European Environment Agency

INSPIRE compliance process for datasets in alternative encodings

Version: 1.0

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Date
10.12.2025

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Contents

List of figures

List of tables

Terms and acronyms

Terms

Conceptual data model	High-level representation of the entities that a system stores and processes, with a focus on the semantics of the entities and the relationships of these entities (e.g. is-a, has-a relationship). The conceptual model also defines key properties of the entities.
Logical data model	Detailed representation of data structures and their relationships. It specifies the details of the conceptual data model entities e.g., the data type of a property.
Physical schema	Computer-readable data description that defines the data structure and the data types. Examples of physical schemas are an XML application schema (xsd), a JSON schema or a GeoPackage template.
GeoPackage[1]	GeoPackage is an open standard file format for storing geospatial data, widely used in Geographic Information Systems (GIS). It is based on SQLite database technology. GeoPackage tables allow the storage of various types of geographic data, including vector data, raster data, and attribute data.
GeoJSON[2]	GeoJSON is an open standard format designed for representing simple geographical features, along with their non-spatial attributes, based on the JSON format.

[1] https://www.geopackage.org/
[2] https://geojson.org/

Acronyms

END	Environmental Noise Directive (2002/49/EC)
GML	Geography Markup Language
INSPIRE	Infrastructure for spatial information in Europe
INSPIRE IR	INSPIRE Implementing Rules
INSPIRE TG	INSPIRE Technical Guidelines
INSPIRE MIG	INSPIRE Maintenance and Implementation Group
UML	Unified Modelling Language
XML	Extensible Markup Language
GIS	Geographic Information Systems

1 Introduction

This document provides practical guidance on how to prove the compliance of datasets in alternative encodings (i.e., encodings other than GML) with the requirements laid out in the INSPIRE Directive and how to document this compliance in the INSPIRE metadata.

The document begins with a brief overview of INSPIRE, distinguishing between legal obligations and technical implementation recommendations.

The relevance of INSPIRE for environmental reporting is outlined, along with the opportunity to streamline alignment and facilitate compliance by taking advantage of the latest developments in the technological evolution process of the Directive. These developments aim to facilitate INSPIRE implementation, better align it with specific use cases, and ensure full compatibility with mainstream technologies.

As part of the modernization and simplification process, the INSPIRE alternative encodings are introduced as an effective way to enhance the usability of INSPIRE data e.g., ensuring that the data can be efficiently utilized in GIS environments or through web-based applications. It is highlighted that datasets in alternative encodings shall comply with all the requirements set out in the INSPIRE Implementing Rules.

The approach to demonstrating INSPIRE compliance is then detailed, with a focus on the evidence required to prove the compliance of datasets in alternative encodings.

A methodology for generating the required evidence is presented in the form of a structured to-do list and step-by-step instructions. A non-exhaustive list of tools that can be used to implement the compliance assessment process is provided.

Finally, the document outlines a proposal for documenting the compliance of datasets in alternative encodings in the associated INSPIRE metadata and concludes with an example of the application of the overall methodology in the case of the Environmental Noise Directive (END) reporting datasets, with lessons learnt.

2 About INSPIRE

The INSPIRE Directive[3] lays down general rules for the establishment of a European Spatial Data Infrastructure (SDI) to support Community environmental policies and policies or activities that may have an impact on the environment. The overall objective is to facilitate the exchange of and access to interoperable spatial data across Europe in order to support better informed decision-making at all levels of government.

In its role as an SDI for European environmental policy, INSPIRE is composed of the following components: "*metadata, spatial data sets and spatial data services, network services and technologies, agreements on sharing, access and use, and coordination and monitoring mechanisms, processes and procedures, established, operated or made available in accordance with the Directive*"[4].

INSPIRE is based on the spatial data infrastructures established and operated by the Member States of the European Union and other European countries.

Specifically, the Directive imposes obligations on EU Member States to establish spatial data infrastructures following legally binding Implementing Rules[5] and non-legally binding Technical Guidelines[6] which specify the essential requirements for the interoperability and the harmonisation of spatial data sets and spatial data services, as well as for the associated documentation (metadata).

Datasets in the scope of INSPIRE are those:

- owned by public sector organizations, government bodies and third parties that manage the data on behalf of governmental entities
- that come under one or more of the 34 INSPIRE data themes[7].

For some environmental reporting datasets (e.g. Noise, Protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (Sewage sludge)) the compliance with INSPIRE is mandated by the Regulation on the alignment of reporting obligations in the field of legislation related to the environment[8] [Regulation EU 2019/1010]. However, given that the reported geospatial information overlaps with the INSPIRE scope, the INSPIRE compliance of environmental reporting datasets is desirable to reduce the administrative burden on Member States, streamline provisions and enhance data consistency by providing datasets that fulfil both requirements, i.e. reporting and INSPIRE.

[3] https://eur-lex.europa.eu/eli/dir/2007/2/oj
[4] https://interoperable-europe.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/glossary/term/spatial-data-infrastructure
[5] https://knowledge-base.inspire.ec.europa.eu/legislation/implementing-rules_en
[6] https://knowledge-base.inspire.ec.europa.eu/legislation/technical-guidelines_en
[7] https://knowledge-base.inspire.ec.europa.eu/tools/inspire-themes_en
[8] http://data.europa.eu/eli/reg/2019/1010/oj

2.1 Relationships between the INSPIRE Implementing Rules and the INSPIRE Technical Guidelines.

The INSPIRE Implementing Rules (IR) contain legally binding requirements that describe, usually on an abstract level, what Member States must implement. The Implementing Rules also specify what feature concepts the data sets must contain.

In contrast, the Technical Guidelines (TG) define how Member States can implement the requirements contained in the INSPIRE IR and contain non-binding technical requirements.

The Technical Guidelines are the reference implementation of the INSPIRE Implementing Rules, even though technical implementations other than those described in the TG may meet the requirements of the IR.

The TG are aimed to maximize the interoperability and to enable the 'reference' validation of INSPIRE data sets, network services and metadata. They include the logical and physical models of data sets.

The INSPIRE Reference Validator[9] is the reference INSPIRE validation tool which is used to assesses the technical compliance against the Technical Guidelines of metadata, datasets and network services.

The Figure 1 below illustrates the relationship between INSPIRE Implementing Rules and Technical Guidelines.

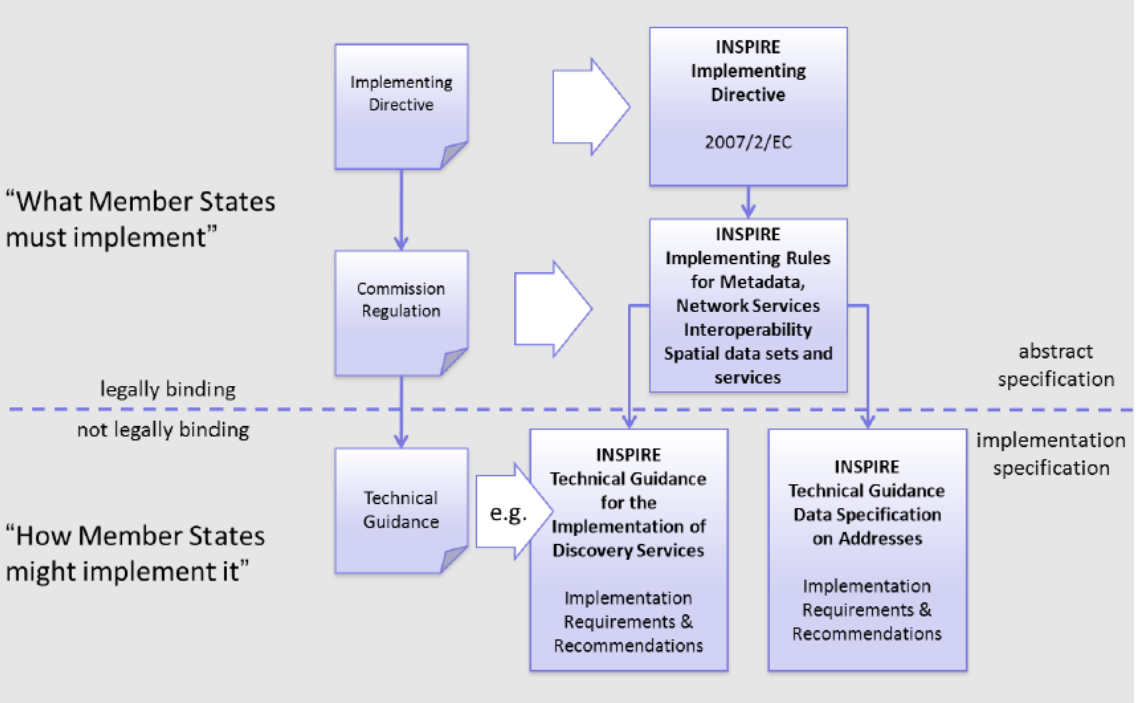

Figure 1 Relationship between INSPIRE Implementing Rules and Technical Guidelines

[9] https://inspire.ec.europa.eu/validator/home/index.html

2.2 Simplification of INSPIRE implementation

In the wider context of the European Strategy for data[10] and the establishment of the Green Deal Data Space[11], a process of modernisation and simplification of INSPIRE and its technical requirements is being carried out (see INSPIRE work programme 2021-2024[12]). As a result of this process, the INSPIRE Good Practice documents[13] complement the initial set of Technical Guidelines to, inter alia, simplify implementation, support the needs of specific communities and take advantage of opportunities offered by emerging technologies and standards. Examples of endorsed Good Practices include:

- Good practices where implementers extend/simplify INSPIRE models to support the needs of their communities
- Good practices related to tools and technologies which may help to link INSPIRE with other initiatives, including the use of encodings alternative to the default GML to share INSPIRE data (e.g. Good Practice on GeoPackage encoding of INSPIRE datasets)
- Good practices related to emerging technologies to improve the usability/usefulness of the infrastructure (e.g. OGC API Features download services).

A light-weight procedure is in place to propose, document, review and publish the Good Practices. The process is community driven, starting with a group of implementers submitting a 'good practice fiche', followed by the organization of a public outreach webinar by the proposer, and culminating in the approval by the INSPIRE Maintenance and Implementation Group (MIG). Details of the process (which involves several steps) can be found on the 'Good Practice Library' page[14] in the INSPIRE Knowledge Base[15].

2.2.1 INSPIRE Alternative Encodings

The default encoding for the INSPIRE datasets is the GML (Geography Markup Language) described in the Guidelines for the encoding of spatial data[16]. This is the GML version 3.3, which supports a wide range of geographic features and complex data structures with arbitrary nesting of features and feature properties.

While it provides a standardized way to encode geographic information, it has proven to be complex and difficult to use, especially for large datasets, with mainstream applications and software tools often inadequate for the needs of implementers and users.

To address the difficulties in consuming and fully exploiting the GML data, a mechanism for using alternative encodings has been established.

For an encoding to be recognized as an alternative encoding for INSPIRE data, it must not cause any loss of information compared to the default encoding (if it does, the encoding is considered as additional to, rather than a replacement for, the default encoding).

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[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0066
[11] https://green-deal-dataspace.eu/
[12] https://wikis.ec.europa.eu/display/InspireMIG/INSPIRE+work+programme+2021-24
[13] https://knowledge-base.inspire.ec.europa.eu/evolution/good-practice-library_en
[14] https://knowledge-base.inspire.ec.europa.eu/evolution/good-practice-library_en
[15] https://knowledge-base.inspire.ec.europa.eu/index_en
[16] https://knowledge-base.inspire.ec.europa.eu/publications/guidelines-encoding-spatial-data_en

INSPIRE Good Practice specifications exist for GeoPackage[17] and GeoJSON[18] alternative encodings. These describe how data falling under any INSPIRE theme can be encoded in these alternative formats in such a way that the requirements of the related INSPIRE Technical Guidelines are met.

The Good Practice specifications describe a model transformation framework, with which specific alternative encoding logical models for INSPIRE data sets can be created.

A set of common processes and model transformation rules[19] to be followed by implementers ensures data interoperability and INSPIRE compliance.

These model transformation rules are intended to reduce the complexity of INSPIRE data, for example by simplifying complex data structures or reducing multiplicity. The rules apply to different encodings, including the default GML encoding where applicable. In the latter case, this is referred to as "simplified GML encoding".

By applying common model transformation and encoding rules, the complex GML data structures are simplified, resulting in more usable INSPIRE data.

The theme-specific or use-case specific encoding rules are available in the INSPIRE-MIF[20] GitHub repository dedicated to the specific encoding e.g., the repository for the GeoPackage encoding[21].

The creation of an Alternative Encoding for a specific INSPIRE Theme is a two-step approach:

- streamline the conceptual model, expressed using the Unified Modelling Language (UML)
- apply the UML-to-Alternative Encoding rules.

First, the common model transformation rules are applied to create the modified UML model more suitable for a specific use case, then the encoding-specific rules (e.g., UML-to-GeoPackage) are applied to encode INSPIRE datasets.

Encoding rules for INSPIRE alternative encodings are defined in dedicated Good Practices, like the Good Practice on the “GeoPackage encoding of INSPIRE datasets”[22].

The process illustrated in Figure 2 for the creation of a simplified GML encoding and the related GML application schema can be applied to a generic (alternative) encoding format to derive, for example, a GeoPackage template or a JSON schema.

[17] https://www.geopackage.org/
[18] https://geojson.org/
[19] https://github.com/INSPIRE-MIF/model-transformation-rules/tree/main/rules
[20] https://github.com/INSPIRE-MIF
[21] https://github.com/INSPIRE-MIF/gp-geopackage-encodings
[22] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/blob/main/spec/GeoPackage_Good_Practice_initiation_fiche.md

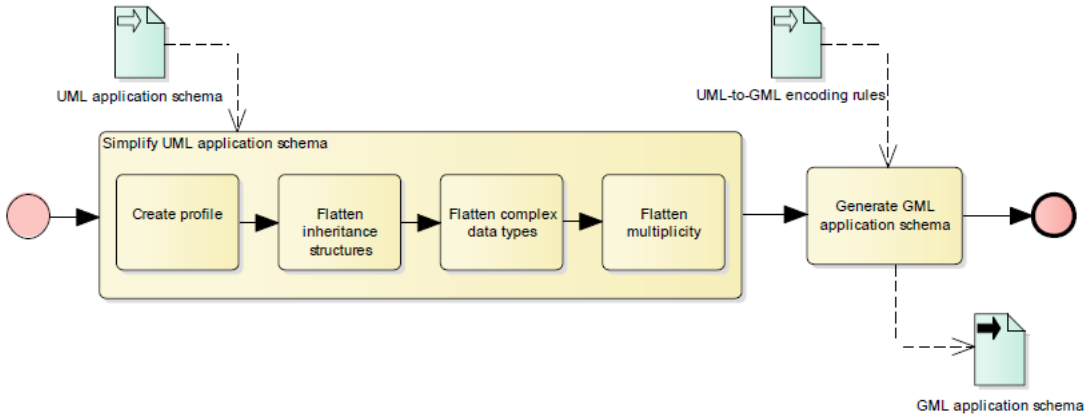

Figure 2 Overview of the process to create a simplified GML encoding

2.3 INSPIRE compliance of datasets

INSPIRE datasets need to be harmonised, documented with metadata and shared across network services in accordance with relevant INSPIRE Implementing Rules.
As already explained in Section 2.1, the Implementing Rules define requirements at an abstract level for which the Technical Guidelines provide a possible technical implementation.

The TGs contain additional requirements to the IR, which must be met when using the specific technical implementation proposed therein.

The Technical Guidelines are the reference technical implementation of the INSPIRE Implementing Rules, and following the Technical Guidelines is a means of ensuring compliance with the Implementing Rules.

The INSPIRE Reference Validator, the reference tool for INSPIRE conformity assessment, verifies compliance with the Technical Guidelines.

In summary,

- datasets are 'INSPIRE-compliant' (i.e., in conformity with INSPIRE) if they meet the requirements contained in the INSPIRE Implementing Rules as regards interoperability of spatial datasets and services[23]
- to pass the conformity assessment of the INSPIRE Validator, they shall comply with requirements contained in the Data Specifications – Technical Guidelines of the relevant INSPIRE data theme.

2.3.1 Compliance assessment for datasets in the default GML encoding

Technical compliance with the INSPIRE Implementing Rules shall be demonstrated by successfully validating the datasets in GML encoding through the INSPIRE Reference Validator.

Specifically, when testing a dataset, the conformance class specific to the relevant INSPIRE spatial data theme must be selected.

Figure 3 below shows the test configuration for a dataset falling under the 'Area management/restriction/regulation zones and reporting units' (AM) data theme.

[23] https://eur-lex.europa.eu/eli/reg/2010/1089

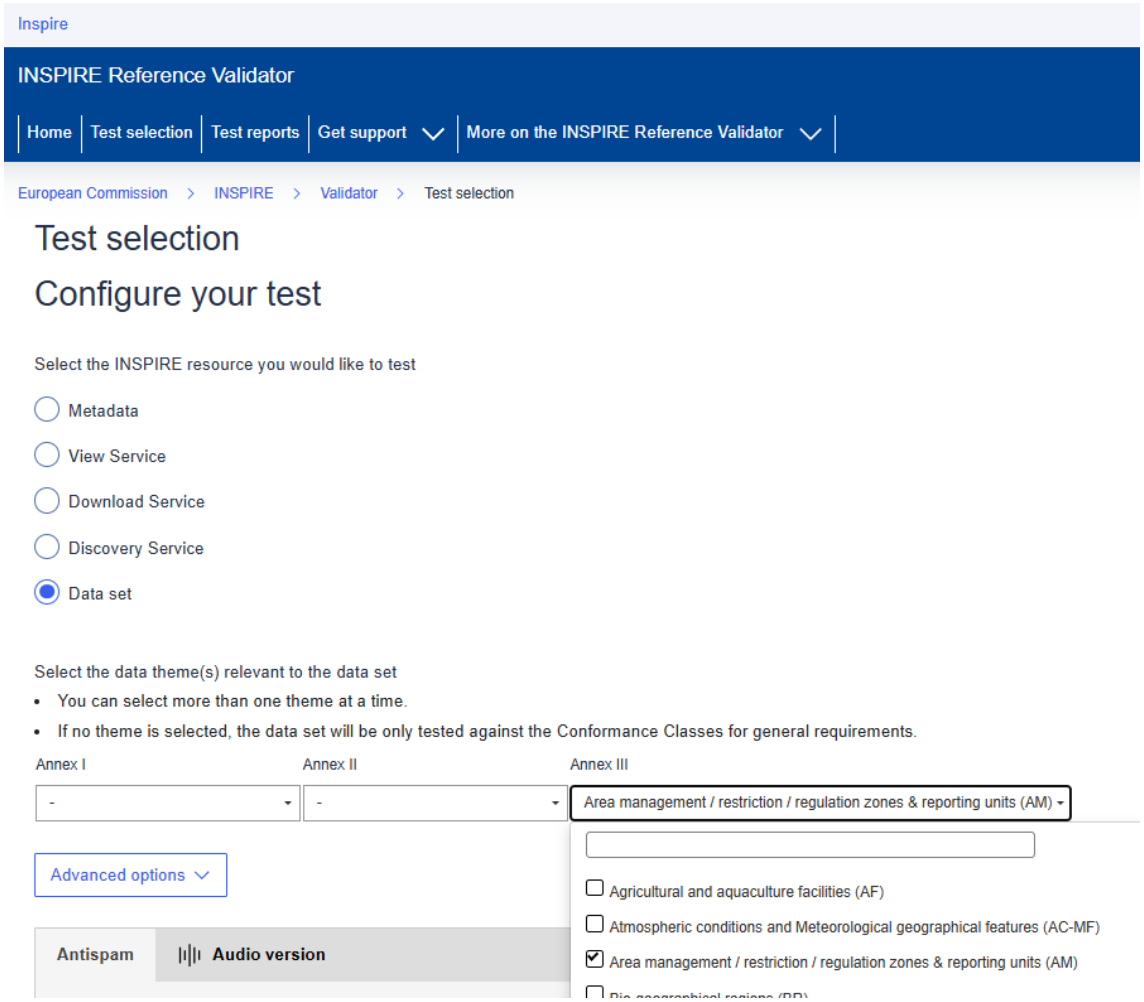

Figure 3 INSPIRE Validator test interface

2.3.2 Compliance for datasets in alternative encodings

Technical compliance with the INSPIRE Implementing Rules shall be demonstrated by:

1) data transformation to the default encoding (GML).
2) successful validation of the resulting dataset (or a subset thereof) using the INSPIRE Validator. The test must be configured by selecting the conformance class specific to the addressed INSPIRE spatial data theme (see above Figure 3).
3) provision of additional documentation (for more details see section 3.1), including:
   a) a description of the logical model, with expected benefits and limitations compared to the default encoding
   b) the physical schema, i.e., a computer-readable data description defining the data structure (such as a GeoPackage template, a JSON schema or an XML application schema (xsd)).

c) a formal specification of the encoding rules allowing transformation from the INSPIRE UML model to the Alternative-Encoding model, following the generic INSPIRE model transformation rules[24].
d) an executable data transformation process that allows data in alternative encoding to be transformed into GML (e.g., hale studio or FME project, a standalone program or even a data transformation service).

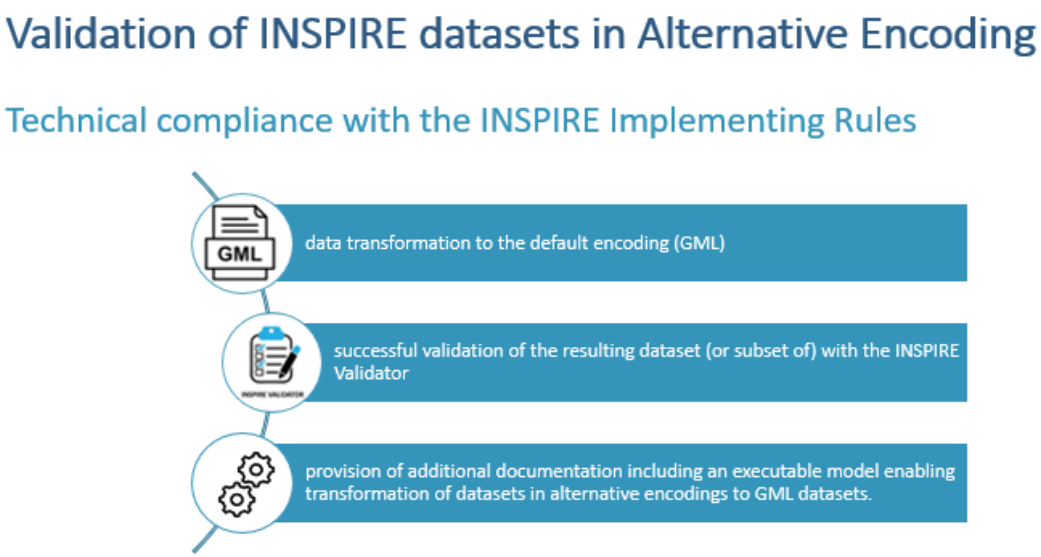

Figure 4 Validation of datasets in alternative encodings

[24] https://github.com/INSPIRE-MIF/model-transformation-rules/tree/main/rules

3 Methodology to demonstrate INSPIRE compliance of datasets in alternative encodings

A methodology for generating the evidence required to demonstrate INSPIRE compliance of datasets in alternative encodings is presented below, in the form of a step-by-step guide and quick reference checklist.

The methodology is premised on the fact that INSPIRE does not have a reference tool to directly validate data in alternative encodings and therefore requires the transformation of data (or a subset thereof) into GML format, for which there is a reference tool, the INSPIRE Reference Validator.

Specifically, the demonstration of compliance requires:

- producing publicly available documentation of the associated data model and encoding rules
- transforming the data into GML encoding and making available the executable data transformation project used
- successfully validating the GML dataset by the INSPIRE Reference Validator.

Subsection 3.1 below details the steps to prove compliance, while subsection 3.2 provides a non-exhaustive list of tools that can be used to carry out these steps.

3.1 Steps to demonstrate compliance

1) Produce the dataset documentation, namely:

    a) a document describing the logical data model to which the dataset conforms, specifying the expected benefits and limitations compared to the default encoding.
    Typically, the logical data model is obtained by simplifying and streamlining the UML model of the addressed INSPIRE spatial data theme, extending it through additional elements as needed to fulfil specific obligations such as reporting requirements.

    b) a document describing the encoding rules that allow the transformation from the INSPIRE model to the logical model of the dataset in alternative encoding. The encoding rules address several aspects, including handling INSPIRE voidable attributes, flattening hierarchical structures, dealing with complex types by substituting them with simpler types and dealing with multiplicities of attributes or associations.

    c) a physical schema i.e., a computer-readable data description that defines the data structure and the data types. Examples of physical schemas are an XML application schema (xsd), a JSON schema or a GeoPackage template.

d) a mapping table establishing relationships between the corresponding data properties / structures in alternative encoding and in GML

2) Transform the alternative encoding dataset into a GML dataset:
    a) Create an executable data transformation process (such as a hale studio or FME project) that allows input data in alternative encoding (for example a GeoPackage file) to be transformed into INSPIRE GML encoding.
    The target data model shall be the xml application schema (xsd) of the INSPIRE data theme relevant to the datasets.
    If the alternative encoding includes extensions, such as for environmental reporting obligations or other specific thematic extensions, these additional attributes to the INSPIRE model will not be included in the resulting GML dataset.
    b) Run the data transformation process and obtain the INSPIRE GML dataset.

3) Validate the GML dataset (or subset thereof) using the INSPIRE Reference Validator.
    When testing the dataset, the relevant theme-specific conformance class must be selected (see Figure 3).
    If errors are reported, correct them (e.g. by refining the data transformation project and re-exporting the GML) and re-validate until validation is successful. Download the validation report.

4) Produce an example of INSPIRE compliant metadata which documents compliance of the dataset in alternative encoding with INSPIRE and, when applicable, the compliance to additional directives e.g., to the reporting obligation.

5) Create a public repository to make available:
    a) the dataset in alternative encoding
    b) the dataset documentation (see point 1)
    c) the data transformation project
    d) the GML dataset that has been validated
    e) the successful validation report from the INSPIRE Validator
    f) the example metadata

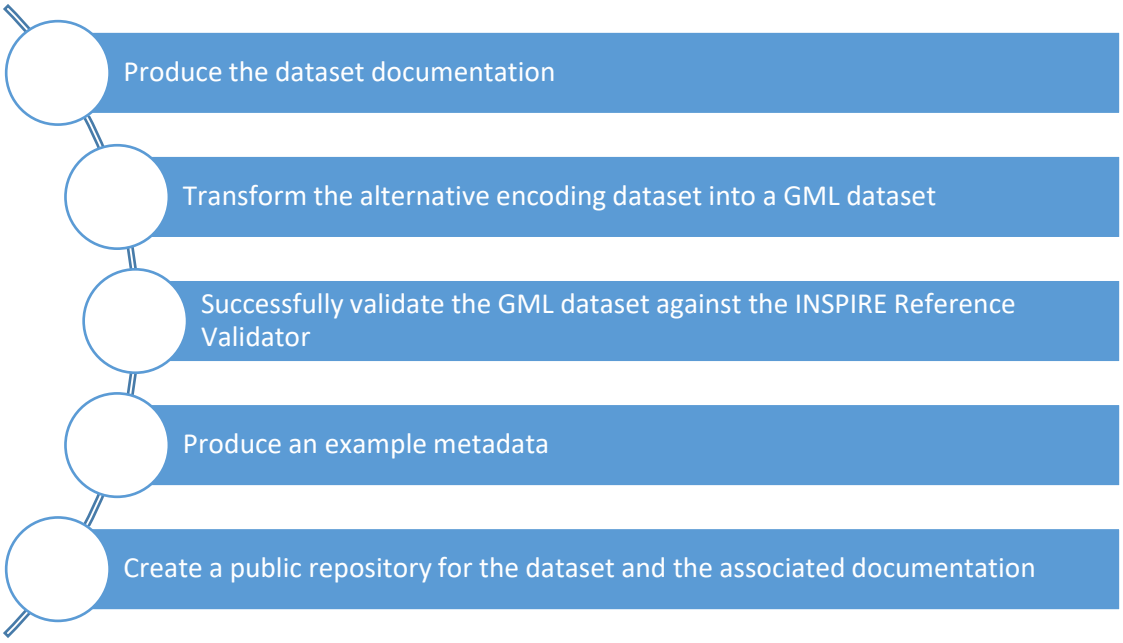

Figure 5 Steps to demonstrate compliance of data in alternative encodings

3.2 Tools to demonstrate compliance

The Table 1 provides a list of tools that can be used to perform the compliance demonstration steps described above. For each tool, the compliance step covered, a brief description of the task that it can perform and the license terms and are reported.

The list is not exhaustive - other software tools than those listed may perform the same tasks. In some cases, alternative tools for the same task are listed.

Note that, depending on the specific encoding, the tool used to perform the operation may vary. In this case, the table column 'Description' explains the correct use.

For example, the schema generation task may require a database administration tool (such as DBeaver or DB Browser for SQLite) if the targeted encoding is GeoPackage, whereas an XML editor (such as XMLSpy or Oxygen) may be more appropriate if the encoding is JSON or GML.

Compliance step	Name	Description	Licence
Step 1	Enterprise Architect	Data modelling and design tool. It can be used to create the logical model (UML).	Proprietary
Step 1	DBeaver	DB administration tool. It can be used to create GeoPackage templates	Proprietary (with free Community Edition)
Step 1	DB Browser for SQL	DB administration tool. It can be used to create GeoPackage templates	Free

Compliance step	Name	Description	Licence
Step 1	Oxygen	XML editor. It can be used to create xsd and JSON schemas	Proprietary
Step 1	XMLSpy	XML editor. It can be used to create xsd and JSON schemas	Proprietary
Step 1	NotePad ++	XML editor. It can be used to create xsd and JSON schemas	Free
Step 1	MS Excel	Spreadsheet software. Can be used to create mapping tables	Proprietary
Step 2	FME	ETL platform. Can be used to transform alternative encoding data into GML format	Proprietary
Step 2	hale studio	Data transformation tool. Can be used to transform alternative encoding data into GML format	Free
Step 3	INSPIRE Reference Validator	Reference tool for INSPIRE validation (of datasets, metadata and network services)	Free
Step 4	GeoNetwork	Cataloguing application. It can be used to create and edit metadata	Free
Step 5	GitHub	Web-based platform for version control and collaborative software development. It can be used to create a public repository for the dataset and the associated documentation.	Free

Table 1 Tools to demonstrate compliance

3.3 Compliance checklist

A quick reference checklist is provided below to ensure that no step is missed.

Compliance step	Piece of evidence required
Step 1	Logical Data Model (UML)
Step 1	Document describing the logical data model, its benefits and limitations
Step 1	Encoding Rules
Step 1	Physical Schema for alternative encoding
Step 1	Mapping Table
Step 2	Alternative encoding dataset
Step 2	Data transformation executable process
Step 2	INSPIRE GML dataset
Step 3	Successful validation report from the INSPIRE Validator
Step 4	Metadata Example
Step 5	Public repository to store INSPIRE validation evidence

Table 2 Compliance checklist

4 How to document INSPIRE compliance of datasets in alternative encodings in the INSPIRE metadata

The INSPIRE Directive requires Member States to provide accurate and detailed descriptions of spatial datasets to ensure that they are discoverable, accessible and reusable. For this reason, metadata documents must be published for INSPIRE data and kept up to date. These documents must comply with the corresponding INSPIRE Metadata IR and TG, in turn based on ISO 19115 and ISO 19139 metadata standards.

Dataset compliance with the INSPIRE Implementing Rules as regards interoperability of spatial datasets and services is one of the pieces of information that must be provided in the metadata. The metadata Technical Guidelines describe how to encode this information, but only in relation to the default GML encoding.

In the context of the END reporting (see section 5 for details) a proposal for documenting the compliance of datasets in GeoPackage alternative encoding has been developed, shared[25] in the INSPIRE MIF GeoPackage repository[26] with a related INSPIRE metadata example and presented to the INSPIRE MIG without objection.

The proposal consists of the three parts, respectively addressing how to document:

1) the dataset distribution format (i.e., the dataset physical schema and encoding rules)
2) the procedure used to evaluate conformity (i.e., data transformation to the default GML encoding)
3) the conformance declaration (to INSPIRE and possible other obligations).

The excerpts below are from the INSPIRE metadata example documenting the END agglomeration sources[27] and show how these pieces of information can be encoded (explanatory comments appear in green colour):

1. The <*gmd:distributionFormat*> metadata element links to the dataset physical schema and encoding rules published in a public repository e.g., the repository where INSPIRE compliance evidence is provided.

```
<gmd:distributionFormat>
  <gmd:MD_Format>
<!-- Provide a link to relevant END GeoPackage template in the Eionet Noise repository -->
    <gmd:name>
      <gmx:Anchor
xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/templates/df1_5/agglomerationsource.gpkg/@@download/file/AgglomerationSource.gpkg">END GeoPackage Template DF1_5 AgglomerationSource</gmx:Anchor>
    </gmd:name>
```

[25] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/issues/25#issuecomment-1580380410

[26] https://github.com/INSPIRE-MIF/gp-geopackage-encodings

[27] https://github.com/INSPIRE-MIF/gp-geopackage-encodings/files/13503792/END_reporting-DF1_5.Agglomeration-source-dataset_metadata.zip

```
        <gmd:version>
          <gco:CharacterString>1.0</gco:CharacterString>
        </gmd:version>
        <gmd:specification>
 <!--  Provide a link to GeoPackage Encoding Rule for Environmental Noise Directive Reporting
Data specification document -->
          <gmx:Anchor
xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/guidelines/geopackage-
encoding-rule-end.pdf">GeoPackage Encoding Rule for Environmental Noise Directive Reporting
Data</gmx:Anchor>
        </gmd:specification>
      </gmd:MD_Format>
    </gmd:distributionFormat>
```

2. The *<gmd:evaluationProcedure>* metadata element links to the executable data transformation project (from alternative encoding to GML).

```
<gmd:report>
  <gmd:DQ_DomainConsistency>
        <!-- Compliance to INSPIRE IR for GPKG: use gmd:evaluationProcedure under the
gmd:report element -->
        <gmd:evaluationProcedure>
          <!-- reference to the procedure information.
            Insert here the link to the online document that contains the description of the
executable data transformation project and gives access to it. -->
          <gmd:CI_Citation>
            <gmd:title>
              <gmx:Anchor xlink:href="https://www.eionet.europa.eu/reportnet/docs/noise/inspire-
validation/noise-sources-df1_5">GPKG-to-GML executable transformation project from DF1_5
Agglomeration Source to INSPIRE AM</gmx:Anchor>
            </gmd:title>
            <gmd:date>
              <gmd:CI_Date>
                <gmd:date>
                  <!-- insert here date(s) of the reference document -->
                  <gco:Date>2023-07-20</gco:Date>
                </gmd:date>
                <gmd:dateType>
                  <gmd:CI_DateTypeCode
codeList="http://standards.iso.org/iso/19139/resources/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication">Publication</gmd:CI_DateTypeCode>
                </gmd:dateType>
              </gmd:CI_Date>
            </gmd:date>
          </gmd:CI_Citation>
        </gmd:evaluationProcedure>
```

3. The *<gmd:report>* element is used to declare degree of conformity of the dataset with the INSPIRE IR as well as possible conformity of the dataset with other obligations.

The excerpt below shows how to document the compliance to the INSPIRE Implementing rules and to the Noise Implementing Decision by using two <gmd:report> subsequent elements.

```
<!-- Conformity to the INSPIRE Implementing Rule (Commission Regulation (EU) No 1089/2010 ) -->

<gmd:report>
    <gmd:DQ_DomainConsistency>
      .....
    <gmd:result>
      <gmd:DQ_ConformanceResult>
       <gmd:specification>
        <gmd:CI_Citation>
         <gmd:title>
          <gmx:Anchor xlink:href="http://data.europa.eu/eli/reg/2010/1089">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</gmx:Anchor>
         </gmd:title>
         <gmd:date>
          <gmd:CI_Date>
           <gmd:date>
            <gco:Date>2010-12-08</gco:Date>
           </gmd:date>
           <gmd:dateType>
            <gmd:CI_DateTypeCode
codeList="http://standards.iso.org/iso/19139/resources/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="publication">Publication</gmd:CI_DateTypeCode>
           </gmd:dateType>
          </gmd:CI_Date>
         </gmd:date>
        </gmd:CI_Citation>
       </gmd:specification>
       <gmd:explanation>
        <gco:CharacterString>This data set is conformant with the INSPIRE Implementing Rules for the
interoperability of spatial data sets and services</gco:CharacterString>
       </gmd:explanation>
       <gmd:pass>
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  </gmd:report>

 <!-- Conformity to the Noise Implementing Decision (Commission Implementing Decision (EU)
2021/1967 ) -->

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</gmd:report>

5 The END reporting datasets example

The spatial data provided under the European Noise Directive (END) reporting obligations are also in the scope of INSPIRE spatial data themes as priority datasets related to environmental reporting[28], and provide an example of INSPIRE datasets in alternative encoding.

Specifically,

1. the END datasets contain all the information required:
   - for Noise Reporting
   - to derive INSPIRE compliant GML datasets (AM, TN, HH data themes).
2. the encoding of END spatial data implements the INSPIRE Good Practice on "GeoPackage encoding of INSPIRE datasets", endorsed by the 16th INSPIRE MIG meeting in November 2020, and hereafter referred to as the "GeoPackage Good Practice".

In order to meet the requirements for declaring END reporting as an implementation of the GeoPackage Good Practice, the workflow shown in Figure 6 was defined, following the methodology described in Section 3 and applying the steps described in Section 3.1.

Figure 6 also shows the tools that have been used for the implementation of the individual steps.

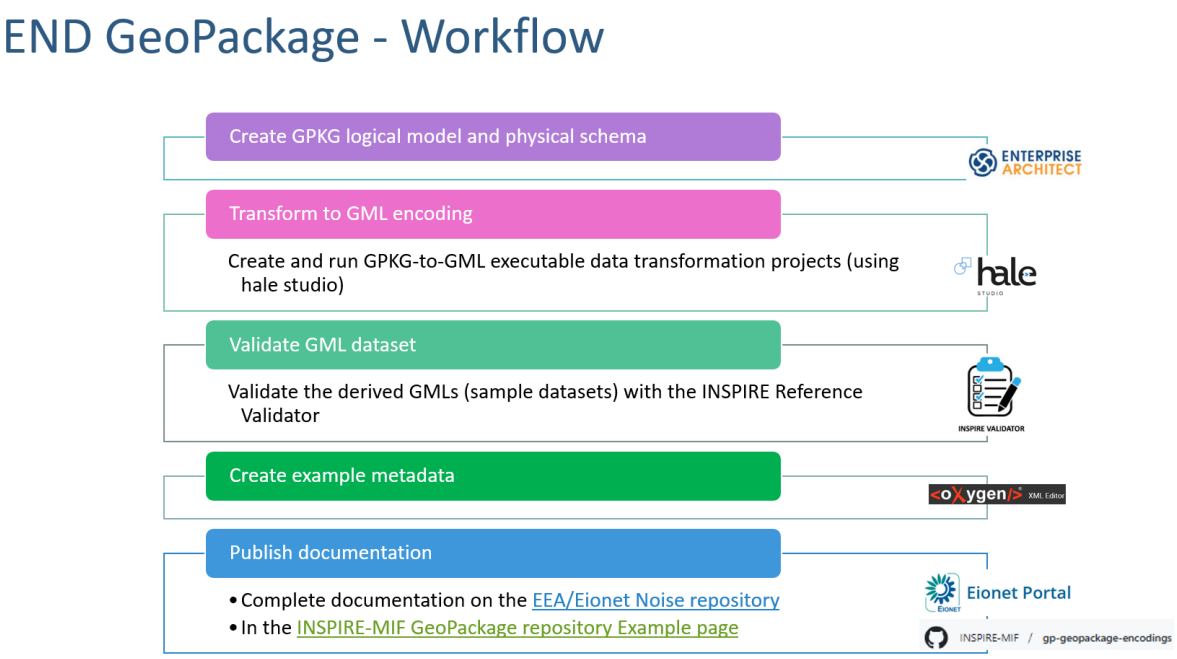

Figure 6 END GeoPackage workflow

[28] https://inspire.ec.europa.eu/metadata-codelist/PriorityDataset

Evidence of END datasets compliance with INSPIRE (see the Compliance checklist) has been published in a dedicated Noise repository[29] on the Eionet Portal[30] (see Figure 7).

This evidence of compliance can be referenced by INSPIRE data providers using the END GeoPackage templates for their datasets, thus reducing the burden of applying the full INSPIRE compliance demonstration process to each END dataset reported under the INSPIRE obligation.

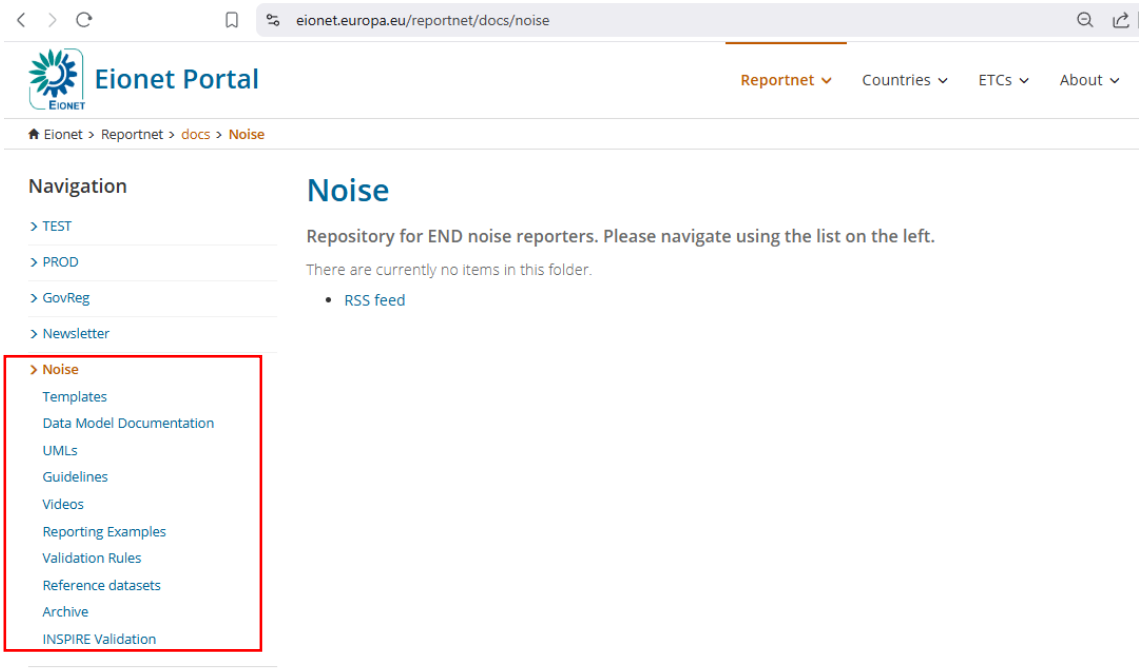

Figure 7 Noise repository on the Eionet Portal

5.1 Compliance evidence

The following evidence has been published in the Noise repository:

1. the END conceptual data model[31], presenting the agreed content for the END reporting data flows and the relation to INSPIRE spatial data themes

2. The GeoPackage encoding rules for the END reporting datasets[32]

3. for all the END spatial dataflows, in dataflow-specific folders:

[29] https://www.eionet.europa.eu/reportnet/docs/noise
[30] https://www.eionet.europa.eu/
[31] https://www.eionet.europa.eu/reportnet/docs/noise/data-model-documentation
[32] https://www.eionet.europa.eu/reportnet/docs/noise/guidelines/geopackage-encoding-rule-end.pdf/view

a) The logical data model (UML)[33]
b) The physical schema (END GeoPackage Template)

4. One-off documentation on INSPIRE validation in the INSPIRE Validation folder[34]. In particular, dataflow-specific subfolders make available:
    a) the hale studio GPKG-to-GML data transformation projects (in the form of an archive also containing sample input data)
    b) a sample GML file (corresponding to the sample input data)
    c) the INSPIRE validation report for the sample GML
    d) GPKG to GML mapping table.

5.2 Lessons learnt

Demonstrating the INSPIRE compliance of the END GeoPackage datasets was a fairly smooth exercise. This is because INSPIRE compliance has been integrated into the data modelling activities from the outset. The INSPIRE data models have been simplified and extended to meet the specific requirements of the END by using the common model transformation and encoding rules (see section 2.2.1) specifically designed to allow simplification of INSPIRE data while maintaining data interoperability and compliance with the Directive.

This approach ensured that datasets complied with INSPIRE requirements from the design phase, embedding compliance directly into the system architecture rather than relying on retrospective adjustments. In addition, a comparative analysis of the information needs of the different data flows under the END reporting obligation enabled the reuse of common concepts, features and data types (building blocks) derived from simplified INSPIRE models throughout the design of the different data flow models. This not only improved consistency but also optimized the reuse of quality controls and validation procedures.

The approach also leveraged the INSPIRE Good Practice procedure to adopt the most suitable encoding for END data delivery, while ensuring compliance with INSPIRE requirements. This was achieved by proposing the END models as a specific implementation of the Good Practice on the GeoPackage encoding of INSPIRE datasets.

Figure below illustrates the END approach to the INSPIRE compliance ‘by design’.

[33] https://www.eionet.europa.eu/reportnet/docs/noise/umls
[34] https://www.eionet.europa.eu/reportnet/docs/noise/inspire-validation

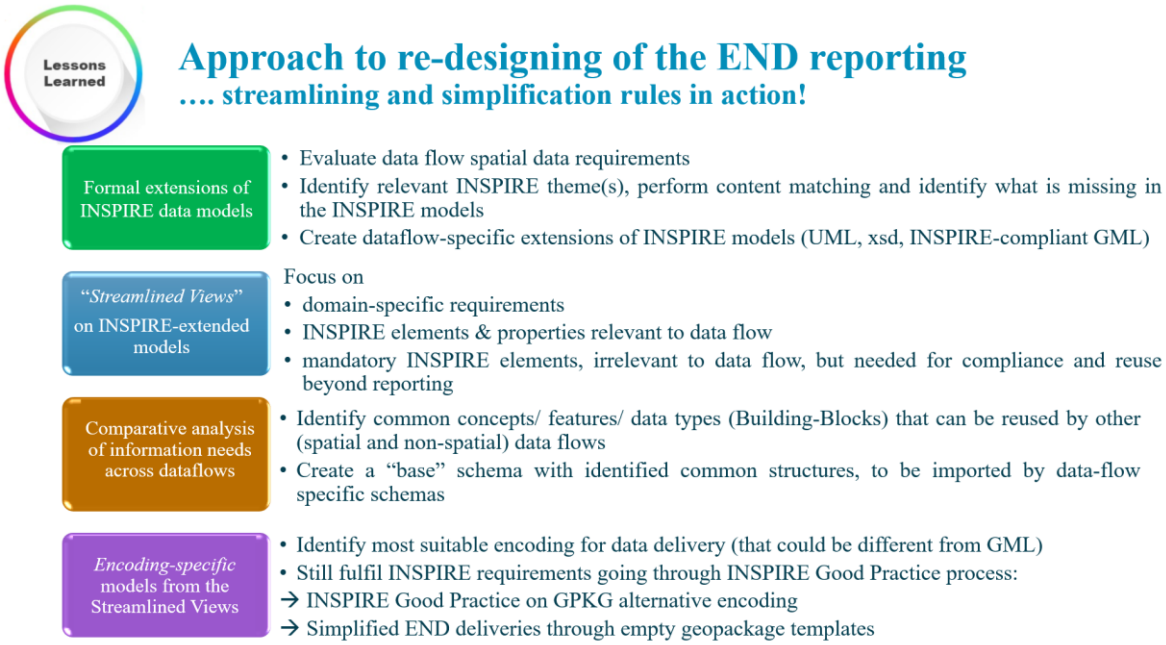

Figure 8 END approach to INSPIRE compliance 'by design'

As an example of the INSPIRE compliance by design approach, the Figure 8 and Figure 9 below show the UML diagram (full view and streamlined one) of INSPIRE-based logical model for the DF1_5 Agglomeration sources dataflow.

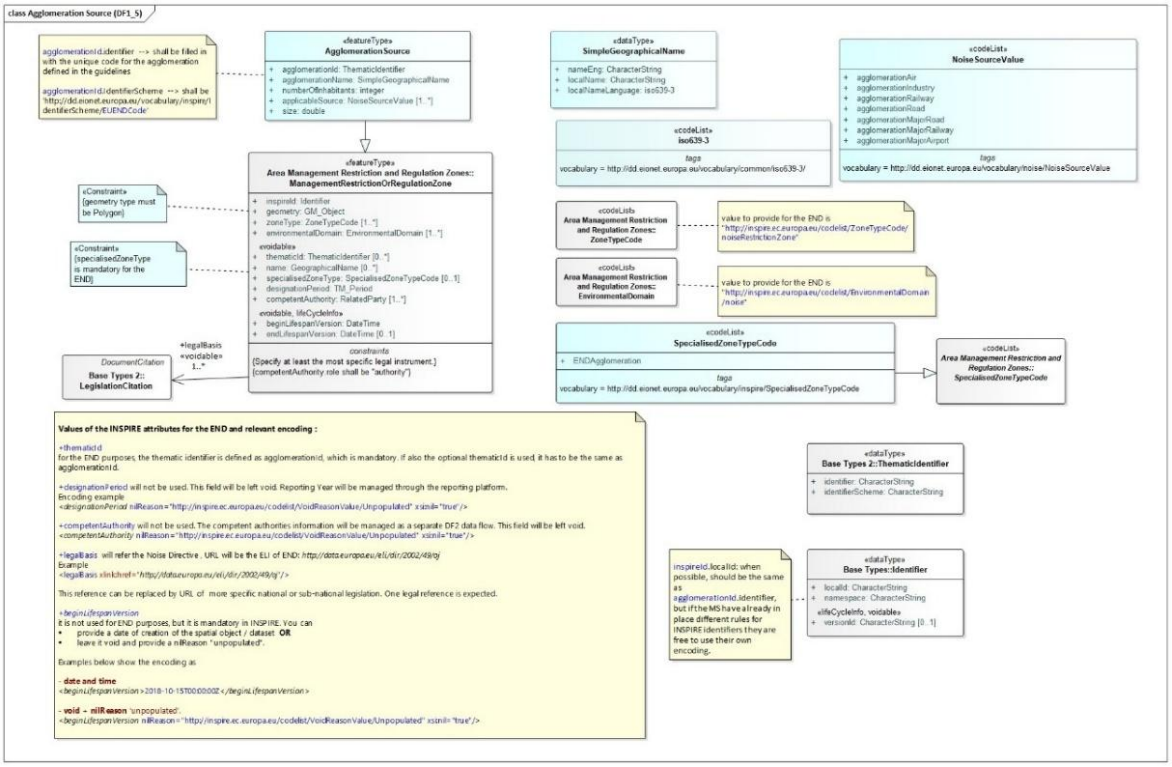

Figure 9 END Agglomeration source UML (full view)

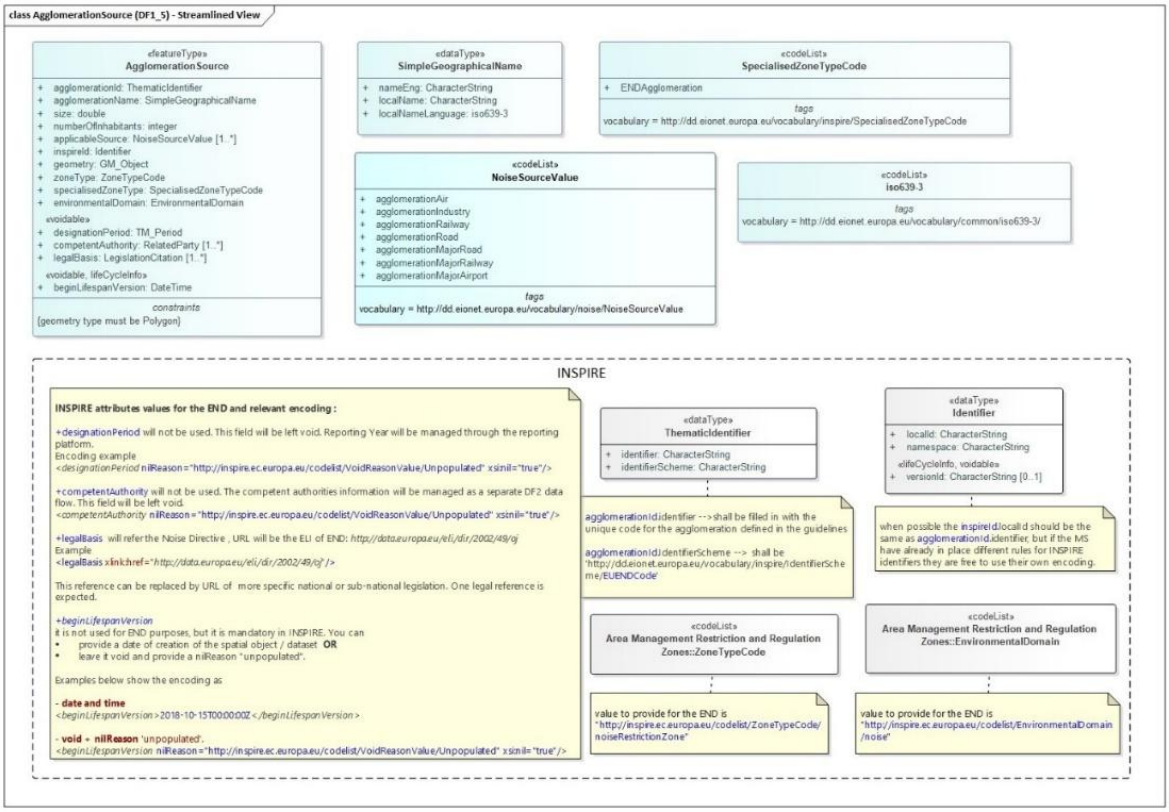

Figure 10 Agglomeration source UML (streamlined view)

Following the requirements in the GeoPackage Good Practice, compliance evidence for the END datasets has been shared in public repository. This is particularly beneficial for the END data providers, who can reuse the same templates, processes and examples that have already been demonstrated to be INSPIRE compliant. Once END GeoPackage datasets have been successfully reported to the EEA (i.e. they have passed the quality controls to ensure compliance with the END specification), data providers can 'inherit' the associated INSPIRE compliance evidence by simply referencing the corresponding artefacts in the Eionet Noise repository in their dataset metadata (as shown in section 4).

This reduces the burden of applying the full INSPIRE compliance process to END datasets that they need to report under INSPIRE.

6 Conclusions

The INSPIRE Directive lays down general rules for the establishment of a European Spatial Data Infrastructure to support Community environmental policies and policies or activities that may have an impact on the environment. The overall objective is to support better informed decision-making at all levels of government by facilitating the exchange of and access to interoperable spatial data across Europe.

Compliance with the INSPIRE is mandatory for some environmental reporting datasets (e.g. noise) under EU Regulation 2019/1010. However, as the reported geospatial information overlaps with the scope of INSPIRE, the compliance with its requirements is generally desirable to reduce the administrative burden on Member States, streamline provisions and enhance data consistency.

Alignment with INSPIRE can be facilitated by taking advantage of the latest developments in the technological evolution process of the Directive, which sits in the broader context of the European Data Strategy and the establishment of the Green Deal Data Space.

One of the outcomes of this modernisation and simplification process is the ability to use alternative encodings to GML for INSPIRE datasets, with the aim of making them more accessible and easier to use by a wider range of (mainstream) applications and tools, thereby improving the interoperability and usefulness of the data in real-world scenarios.

INSPIRE datasets in alternative encodings must comply with all the requirements set out in the Implementing Rules. This document provides practical guidance on how to demonstrate and document their compliance.

Section 2 presents a brief overview of the INSPIRE Directive, distinguishing between the legally binding requirements in the Implementing Rules and the non-binding requirements in the Technical Guidelines. It then introduces the INSPIRE alternative encodings and details the concept of INSPIRE compliance for both the standard GML and the alternative encoding datasets.

A methodology for generating INSPIRE compliance evidence for the datasets in alternative encoding is presented in section 3, in the form of a step-by-step guide and quick reference checklist, together with a non-exhaustive list of tools that can be used to accomplish individual steps.

The methodology is premised on the fact that INSPIRE has no reference tool to directly validate data in alternative encodings, and their compliance has to be demonstrated by transformation into GML format, for which a reference tool (the INSPIRE Reference Validator) exists.

A proposal to document the compliance in the INSPIRE metadata is illustrated in section 4.

The case of the reporting under the Environmental Noise Directive, for which INSPIRE compliance is required by law (Regulation EU 2019/1010), is presented in section 5 as an operational example of the methodology for generating INSPIRE compliance evidence described in section 3.

In particular, section 5.2 comments on the positive experience with the validation of END datasets and summarises main lessons learnt.

One of the key takeaways is the effectiveness of the END approach to achieving INSPIRE compliance, that can be defined as “INSPIRE compliance by design”.

This approach involves integrating INSPIRE compliance into the data model design by utilizing the common model transformation and encoding rules that are specifically intended to simplify INSPIRE requirements while ensuring data interoperability and compliance (see section 2.2.1).

INSPIRE compliance by design ensures that compliance is seamlessly embedded into the data model architecture from the outset, rather than being applied retrospectively. Additionally, a comparative analysis of information needs enables the reuse of common concepts, features, and data types (building blocks) derived from simplified INSPIRE models in the design of various data flow models under the same or similar obligations. This approach not only enhances consistency but also optimizes the reuse of quality control and validation procedures.

Another important lesson from the END experience is that publishing evidence of INSPIRE compliance is particularly valuable for data providers, who can "inherit" this evidence for the purposes of INSPIRE compliance declarations of their datasets. In particular, in the INSPIRE metadata of their datasets they can reference relevant evidence of compliance published in a public repository. This minimizes the effort that would otherwise be needed to apply the full INSPIRE compliance process to datasets in alternative encodings reported under INSPIRE.