura2000” to a Geopackage with the name “ProtectedSites.GPKG”. Remove the original layer from the list of layers and group all view services as “Protected Sites - View Services”.

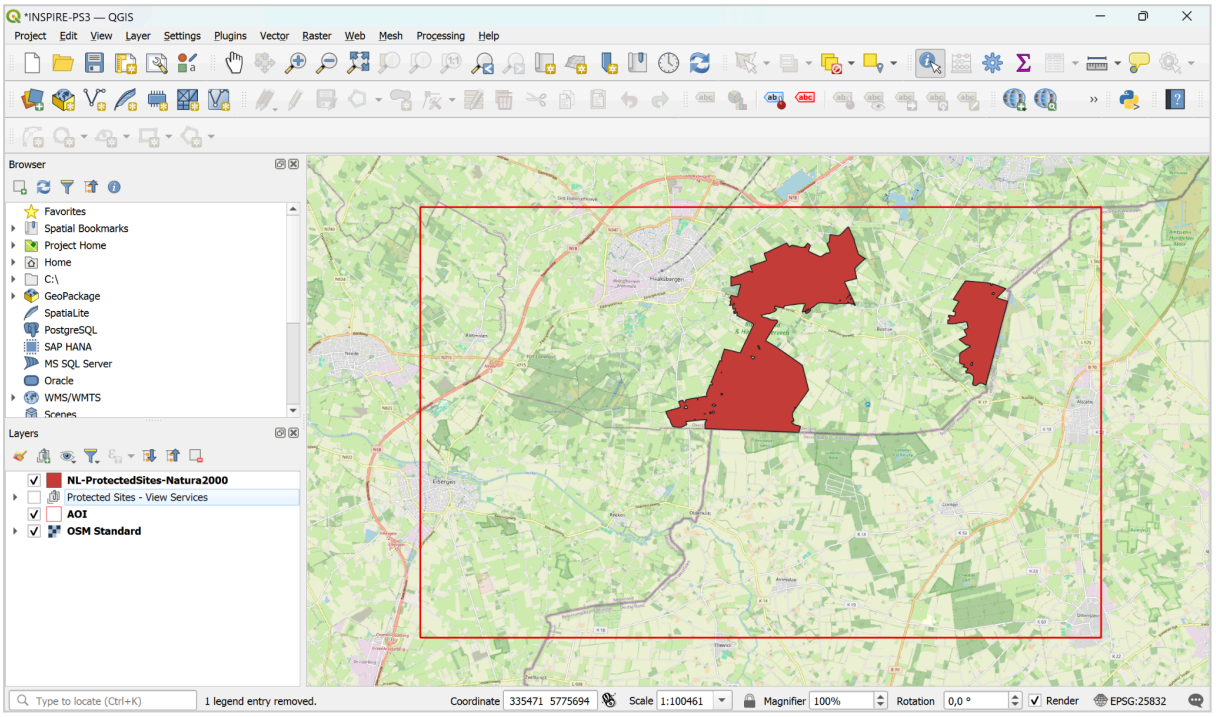

Fig. 19: Protected Sites from the NL Natura 2000 dataset stored in a GeoPackage

Now we want to download and extract Protected Sites from the German data source. Use the data manager to open new WFS server connection “DE-ProtectedSites”, copy-paste the URL of the download service that we found in the metadata record of the German protected sites dataset (see section 2.1), select “Invert axis orientation”[17] and connect to the WFS server.

[17] This is due to the fact that QGIS expects a different order of coordinate values for longitude and latitude than the WFS provides.

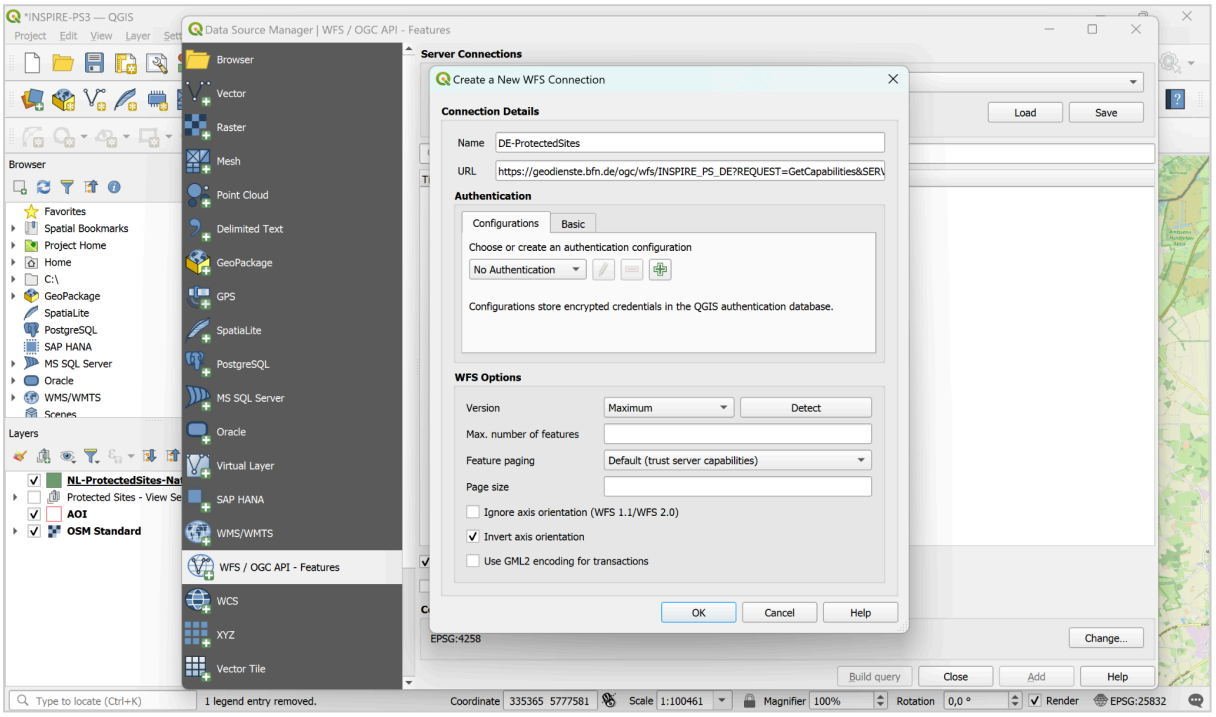

Fig. 20: Connecting to the German protected sites WFS

Select the feature types “PS.ProtectedSites.FFH” and “PS.ProtectedSites.VSG” and make sure that the option “Only request features overlapping the view extent” is NOT activated[18]. Now add the layers to the project.

[18] We have changed the order of the lat-lon coordinate values, but the bounding box coordinates are also interpreted incorrectly in the communication with the WFS. This means that no data is returned by the WFS if the intersection with the bounding box is used as a filter.

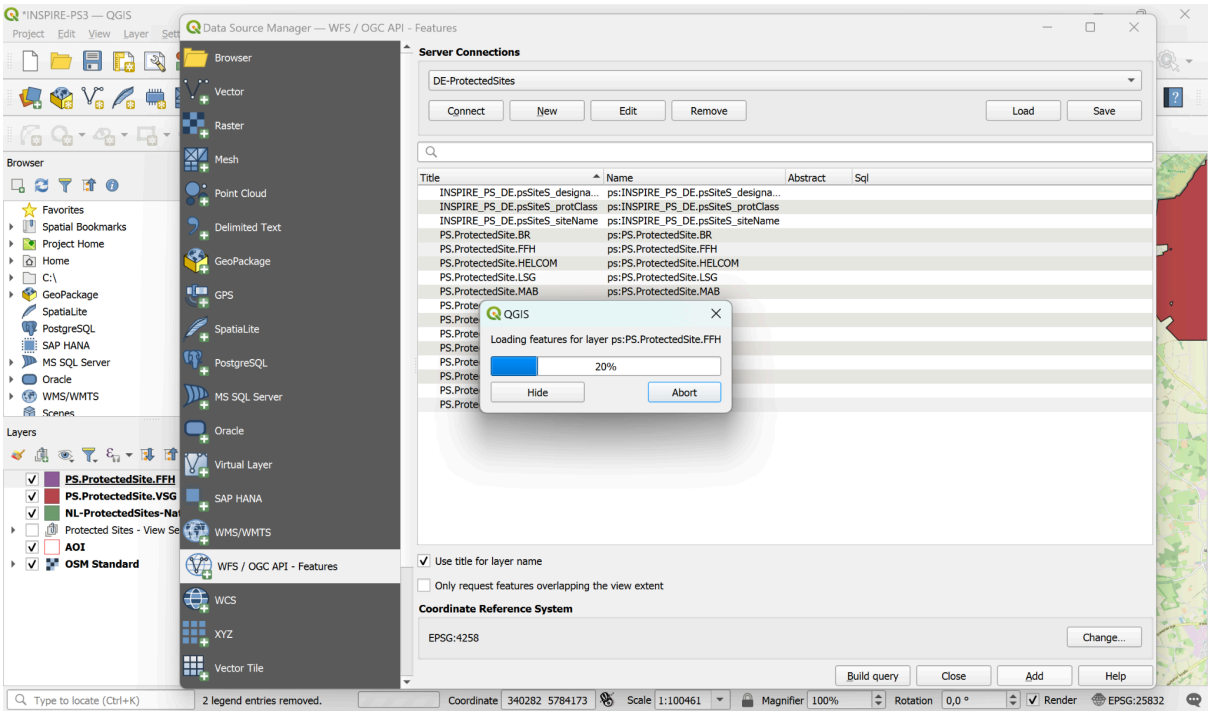

Fig. 21: Adding features from the German Protected Sites WFS

Now use the processing tool “Vector selection” / “Extract by location” to extract and store all features from “PS.ProtectedSites.FFH” that intersect with our area of interest as a layer “DE-ProtectedSites-FFH” to our “ProtectedSites.GPKG”. Extract in the same way the features from “PS.ProtectedSites.VSG” and store it as a layer “DE-ProtectedSites-FFH” to our “ProtectedSites.GPKG”. Remove the original WFS layers from the list of layers.

As a final step, use the processing tool “Merge vector layers” to combine all three data sources to one dataset “AOI-ProtectedSites-N2000”, which now contains all exclusion areas due to either the European Habitats Directive or the European Birds Directive.

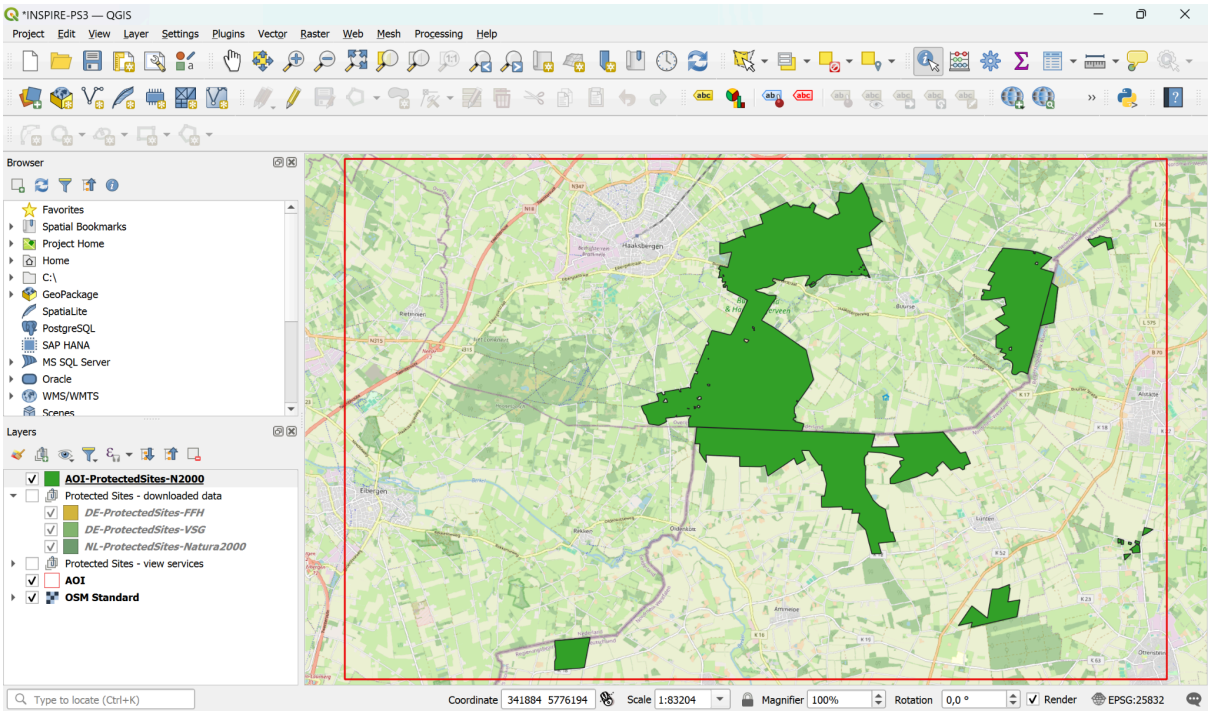

Fig. 22: Merged dataset, integrating Protected Sites data from The Netherlands and Germany

Congratulations!

Now you know how to identify INSPIRE data sets and how to visualize and access the data using INSPIRE view and download services. You have also seen how INSPIRE uses international standards to implement view and download services.

4. Discussion

As we have learned in the beginning, INSPIRE's main mission is to improve the availability and usability of spatial information in Europe. So, what is your opinion? Does INSPIRE a good job or where do you see room for improvements?

Let's reflect the experience from our small exercise:

- Discoverability of data

  Even the most valuable data is useless to you if you don't know that it exists, under what conditions you are allowed to use it and how you can access it. We saw that we can use the metadata to find and get direct access to the data we were interested in.

  However, don't expect to get all your questions on the data answered just by reading the metadata. You have to understand the data to be able to use it in a meaningful way! This also means that you should have in-depth knowledge of the subject area, especially for critical applications.

- Usability of the data

  Usability refers (among other things) to a) whether I am technically able to access and process the data and b) whether I am allowed to do so.

  INSPIRE urges the member states to make the data freely available wherever possible. This has significantly reduced previously existing restrictions. Thank you INSPIRE!

  As far as technical accessibility and processability are concerned, INSPIRE has stipulated that standardized view and download services must be provided.
  We were able to use a simple standard software like QGIS without customization to connect to the view services and create a cross-border interactive map of the protected areas with just a few clicks.
  We were able to download the data, which was available in a standardized data model and format, and thus seamlessly merge two data sets on protected sites from different countries. Thank you INSPIRE!

  However, we also found that the data on protected sites varied considerably despite the standardization efforts of INSPIRE. The data set from the Netherlands did not distinguish between bird protection areas and areas protected under the Habitats Directive. Furthermore, no common vocabulary was used for the data. The question is whether the elaborate implementing rules serve their purpose here.

  INSPIRE recommends GML encodings as the standard for exchanging feature data. This makes sense because GML can be used for feature data of almost any complexity. Most INSPIRE data models actually use complex structures that are served well by the expressiveness of GML. However, this complexity goes beyond the capabilities of simple GIS applications and makes use extremely difficult. Please note: the problem is not the expressiveness of GML, but the way it is used. Of course, there are attractive alternatives for many applications, such as GeoJSON, which has the advantage of being easier to use in a web context with programming languages like JavaScript.

5. Check your knowledge

Task 4-A

Where do we find the specification of the abstract data model (feature types, attributes) of protected sites? a) In the INSPIRE Directive b) in the INSPIRE Implementing Rules on the interoperability of datasets and services c) in the Protected Sites Data Specification?

Task 4-B

Where do we find the implementation specification of the Protected Sites data model (UML model, XSD files) of protected sites? a) In the INSPIRE Directive b) in the implementing rules on the interoperability of datasets and services c) in the Protected Sites data specification?

Task 4-C

Can you think of an example, where the INSPIRE requirements on view services go beyond those of a standard OGC WMS?