



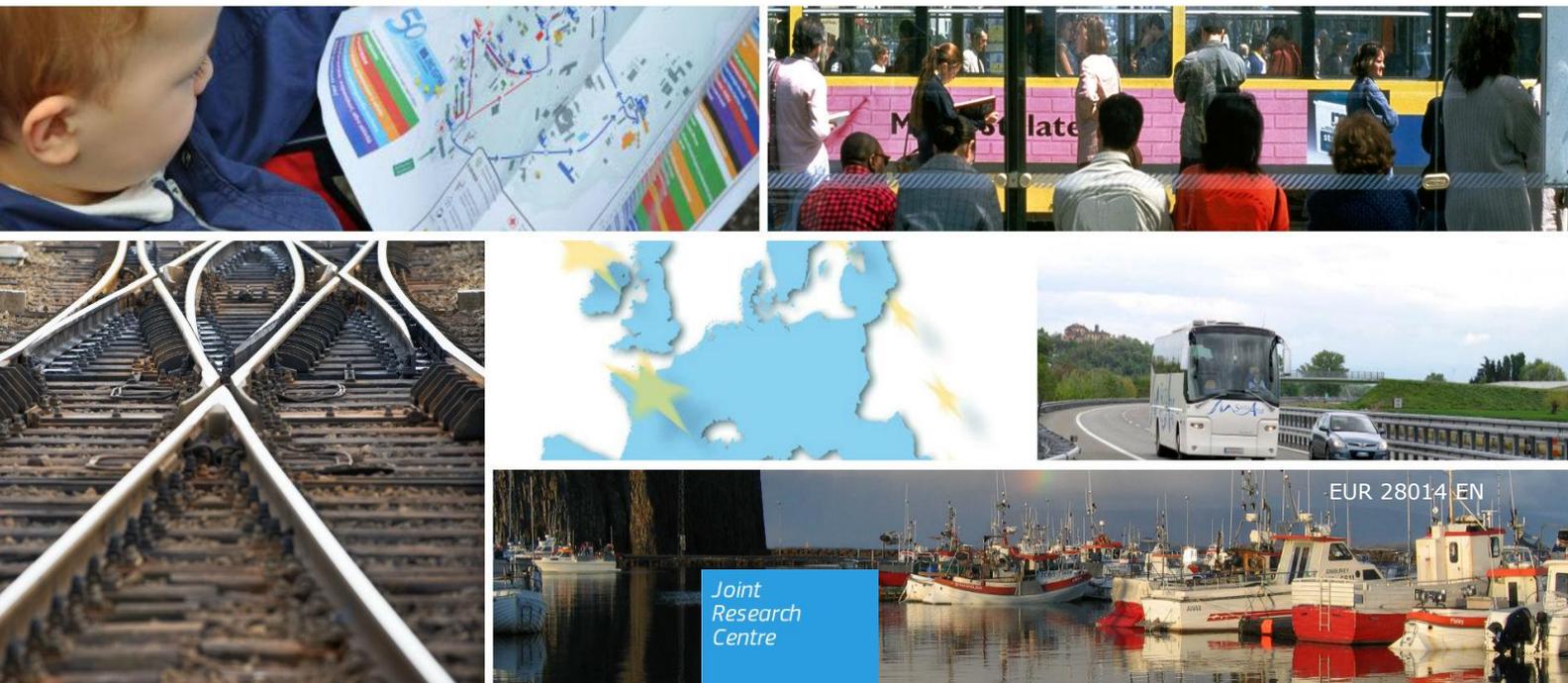
JRC TECHNICAL REPORTS

Buildings related datasets accessible through the INSPIRE geoportal

European Union Location Framework (EULF) Project Energy Pilot

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Abstract

The European Union is giving more and more emphasis to its energy policy, whose strategy and actions are included in the Energy Union Package and the 2030 Framework for Climate and Energy. Buildings in which people live and work are responsible for an important portion of the energy consumption in Europe and there are a series of policies and initiatives that are aiming at improving their energy performances and to collect data of sufficient quality on the effect of energy efficiency policies on building stock across Europe. A related initiative is the EC INSPIRE Directive establishing an Infrastructure for Spatial Information in the European Community [1], addressing a number of data themes, including buildings. This report aims to assess the extent to which the buildings-related datasets which European Member States are sharing following INSPIRE provisions are of good quality and can serve the purposes of the initiatives related to energy efficiency of buildings. A step by step methodology has been applied and documented to guide the reader through the discovery of building-related datasets in the INSPIRE geoportal, focusing primarily on datasets usability in a GIS environment. A first finding is the high number of building related datasets discovered through the INSPIRE Geoportal, which confirms its importance as a source of data for energy efficiency initiatives. Given the several hundreds of datasets discovered, a sampling mechanism to select a small number of datasets to be further inspected has been adopted. Following a more detailed analysis, in particular on datasets that can be downloaded from the Geoportal, we can conclude that some of them are of good quality, in terms of data accuracy and national geographic coverage, while for others these criteria are not fulfilled. This can be related to the fact that the INSPIRE roadmap foresees the full implementation of the Directive in Member States by 2020, so there is the need to wait that date to exploit the full potential which we are starting to see in countries that are already advanced in the implementation for historic and cultural reasons. Moreover, this work has been useful also to identify some recommendations to INSPIRE implementers working in energy thematic communities, in order to better address their efforts in fulfilling on-going and future INSPIRE obligations.

1. Introduction

Buildings are responsible for approximately 40% of the primary energy consumption in Europe and the Energy Union package calls for “creating the right framework to deliver energy efficiency in buildings”, implementing concrete measures such as the review of the Energy Performance of Buildings and Energy Efficiency Directives. However, there is a lack of quality data regarding the effect of energy efficiency policies on building stock across European Member States. Such data would give the possibility to base the interventions on building renovations towards improving their energy efficiency on solid evidence.

To address this issue, the European Commission (DG Energy) is developing a Building Stock Observatory which will be a key open access resource in providing comprehensive information about buildings for decision making (at EU level, but most importantly for national/local authorities), industry and investors. The Observatory should profit from relevant information on the energy performance of buildings and related key policies arising from on-going initiatives, both inside and outside the Commission, involving data collection, analysis and modelling. The launch of the first version of the EU Building Stock Observatory is expected in September 2016.

The JRC is supporting the purpose of the Observatory, producing an inventory of relevant information and data on buildings at Member States level.

In parallel, JRC is leading the EULF (European Union Location Framework¹) project, which is part of the Interoperability Solutions for Public Administrations (ISA) Programme², run by DG Informatics (DIGIT). The EULF is a framework of recommendations, guidance and actions to improve the way location information is used in all public services across Europe, targeting benefits for businesses, citizens and government in key areas of EU activity, such as Transport, Marine and Energy policy.

The EULF Energy Pilot is one of the three pilots (the other two dealing with Transport and Marine sectors, respectively) to test the concept of the EULF. It started in the last quarter of 2015, based on the outcomes of a feasibility study which are documented in the "Location data for energy efficiency policies" JRC Technical Report³[2]. The feasibility study aimed to verify the potential for an effective application of spatial data to support the monitoring requirements of the different EU energy efficiency policies and initiatives, which include data from different sources and at different scales (building, district and national).

The EULF in general and its pilots in particular, build on the spatial data infrastructure for Europe being implemented by the INSPIRE Directive and aim at extending the INSPIRE concept and use in e-government and other areas beyond the environment.

The INSPIRE Directive, entered into force in 2007, aims to support EU environmental policies, and policies or activities which may have an impact on the environment, such as energy policies. INSPIRE is based on the infrastructures for spatial information established and operated by the 28 Member States of the European Union and it addresses 34 spatial data themes, including the one related to buildings. Each EU

¹ Information about the EULF, including links to publications and key events, can be found at http://ec.europa.eu/isa/actions/02-interoperability-architecture/2-13action_en.htm

² Information about ISA is available at <http://ec.europa.eu/isa/> and at http://ec.europa.eu/isa/library/isa-work-programme/index_en.htm

³ <http://publications.jrc.ec.europa.eu/repository/handle/JRC96946>

Member State is responsible for national official catalogues published in national geoportals, feeding the EU-wide INSPIRE Geoportal, which includes data about buildings.

This report is an output of the EULF project and it was carried out upon DG Energy request. It aims to assess the extent to which the buildings-related datasets which European Member States are sharing following INSPIRE provisions are of good quality and can serve the purposes of the initiatives related to energy efficiency of buildings.

The report is structured as follows: after this introduction, Section 2 provides some underlying considerations related to the INSPIRE context and a description of the INSPIRE data model for the theme "buildings". Section 3 describes the methodology adopted to select and analyse the datasets, whereas section 4 contains a summary of the findings, as well as details of the datasets more deeply analysed. Section 5 shows details of the inspected datasets analysed in a GIS environment and conclusions are summed up in section 6.

Text in *italics* has been extracted from INSPIRE official documents⁴.

It is worth to note that building related datasets potentially relevant to energy policies purposes that can be found in other data portals different from the INSPIRE geoportal, are out of scope of the activities presented in this technical report.

⁴ Available at <http://inspire.ec.europa.eu/index.cfm>

2. INSPIRE context

It is important to underline some considerations related to the INSPIRE context in which the reported activities have been performed, in order not to overemphasise INSPIRE expectations and benefits, which are still not easily measurable. At the same time, it is worth to highlight and clarify the potential related to the implementation of the INSPIRE provisions across the European Union.

INSPIRE has an implementation roadmap⁵, shown in *Figure 1*, which sets deadlines for Member States to make accessible in an harmonised and interoperable way datasets belonging to 34 data themes (grouped into three Annexes), using specific data models as well as specific web based network services.

Even though the deadline relevant to Annex I, II and III datasets are set in 2017 and 2020 respectively, there are intermediate deadlines (some of them already passed), requiring that datasets published by Member States in their national geoportals have to be made accessible through the INSPIRE geoportal, even though these datasets are not yet conformant to the INSPIRE data models.

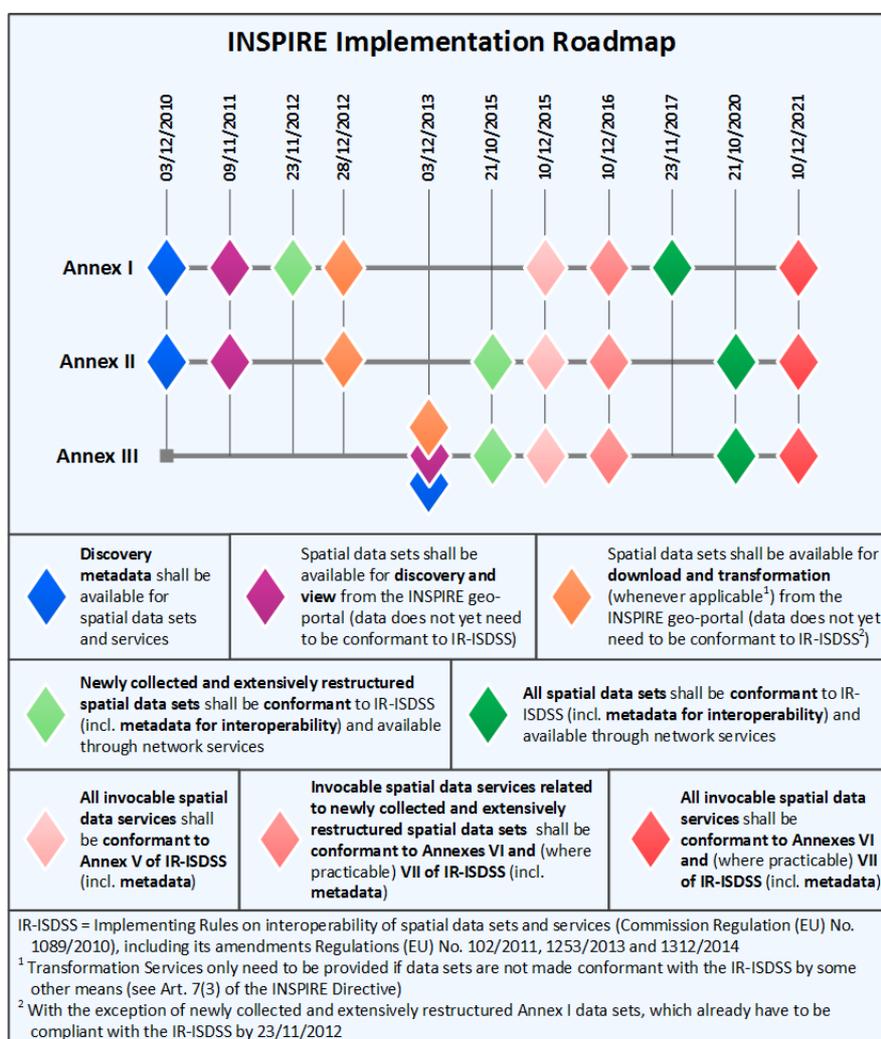


Figure 1: INSPIRE Implementation Roadmap⁶

⁵ <http://inspire.ec.europa.eu/index.cfm/pageid/44>

⁶ <http://inspire.ec.europa.eu/index.cfm/pageid/44>

2.1 Relevance of BU (Buildings) datasets

Among the INSPIRE 34 data themes, “Buildings” is one of the most relevant to support the energy policies lifecycle.

The INSPIRE Data Specification on Buildings⁷ [3] provides six different data models (or application schemas), covering different levels of detail from the semantic and geometric points of view (base vs. extended and 2D vs. 3D).

The relationships between the six application schemas are shown in *Figure 2*, in which Feature types are represented in blue, abstract application schemas are represented in green and instantiable application schemas are represented in red.

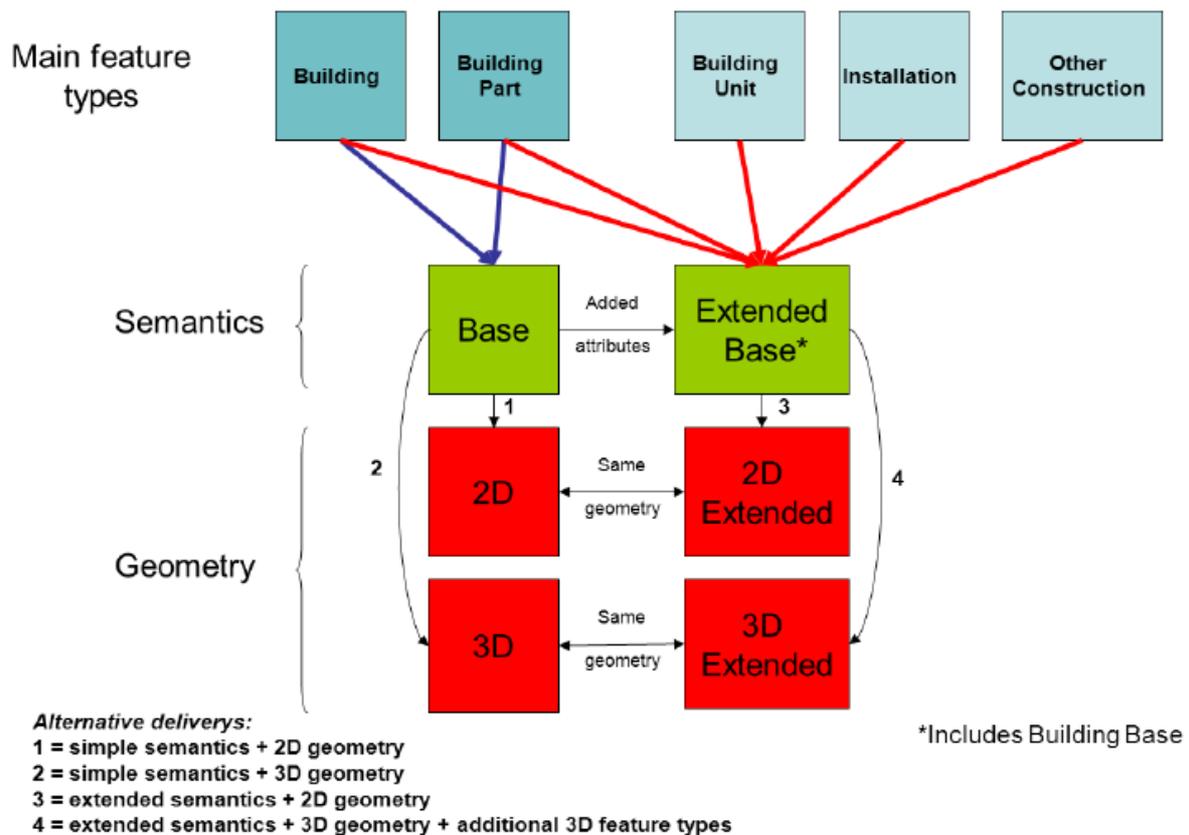


Figure 2: Content and structure of application schemas for theme Buildings

It should be noted that various user requirements were collected by groups of experts in order to define these data models. As stated in the INSPIRE Data Specification on Buildings, “... Because it seemed impossible to require data harmonisation at European level for all these requirements, the data specification on Buildings has defined some priority ...”, as shown in the following *Figure 3*, in which “Feature types are represented in bright colours, whereas their properties are represented in clearer colours”.

⁷ http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_BU_v3_0.pdf

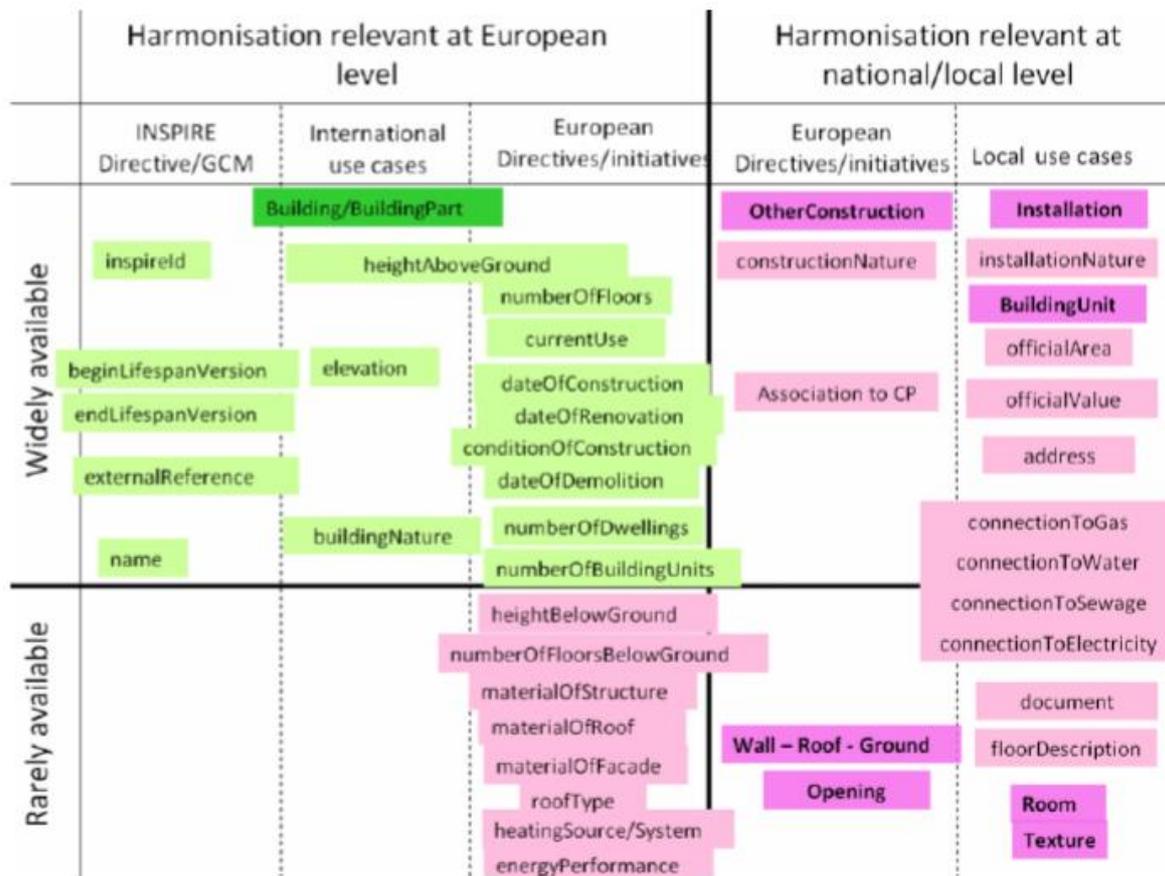


Figure 3: The hierarchy of semantics user requirements

With reference to Figure 2 and Figure 3, as stated in the INSPIRE Data Specification on Buildings, "... two kinds of semantic profiles are proposed in the data specification on Buildings:

- **normative** (i.e. binding by law) **core profile**, based on the data widely used, widely available and whose harmonisation is required at European level, e.g. for homogeneous reporting on Environmental Directives;
- **informative** (i.e. not binding by law) **extended profile**, based on data that is widely required but whose harmonisation is not easily achievable at short term (e.g. data rarely available or data whose harmonisation may/should be done at national level).

The common semantics used by all profiles has been described in a base application schema.

Core profile includes both basic topographic data (such as height, number of floors, nature of buildings, date of construction ...) and coarse official data (such as current use, number of dwellings or of building units); the core profile aims to fulfil most user requirements, at least in a rough way. Core profile is based on the concepts shown in green in Figure 3.

Extended profile includes more detailed information about buildings and building related objects. Extended profile is based on the concepts shown in pink in Figure 3 ...".

In summary, the six application schemas of the Buildings theme shown in *Figure 2* are listed and briefly described below:

- **BuildingsBase**, describing the concepts that are common to all other Buildings application schemas; it contains mainly the core normative semantics of theme Buildings;
- **Buildings2D**, describing the 2D geometric representation of the spatial object types defined in Buildings Base application schema, namely buildings and building parts; it inherits from the common semantics of Buildings base
- **Buildings3D**, describing the 3D geometric representation of the spatial object types defined in Buildings Base application schema, namely buildings and building parts; it inherits from the common semantics of Buildings base
- **BuildingsExtendedBase**, describing the additional semantics that should be used to extend normative profiles, whatever the chosen geometric representation (2D or 3D) is.
- **BuildingsExtended2D**, describing the 2D geometric representation of the additional spatial object types (namely installations, other constructions, building units); it inherits both from the common semantics of <Buildings ExtendedBase> and of the 2D geometric representation of buildings and building parts.
- **BuildingsExtended3D**, describing both the 3D geometric representation of the additional spatial object types (namely installations, other constructions, building units) and the additional concepts that should be used to provide more detailed information about buildings and associated objects, when represented by 3D data (walls, roofs, openings, room, textures, ...); it inherits both from the common semantics of <Buildings ExtendedBase> and of the 3D geometric representation of buildings and building parts."

Regarding the INSPIRE implementation roadmap, it is important to highlight that the deadline of 2020 requires that Member States will have to make their datasets on Buildings conformant to one of the two core profiles (Buildings2D or Buildings3D).

In the meanwhile, thematic communities are encouraged to use/refine the present draft version of the extended data models and push their formal approval according to the procedures set by the INSPIRE Maintenance and Implementation Framework⁸.

Nevertheless, despite the issue of core versus extended data models, several aspects affect the relevance of BU datasets to energy efficiency policies, because some of the attributes are optional. Therefore, it cannot be expected that all data providers will deliver datasets containing all this information.

In more technical terms, some of the attributes have the following characteristics:

- They are voidable⁹ and/or optional in the binding-by-law BU core data model (e.g. dateOfConstruction and currentUse in *Figure 4*);
- They are voidable and/or optional in the draft BU extended data model (e.g. energyPerformance, heatingSource, heatingSystem, materialOfFacade, materialOfRoof, materialOfStructure in *Figure 5*).

⁸ <http://inspire.ec.europa.eu/index.cfm/pageid/5160>

⁹ The «voidable» stereotype is used to characterise those properties of a spatial object that may not be present in some spatial data sets, even though they may be present or applicable in the real world.

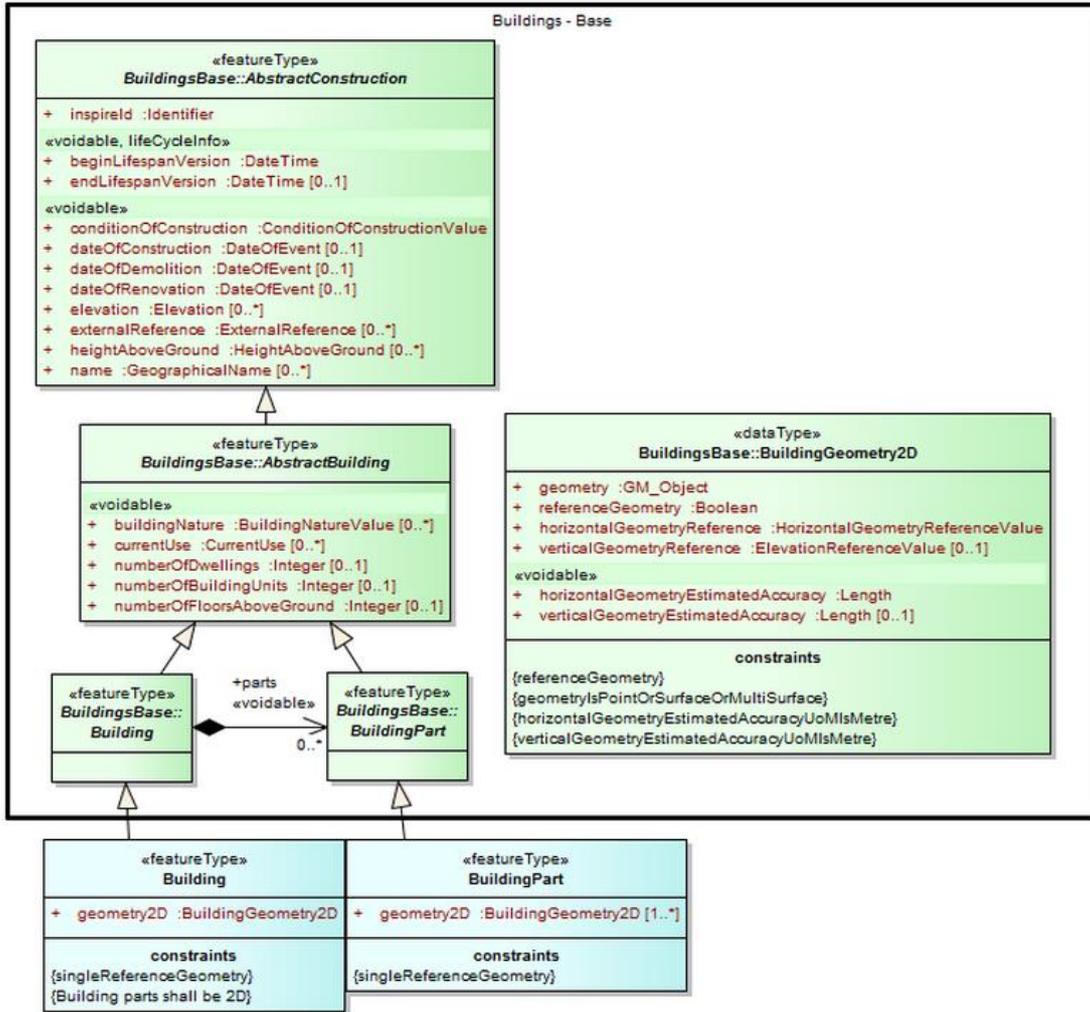


Figure 4: BU Core 2D (Building2D) data model

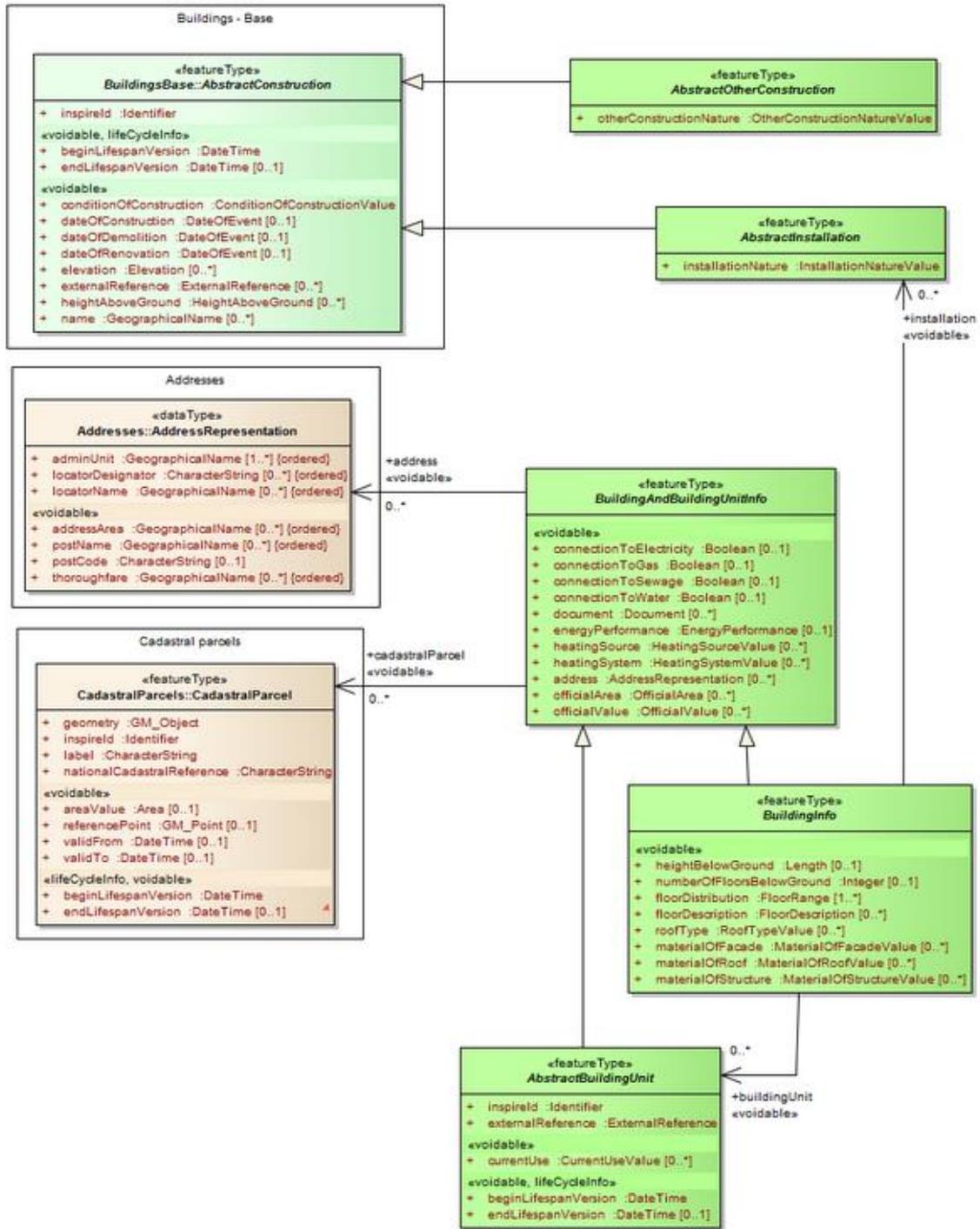


Figure 5: BU Extended Base data model

2.2 Fitness of INSPIRE BU data models for energy-related purposes

As part of the EULF project, an initial mapping exercise has been carried out [2] between

the building related elements of the data models required by EPBD¹⁰ [4] and the corresponding elements present in the INSPIRE data specification on Buildings. The main outcome of this mapping exercise is that the building-related data models required by EPBD and CoM¹¹ are semantically richer than the data models under INSPIRE. For instance, *Figure 6* shows the UML representation of the element of the INSPIRE Buildings Base Extended data model (Feature Type BuildingAndBuildingUnitInfo) which deals with energy related aspects.

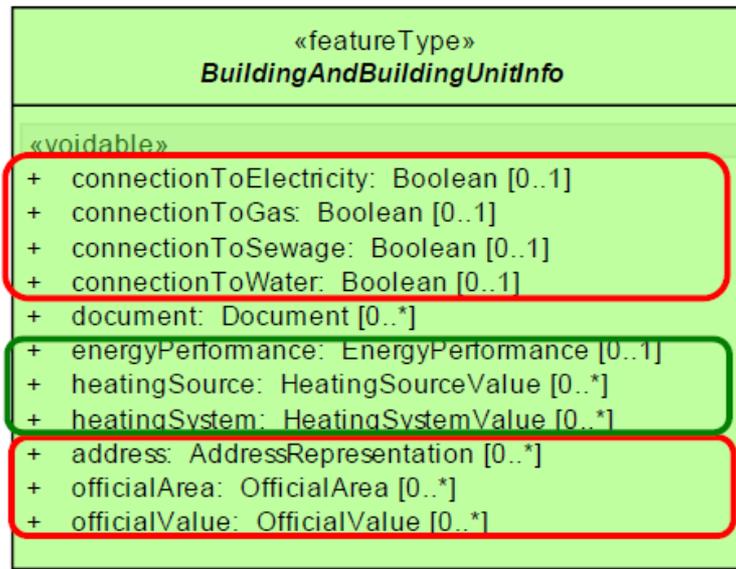


Figure 6: INSPIRE Feature Type BuildingAndBuildingUnitInfo

From this figure it is evident that:

- there are 4 boolean attributes which can be used just to store the information if the building (or building unit) is connected or not to the different networks (electricity, gas, sewage, water)¹²;
- there is one attribute (energyPerformance) which can be used to store the information related to the energy label;
- there is one attribute (heatingSource) which can be used to store the information related to the source of energy used for heating (i.e. electricity, naturalGas, etc.);
- there is one attribute (heatingSystem) which can be used to store the information related to the system of heating (i.e. stove, central heating, heat pump, etc.).

Conversely, there are additional attributes required by the EN 15603 standard [5] (on which the EPBD data modelling requirements are based), like “Energy need” for heating, cooling, ventilation, air conditioning, domestic hot water, lighting, appliances, which do not match with any attribute existing in the current INSPIRE data model for buildings.

In general, because not all the elements of the data models required by EPBD and CoM have a corresponding element in the relevant INSPIRE data model, these elements with

¹⁰ Energy Performance of Buildings Directive - http://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=FZMjThLLzfxmmMCQGp2Y1s2d3Tjwtd8QS3pqdkhXZbwqGwlgY9KN!2064651424?uri=CELEX:32010L0031

¹¹ Covenant of Mayors - <http://www.covenantofmayors.eu/>

¹² It is worth noting the absence of a similar boolean attribute to identify buildings connected to district heating network

a missing correspondence with INSPIRE need to be further analysed in order to properly address an extension of the existing relevant INSPIRE data models, considering that this extension process is subject to precise rules and conditions, set to ensure that they do not break the interoperability of harmonised data and services¹³ [6].

It is also worth highlighting that the Citygml Energy ADE¹⁴ initiative and the GeoSmartCity¹⁵ project are working on similar topics and are producing results whose reuse in the EULF Energy Pilot is also encouraged/recommended.

¹³ INSPIRE Generic Conceptual Model -

http://inspire.ec.europa.eu/documents/Data_Specifications/D2.5_v3.4.pdf

¹⁴ http://en.wiki.energy.sig3d.org/index.php/Main_Page

¹⁵ <https://themes.jrc.ec.europa.eu/discussion/view/61352/extended-bu-data-model-for-energy-efficiency>

3. Methodology

The methodology adopted is based on a dataset discovery activity carried out using the INSPIRE geoportal, which harvests the metadata published in the national official catalogues developed and maintained by Member States.

The INSPIRE Geoportal, accessible at <http://inspire-geoportal.ec.europa.eu/>, offers different tools, namely a metadata¹⁶ editor, a metadata validator, a discovery/viewer and a resource browser to find and view details of the datasets. Its home page is shown in *Figure 7*. The tool used in this activity was the resource browser, in order to discover BU related datasets potentially relevant for the scope of the work.

Each search made through the INSPIRE geoportal is based on real-time harvesting of the metadata published in the official catalogues whose end point has been provided to JRC by Member States. Therefore the number of results of an identical search repeated at different points in time may differ, depending on the accessibility of the harvested catalogues at the moment of the search.

In addition, coherently with the roadmap shown in *Figure 1*, in the INSPIRE geoportal it is possible to find BU related datasets that are not yet conformant to INSPIRE data models.

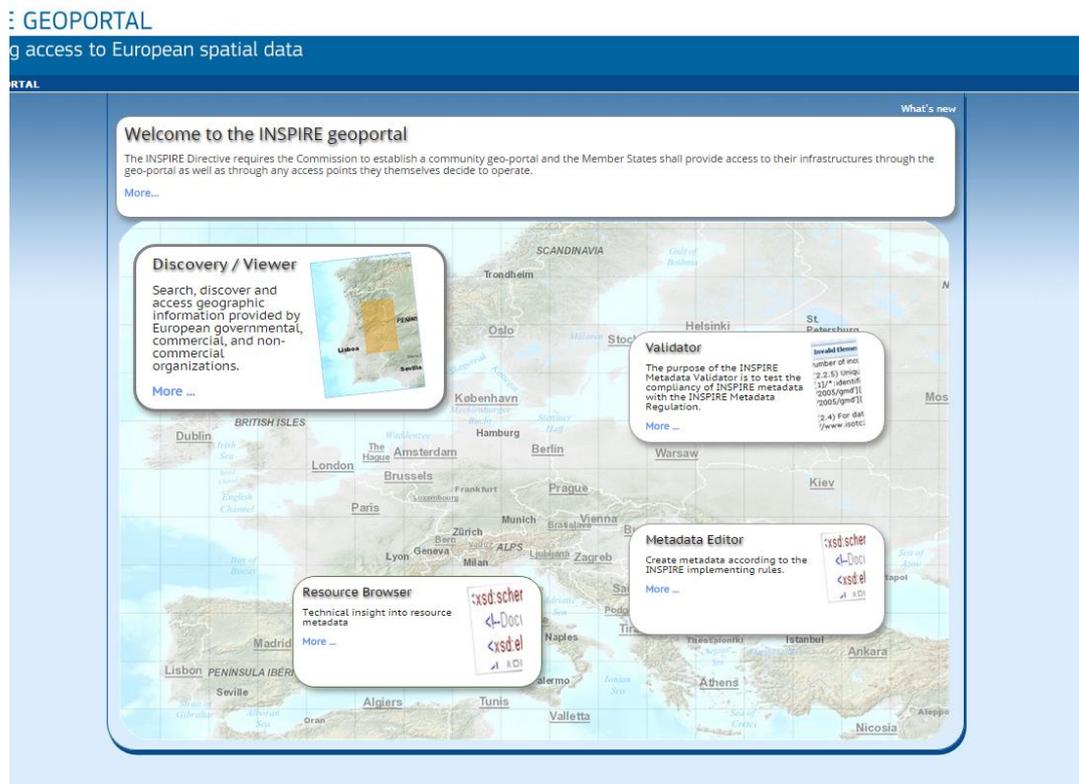


Figure 7: Home page of the INSPIRE geoportal

¹⁶ Metadata are information describing spatial data sets and spatial data services and making it possible to discover, inventory and use them (definition from the INSPIRE glossary <http://inspire.ec.europa.eu/glossary/Metadata>)

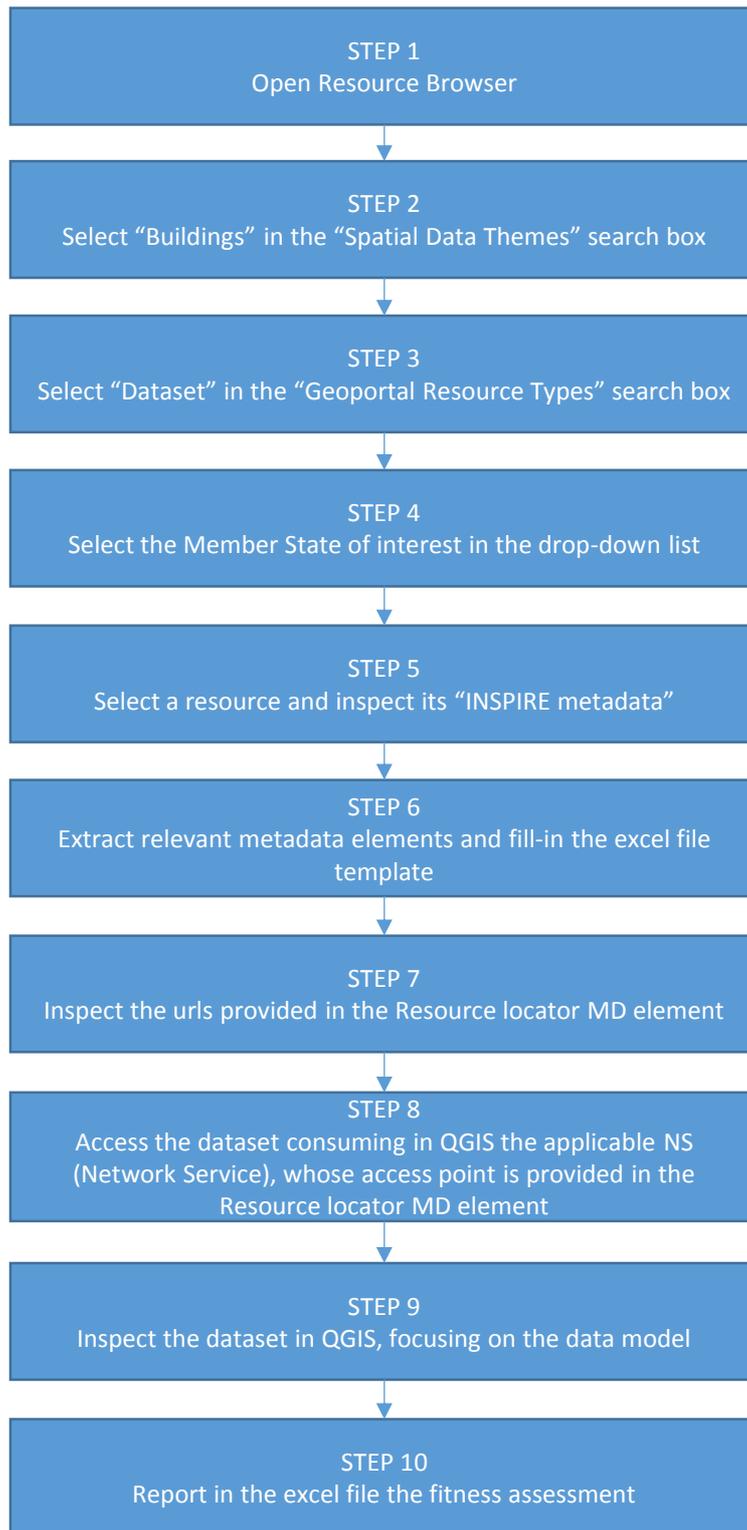


Figure 8: Steps of the methodology

Figure 8 shows the step by step methodology followed. The first four steps relate to the connection to the resource browser and the selection of the search criteria in the fields "Spatial Data Themes", "Geoportal Resource Types" and "Member States". The other steps are explained more in detail below.

Step 5

This step refers to the analysis of the INSPIRE metadata of a given resource found by the search. For this report, only a few of the several hundreds of datasets returned by the search have been selected for inspection (eight in total). This sampling was due to the time consuming activities required by each inspection and also in order to complete the overall activity in a reasonable time. The selection criteria adopted for the sampling consisted in the identification of potentially relevant datasets using the information contained in the two metadata elements "resource title" and "resource abstract".

Indeed, a reading of the resource abstract sometimes led to the exclusion of datasets from further inspection, e.g. points of interests representing historical buildings, complex datasets containing topographic reference data including buildings footprints mixed to many other layers.

At other times, a quick inspection of the URL provided in the "resource locator" metadata element¹⁷ was needed in order to decide to proceed with a deeper inspection or to disregard the dataset.

Language issues were often encountered. In some cases the text provided in the original metadata language did not allow the translator available in the INSPIRE geoportal to deliver an English translation clear enough. In other cases the URL provided in the resource locator metadata element was linked to a website not available in English and therefore not usable for the scope of this activity.

Step 6

The following INSPIRE metadata elements were considered relevant to the scope of this activity and therefore extracted from the Geoportal:

- Resource title
- Resource abstract
- Lineage
- Conditions applying to access and use
- Limitations on public access
- Resource locator

An excel file template was created to store the relevant information for each dataset inspected (see *Table 2*).

Besides the six fields used to store the information contained in the six metadata elements listed above, further fields were added in the excel file table to store the following information (in step 10):

- Member State;
- Geographic coverage (e.g. name of the region/area covered);
- Conformance to INSPIRE data models, i.e. to IR 1089¹⁸ [7] (extracted from "Conformity" metadata element);

¹⁷This metadata element provides "the link(s) to the resource and/or the link to additional information about the resource. The value domain of this metadata element is a character string, commonly expressed as uniform resource locator (URL)"

¹⁸ INSPIRE Implementing Rule on interoperability of spatial data sets and services <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02010R1089-20131230&from=EN>

- Typology of resource locator (in addition to the URL, stored in another separate field), e.g. WFS, WMS, ATOM, generic geoportal URL;
- Dataset applicable/not-applicable to the objectives of the activity reported in this document (this field is filled-in after full inspection of the dataset, including, for some of them, processing in a Geographic Information System (GIS) software (in this work, QGIS was used¹⁹);
- Additional remarks useful for the objectives of the activity reported in this document.

Steps 7, 8 and 9

From the metadata accessible in the INSPIRE geoportal it is possible to obtain information to either download the dataset (by means of WFS or ATOM protocols) or to view it as a map (by means of WMS protocol), or both. In general, this activity has been focused on the downloadable datasets, because they can be further analysed and processed in a GIS client in an easy way. However, at a close inspection of some datasets that were only accessible as maps (WMS), their relevance to the scope of this activity was detected and therefore a deeper analysis was made. In this latter case, focus was given to datasets whose corresponding view service (WMS) had the GetFeatureInfo capability enabled (i.e. clicking on a feature shown on the map, the corresponding attributes appear in a pop-up window).

For sake of completeness, also datasets assessed as “Not applicable” after the inspection were documented in the template.

For two of the eight inspected datasets a deeper analysis of the data model was carried out in Step 9 and a separate template was filled out, providing an English translation of the relevant attributes, in order to facilitate a comparison with the INSPIRE BU data model. This deeper analysis was restricted only to the two datasets containing more attributes with respect to the others.

¹⁹ QGIS (www.qgis.org) is one of the most popular open source GIS desktop client tool

4. Summary of the findings

Table 1 and *Figure 9* provide the results of the searches carried out on the INSPIRE geoportal at two different dates.

From *Table 1* it is evident that at the time of the first search the Spanish metadata catalogue was not working properly and that only a subset of the German metadata were harvested.

As explained above, only eight datasets were analysed and their full details are provided in *Table 2*. The content of the cells of most of the columns has been copied/pasted from the corresponding metadata elements. In order to make readable the whole content, the table has been formatted splitting the columns into two blocks, repeating the first column with the dataset ID in each block.

In *Table 3* and in *Table 4* the data models related to the datasets found for The Netherlands and Italy are shown, respectively. Even though they are not conformant to the INSPIRE data models, they were selected because they have several attributes relevant to energy efficiency purposes.

Table 1: Distribution of number of BU datasets per MS at different dates

Country	N. of datasets harvested on 2015-08-04 at 14:50	N. of datasets harvested on 2015-09-08 at 11:16
AT	7	17
BE	7	14
CZ		1
DE	121	246
EE	2	2
ES	1	222
FI	67	66
FR	168	202
HR	2	3
HU	1	1
IE	1	1
IS	3	3
IT	1	1
LI	1	2
LV	5	5
NL	2	1
NO	11	11
PL	19	19
PT	13	13
RO	9	7
SE	7	10
SK	3	4
SL	2	2
UK	4	3

Total

457

856

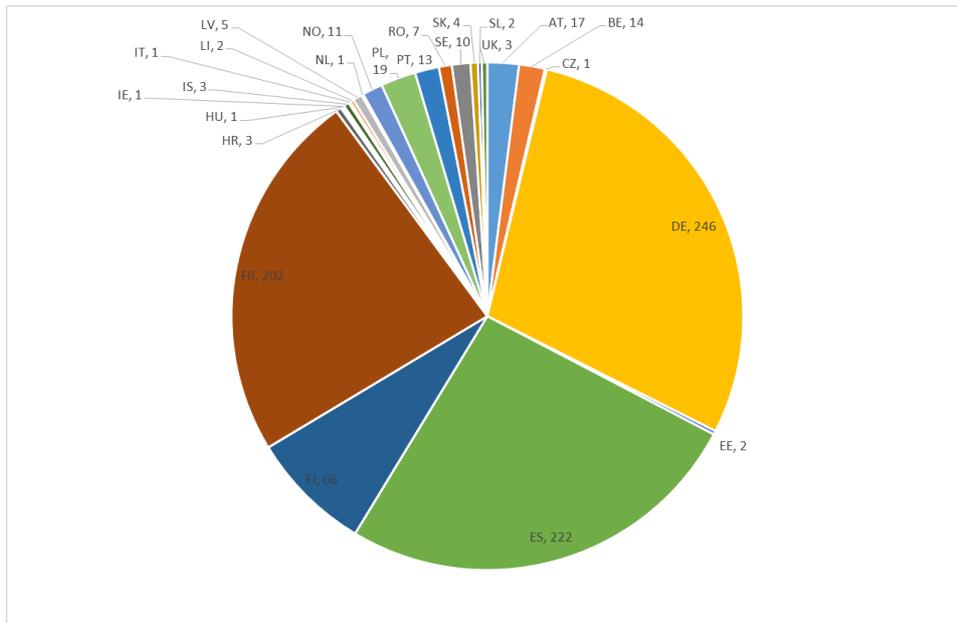


Figure 9: Distribution of number of BU datasets per MS (on 8 September 2015)

Table 2: Details of the INSPIRE metadata elements of the eight inspected datasets

Dataset ID	MS	Conformance to 1089	Region/area/coverage	Resource title	Resource abstract	Lineage
1	FR		Bretagne	Inventaire du patrimoine breton	The corpus brings together buildings and movable objects identified by the Service's inventory of heritage since 1997. It contains also some from scanned files of previous censuses. Folders have been created according to an XML format within the formalism of the DTD "CI", as it is advocated by the Ministry of Culture (http://www.inventaire.culture.gouv.fr/).	Given historically acquired on Scan 25 or leaves cadastral georeferenced by our care. Now, the acquisition from the digital cadastre provided by the Directorate General of taxes is the rule. Subsequently, conversion to the shape format resulted in the passage in type point all data (point or polygon).
2	IT		Provincial capitals	Built (edificato) of provincial capitals.	Built (edificato) of provincial capitals. The provincial capitals represented are those for the year 2003.	Data derived from the analysis and interpretation of technical cartography.
3	NL		Whole country	Buildings	This publication was created specifically to meet the theme INSPIRE guidelines for buildings. It concerns building contours, constructive elements and spatial barriers. This concerns non-harmonised data from the basic registration basic registration Addresses and buildings (BAG) and Topography (TOP10NL).	Data from BAG and TOP10NL

Dataset ID	Conditions Applying To Access And Use	Limitations On Public Access	Resource locator (1)	Resource locator (2)	Applicable/NA	Remarks
1			1. Display this layer in the simple Viewer 2. WFS	http://kartenn.region-bretagne.fr/sviewer/?layers=rb:inventaire_pa_trimoine http://ows.region-bretagne.fr/geoserver/rb/wfs?SERVICE=WFS&REQUEST=GetCapabilities	NA	1. Out of scope (referred to historical buildings and to movable objects) 3. Few attributes 2. High degree of non-conformance
2	This dataset is licensed under a Creative Commons Attribution-ShareAlike 3.0 Italy. Anyone wishing to reproduce or publish the dataset containing processed has the obligation to respect the restrictions established by the license.	Public data unclassified	1. WMS 2. GN Viewer 3. WFS	http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/WMS_v1.3/Vettoriali/Edifici.map http://www.pcn.minambiente.it/viewer/index.php?services=Edificato_Civici_Capoluoghi http://wms.pcn.minambiente.it/ogc?map=/ms_ogc/wfs/Edifici.map	Applicable	Extremely useful dataset (semantically reach and geometrically accurate), assuming to solve the actual problems in connecting to WFS. Quite poor level of info in MD. Extent inconsistency between GN CSW and viewer. Inconsistency between GN and RNDT CSW searches.
3	No use restriction	No restrictions http://creativecommons.org/publicdomain/mark/1.0/deed.nl unclassified	1. WMS (BAG) 2. WFS (BAG) 3. ATOM GML (top10NL) 4. WMS (top10NL)	http://geodata.nationaalgeoregister.nl/bag/wms? http://geodata.nationaalgeoregister.nl/bag/wfs? http://geodata.nationaalgeoregister.nl/top10nl/atom/top10nl.xml http://geodata.nationaalgeoregister.nl/top10nl/v2/wms?	Applicable	3 million of buildings (geometry, height class, status)

Dataset ID	MS	Conformance to 1089	Region/area/coverage	Resource title	Resource abstract	Lineage
4	EE		Whole country	Database of topography in the Estonian-buildings	Database of Estonian topography (ETAK) buildings of ruumiandmekogumi form the ETAK reaalsusmudeli "buildings" group of real-world phenomena, which is classified as a nähtusklassideks: the buildings, kõrgrajatised, other facilities, underground buildings, fencing. -in-the-Nähtusklassi > buildings properties are: building type, the address of the building. Nähtusklassi kõrgrajatised attributes are: kõrgrajatisse type the height of the kõrgrajatisse, navigatsioonimärk, kõrgrajatisse, relationship building, the building of the ETAK_ID. Nähtusklassi other facilities the properties are: other type of facility, navigatsioonimärk. Nähtusklassi underground buildings property is: land-base building type. Nähtusklassi guards properties are: type of barrier, piirdel Woody taxa. -in-the-> Estonian Foundation of and maintenance of the database, the topography is based on a database, the topography of the Estonian "Statute" and "Topographic data capture procedures and the general meaning of owning the topographical phenomena". ---> Main andmeallikateks are: aeropildistamise and laserskaneerimise, the data obtained by, or their derivatives, including the Ortho-photos; teabevaldajate in the course of the Exchange by the transmitted data; mõõdistuste made to the controller in the data; as a result of the surveys, and other mõõdistamiste, including from public databases and other sources of data.	Ruumiandmekogumi "database of Estonian topograafi-buildings of" the quality of the data corresponds to the "Topographic data kaardistusjuhendile" (http://geoportaal.maaamet.ee/docs/ETAK/ETAK_juhend2013.pdf)
5	DE	Declared conformant to 1089	Saxony	Digital 3D, free State of Saxony	The digital 3D three-dimensional captured building. Each building model is differentiated according to the level of detail, the level of detail (LoD).	There is a nationwide digital 3D. Mostly, the buildings were recorded in the LoD2. The remaining buildings are in the LoD1.

Dataset ID	Conditions Applying To Access And Use	Limitations On Public Access	Resource locator (1)	Resource locator (2)	Applicable/N A	Remarks
4	The disclosure of the data, and the grant of use takes place through the online services. For more information, see http://geoportaal.maaamet.ee/est/Andmete-tellimine/Digitaalsete-aluskaartide-topograafiliste-ruumiandmete-tellimine-p23.html	There are no restrictions on the	geoportal url	http://geoportaal.maaamet.ee/est/Andmed-ja-kaardid/Topograafilised-andmed/Eesti-topograafia-andmekogu-p79.html	?	It was not possible to assess data content and quality, because no download service is available and there are no building data listed in the WMS list
5	There are no conditions.	unclassified	1. geoportal url 1 2. geoportal url 2 3. geoportal url for download	http://www.landesvermessung.sachsen.de/nhalt/produkte/dhm/3dm/3dm.html http://www.landesvermessung.Sachsen.de/nhalt/Produkte/DHM3dm/3dm_best.html http://www.landesvermessung.Sachsen.de/nhalt/Produkte/DHM3dm/3dm_download.html	Partially applicable	MD reports conformance w.r.t. IR 1089, but the gml target schema is citygml instead of buildings

Dataset ID	MS	Conformance to 1089	Region/area/coverage	Resource title	Resource abstract	Lineage
6	DE	Declared conformant to 1089	City of Hamburg	Digital map 1: 5000 Hamburg	Floor plan loyalty figure of the Hamburg State area. Card Foundation is the official land registry information system (ALKIS - content reduced), which is supplemented with topographic content and information. The DK5 is the digital edition of the former German base map (DGK) 1:5000. It serves the economy, administration and planning.	The digital map 1: 5000 is part of basic geodata in Hamburg.
7	PL	Declared conformant to 1089	Whole country (??)	Buildings	A collection of Buildings was formed as a result of the harmonization and integration of the database objects that contains Topograficznych objects, including buildings and other structures. The data have been restated in accordance with the model INSPIRE in terms of topic 3.2 described in the specification "D 2.8. III. 2 Data Specification on Buildings-Technical Guidelines".	Źródłowe data BDOT10k
8	ES		Navarra Region	Buildings (visible)	Layer containing the buildings of Navarre excluding the underground constructions.	Information provided by the producer

Dataset ID	Conditions Applying To Access And Use	Limitations On Public Access	Resource locator (1)	Resource locator (2)	Applicable/NA	Remarks
6	Germany - data license attribution - version 2.0; < a href = "https://www.govdata.de/dl-de/by-2-0" > https://www.govdata.de/dl-de/by-2-0 < /a >. DL-de-by-2.0; Attribution: "Free and Hanseatic City of Hamburg, Landesbetrieb geoinformation and surveying, 2014"	No Hamburg measurement Act (HmbVermG) of 20 April 2005 Hamburg geo data infrastructure Act (HmbGDIG) Hamburg transparency law (HmbTG)	1. jpg 2. jpg 3. zip 4. PDF 5. geoportal 6. WMS 7. WMS 8. WMS	1. http://www.geoportal-Hamburg.de/hmdk_daten/DK5_300dpi.jpg 2. http://www.geoportal-Hamburg.de/hmdk_daten/DK5_72dpi.jpg 3. http://Daten-Hamburg.de/geographie_geologie_geobasisdaten/Digitale_Karte_5000/Digitale_Karte_5000_HH_2014-07-07.zip 4. http://Daten-Hamburg.de/geographie_geologie_geobasisdaten/Digitale_Karte_5000/Digitale_Karte_5000_HH_Legende_2014-09-11.PDF 5. http://www.metaver.de/trefferanzeige?docuid=70B957B1-223A-406D-991B-17775FAED3A1 & plugid = /ingrid group: dsc-scripted-HH & docid = 2075 6. http://geodienste-Hamburg.de/HH_WMS_Kombi_DISK_GB?request=GetCapabilities & SERVICE = WMS 7. http://geodienste-Hamburg.de/HH_WMS_Geobasisdaten?request=GetCapabilities & SERVICE = WMS 8. http://geodienste-Hamburg.de/HH_WMS_DK5?request=GetCapabilities & SERVICE = WMS	NA	Link 3 allows to download 512MB of raster tiles (png + pgw couples) Link 8 points to a wms exposing a raster image with the building contours and no GetFeatureInfo

Dataset ID	Conditions Applying To Access And Use	Limitations On Public Access	Resource locator (1)	Resource locator (2)	Applicable/NA	Remarks
7	<p>Entity permissions on a shared resource materials it use specifies the license issued by the authority in providing these materials in accordance with article 4. 40 c of the Act of 17 May 1989. Geodetic and cartographic law. The fee for the sharing of resource materials is the product of the respective basic rate, number of units and the weightings or the sum of such products. The amount of the basic rate in respect of the relevant units, the amount of the correction factors and the rules for determining these coefficients, as well as the detailed rules for calculating the amount of the fee set out in the annex to the law.</p> <p>Covered by the collection infrastructure and spatial data services, carried out by the Administration, subject to the provision of nieodpłatnemu different administrations to the extent necessary for the execution of public tasks by them.</p> <p>By sharing the harvest provisions of article administrations. 15 of the law of 17 February 2005 on the informatization for bodies pursuing public tasks shall apply mutatis mutandis (article 14, paragraph 1 and paragraph 2 of the law of 4 March 2010 for the infrastructures for spatial information.</p>	license unclassified	<p>Download service that lets you download INSPIRE buildings for Polish territory and the data subject in accordance with the specifications of the ELF. The service uses the Atom interface version 1.0 and OpenSearch version 1.1.</p>	<p>http://mapy.geoportal.gov.pl/wss/service/ATOM/httpauth/atom/BU</p>	NA	From the link provided it is not possible to access any data

Dataset ID	Conditions Applying To Access And Use	Limitations On Public Access	Resource locator (1)	Resource locator (2)	Applicable/N A	Remarks
8	<p>This layer is released under the terms of the license Creative Commons-Attribution (CC-by3.0). It will be necessary to name the source of origin of the information in the following manner: "geographical information owned by the Government of Navarre." Department of Economics, finance, industry and employment. Free public access: [http://idena.navarra.es] "more information about the terms of use at: [http://www.navarra.es/home_es/Open-Data/Datos-abiertos/Terminos-de-uso-de-Open-Data-Navarra/] [http://creativecommons.org/licenses/by3.0/]"</p>	license unclassified	geoportal url	http://idena.navarra.es/navegar/?layerid=DIR_ECC_Pol_Edifaltura	Applicable	<p>From the geoportal it is possible to download a dataset corresponding to the geoportal viewer extent (if too large, it is limited to a portion of 1 square Km). One of the few attributes is the building height.</p>

Table 3: Data model of the NL inspected dataset

Attribute (dutch)	Attribute (EN)	example value (dutch)	example value (EN)
gml_id	gml_id	nl.top10nl.117782721	
identificatie	identifier	nl.top10nl.117782721	
brontype	source type	top10vector	
bronbeschrijving	source description	Digitaal bestand met gecodeerde vectoren. Deze geven tezamen de topografie van Nederland weer op de schaal 1:10.000. Voorloper van Top10NL.	
bronactualiteit		2005-01-01	
bronnauwkeurigheid	source accuracy	2	
dimensie	dimension	2D	
objectBeginTijd	object start time	2008-11-24T00:00:00.000	
versieBeginTijd	version start time	2008-11-24T00:00:00.000	
visualisatieCode	visualization code	13000	
tdnCode		170	
hoogteklasse	height class	laagbouw	Low-rise
hoogteniveau	height level	0	
status	status	in gebruik	in use
typeGebouw	type of buildings	(1:religieus gebouw)	
naamNL	nameNL	NULL	
naamFries		NULL	

Table 4: Data model of the IT inspected dataset

Attribute (IT)	Attribute (EN)	example value
objectid_1		
objectid		
id_edifici		
quota_suolo		55.7
quota_gronda		65.4
altezza	building height	9.7
tipologia	typology	4
area_		3279.86
perimetro		225.3
codice_istat	istat code	8035
provincia	province	REGGIO EMILIA
regione	region	EMILIA ROMAGNA

5. Analysis of the inspected datasets in a GIS environment

In the Step 9 of the methodology schematized in *Figure 8*, a QGIS project has been created in order to test datasets usability in a GIS environment. The inspected datasets have been accessed according to their availability, e.g. adding WFS/WMS layers or simply adding gml files accessed by means of ATOM download services.

The following figures show screenshots relevant to the analysis performed.

Captions contain reference to the dataset examined, as well as information about the particular aspect addressed by the GIS analysis.

The main outcome of the analysis is that accessing meaningful data through network services enables data exploitation, e.g. using GIS clients to process the data in order to extract value added information from them.

On the other hand, the analysis showed the importance to make such meaningful data easily discoverable and accessible, e.g. providing correct metadata.

Moreover, the different data models used by the datasets analysed highlight the potential of adopting a common target model to harmonize the semantic content of heterogeneous data and ultimately to increase data interoperability and usability.

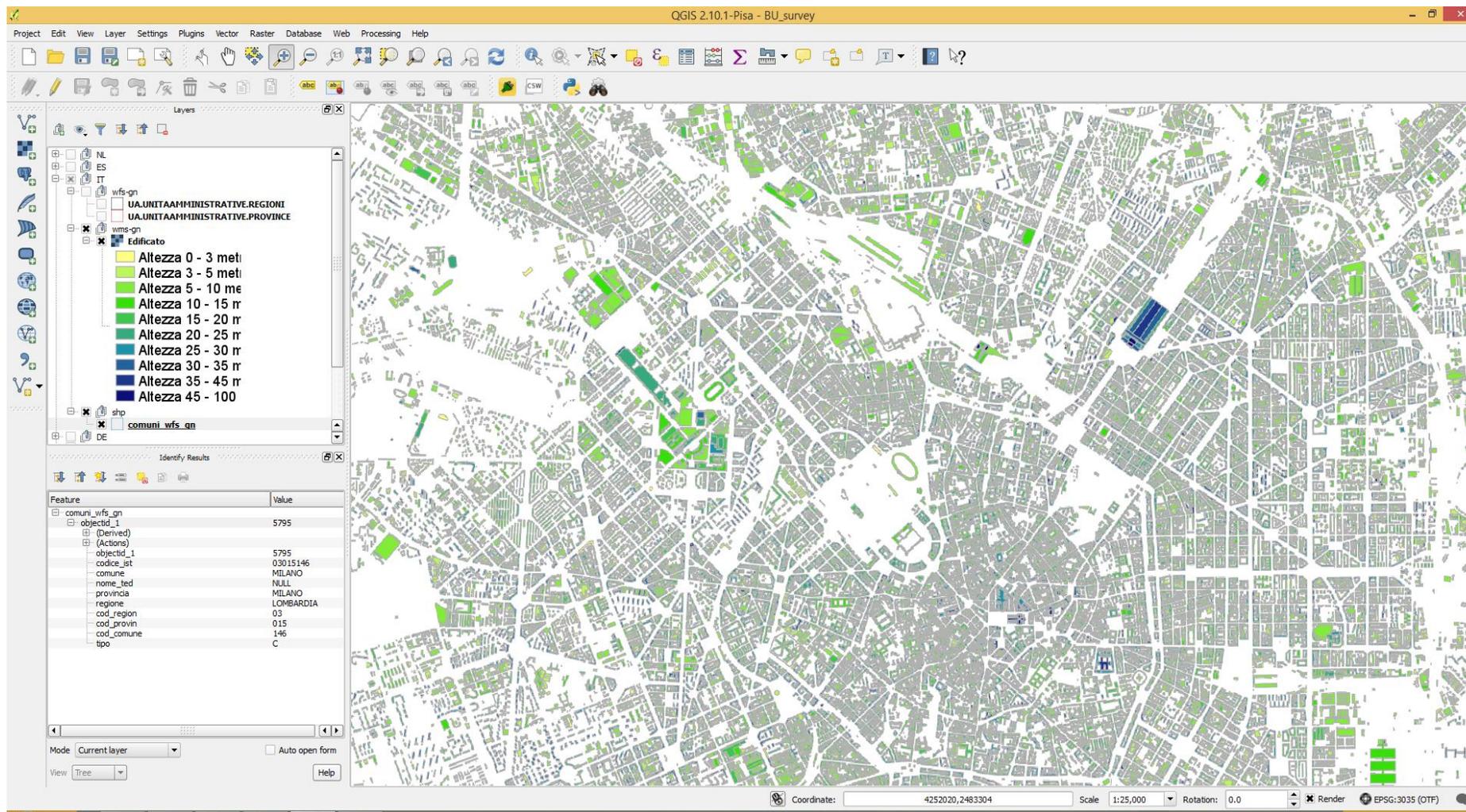


Figure 10: IT dataset (dataset n. 2 in Table 2) published as WMS – scale view 1:25.000, Milan city centre

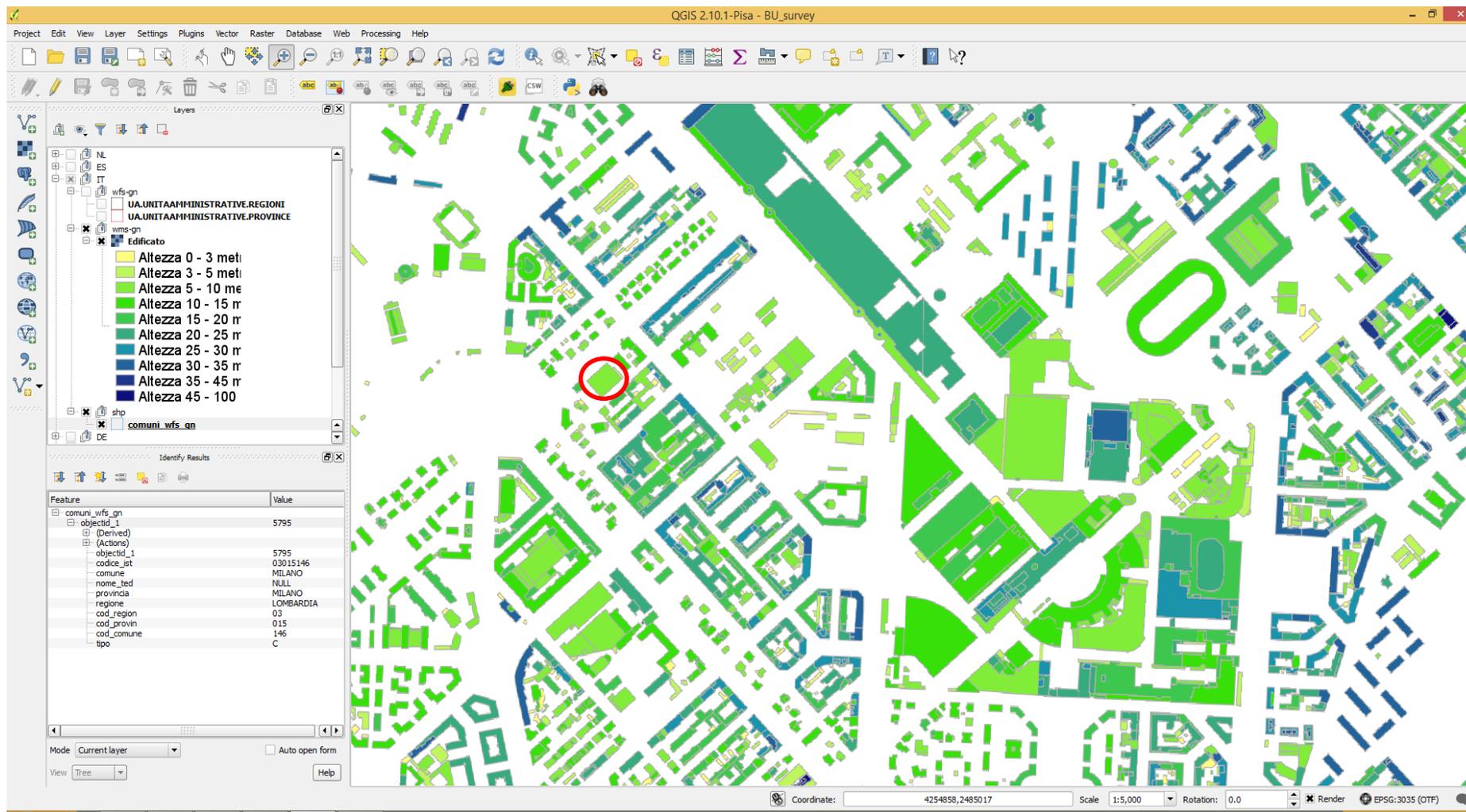


Figure 11: IT dataset (dataset n. 2 in Table 2) published as WMS – scale view 1:5.000, Milan city centre (in the bottom left blue box are visible the attributes of the red-circled building)

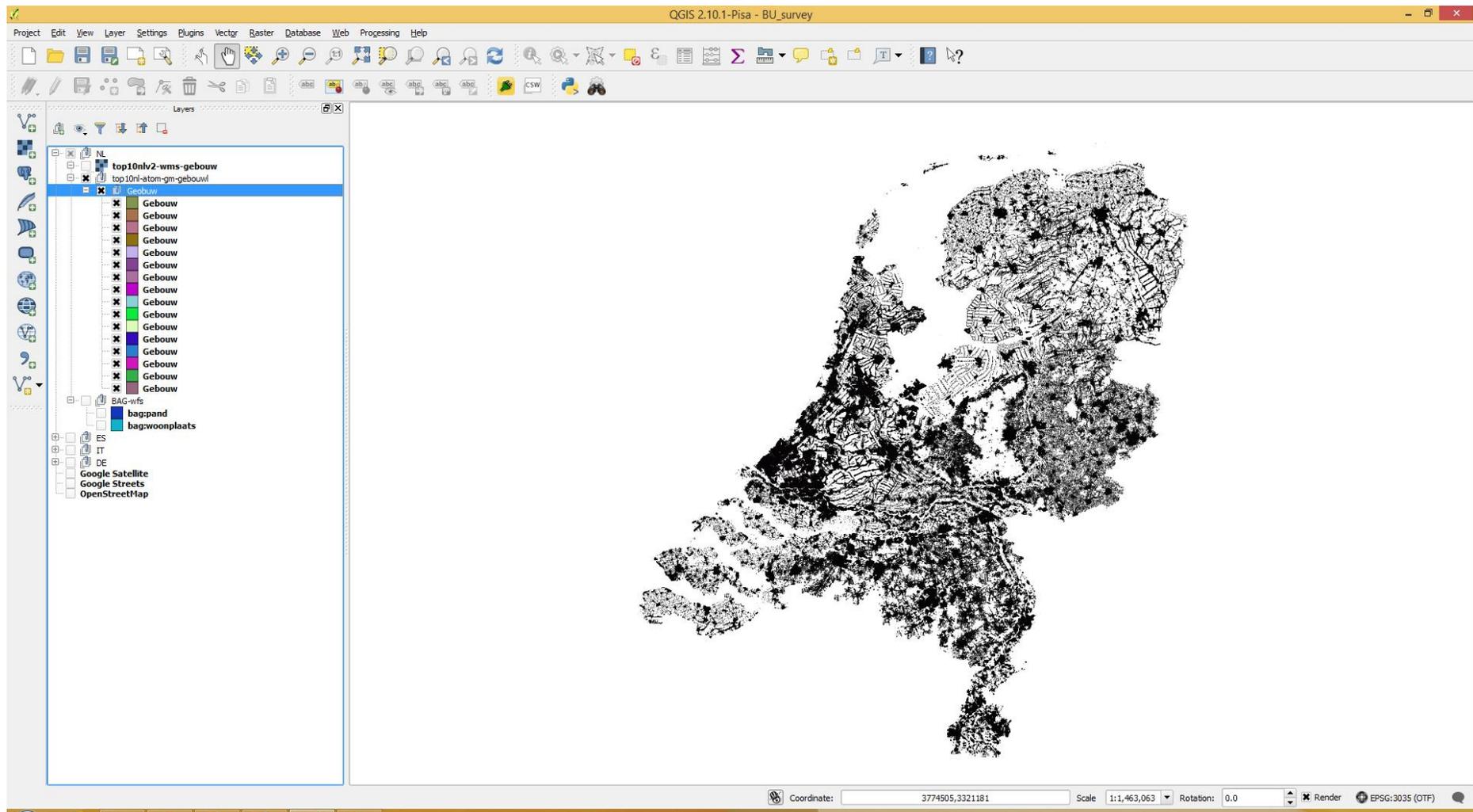


Figure 12: NL dataset (dataset n. 3 in Table 2), consisting of 16 gml files containing 3 million of buildings accessed by means of ATOM download services

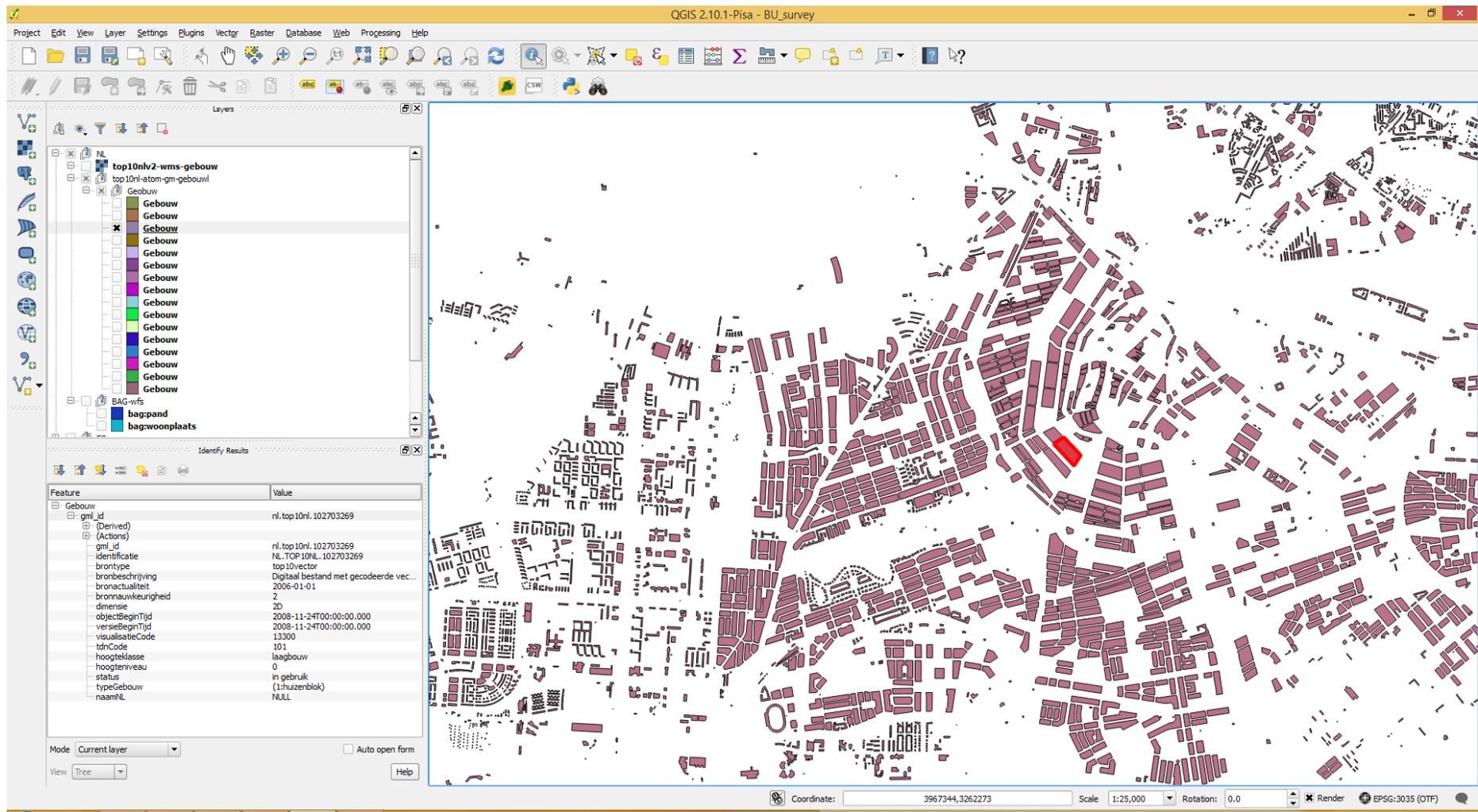


Figure 13: NL dataset (dataset n. 3 in Table 2) - zoomed view 1:25.000 of the city of Amsterdam

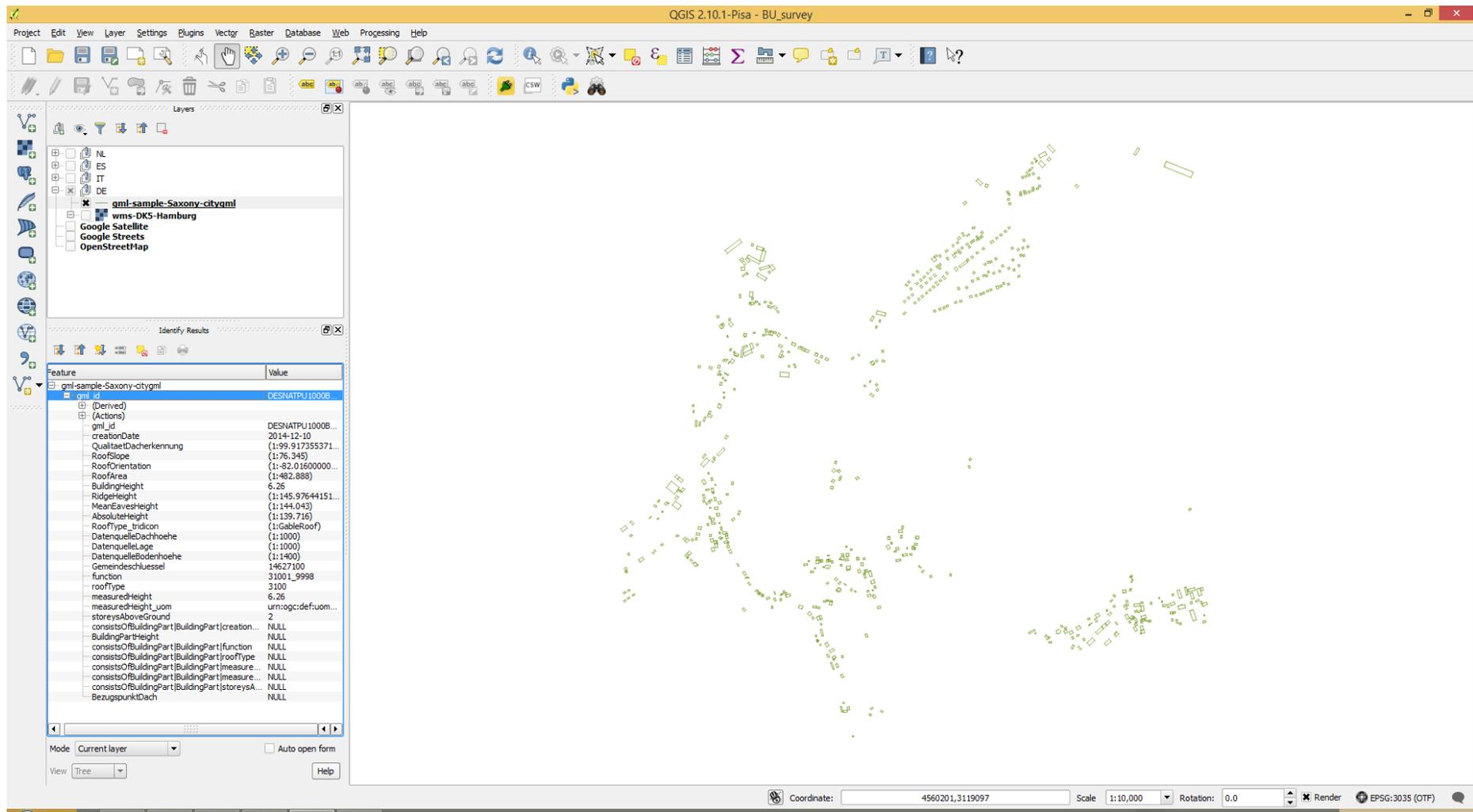


Figure 14: DE dataset (dataset n. 5 in Table 2) - downloaded sample citygml LOD2 of Saxony region

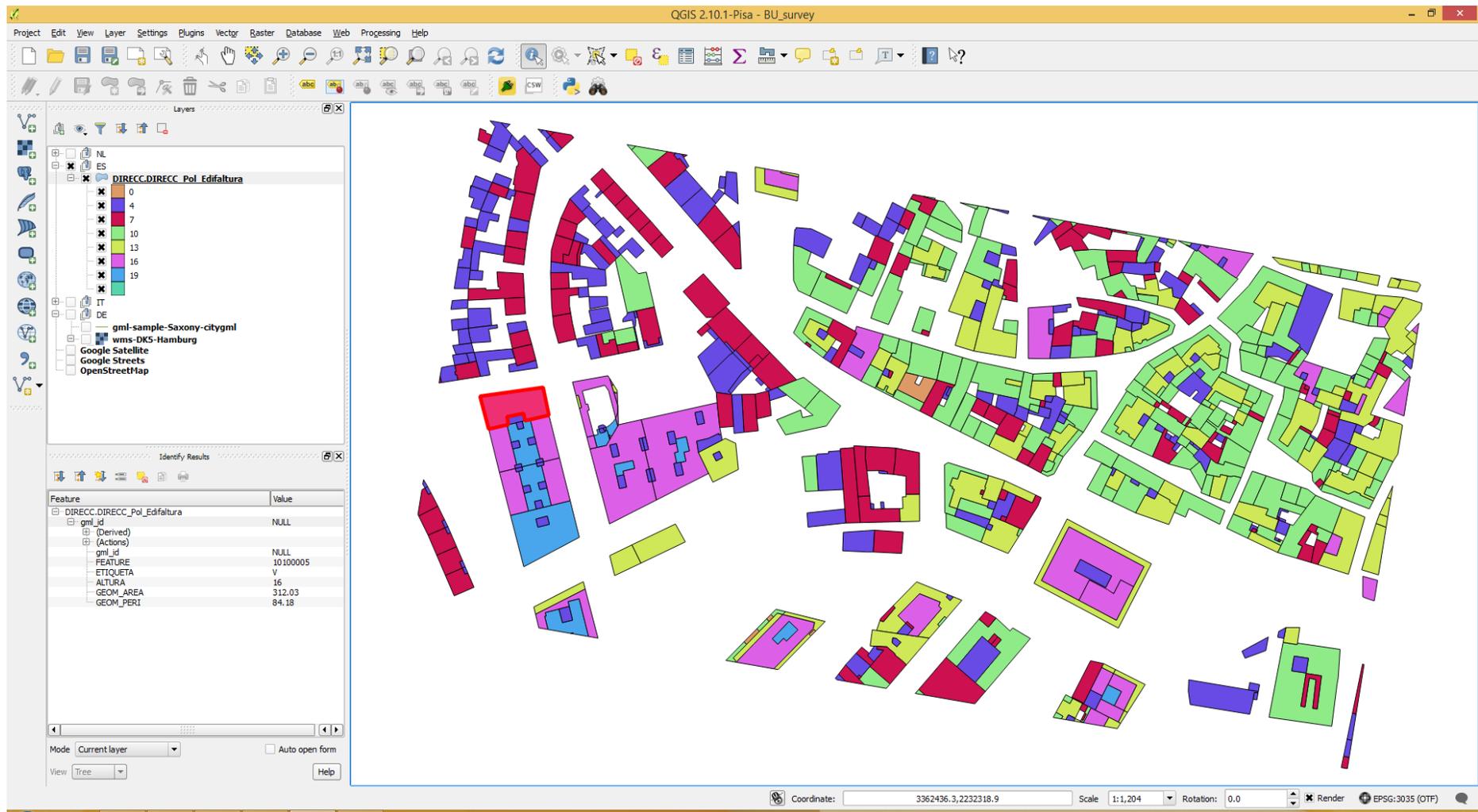


Figure 15: ES GML dataset (dataset n. 8 in Table 2) classified by means of building height attribute

6. Conclusions

The findings presented in this document show the usefulness of the INSPIRE geoportal to discover building-related datasets which fit for the EULF Energy Pilot and the DG Energy's EU Building Stock Observatory purposes.

It is worth to highlight that, coherently with the INSPIRE roadmap, in the INSPIRE geoportal it is possible to find BU related datasets that are not yet conformant to INSPIRE data models; and that the deadline of 2020 requires that Member States will have to make their datasets on Buildings conformant to one of the two core profiles (Buildings2D or Buildings3D), which contain only few attributes relevant to energy policies.

A methodology applied to discover in the INSPIRE geoportal building-related datasets has been described and its results documented, focusing primarily on datasets usability in a GIS environment.

For this report, a sampling mechanism to select a small number of datasets (among the several hundreds discovered in the INSPIRE geoportal) to be further inspected has been adopted.

Even though the datasets inspected cannot be considered fully representative of all the building related datasets present in the INSPIRE geoportal, they showed a still poor level of harmonization across Europe (coherently with the INSPIRE roadmap). However the analyses performed in a GIS environment evidenced that INSPIRE mechanisms to harmonise Buildings related datasets according to semantically rich data models shared by all MS and to make this harmonised datasets accessible through WFS download services, can strongly support energy policies.

This support will be effective especially if the INSPIRE datasets (at building level) will be elaborated in order to obtain aggregated indicators at local, regional or national level. In its first version the EU Building Stock Observatory will collect national data only. However, this tool could evolve to include sub-national data, and then INSPIRE could be an important source of information.

As discussed above, the harmonised building datasets have to be accessible by the end of 2020 so it would be appropriate to continue the monitoring of the datasets made available, also to start the definition of new possible indicators at local level. The methodology presented in this technical report can be easily reused "as-is" in order to inspect more datasets.

Moreover, some recommendations can be addressed to INSPIRE implementers working in energy thematic communities, in order to better address their efforts in fulfilling on-going and future INSPIRE obligations:

- to properly extend existing INSPIRE BU data models in order to take into account the data modelling requirements coming from Energy policies, considering both existing similar activities (e.g. citygml Energy ADE initiative and GeoSmartCity project) and the rules for INSPIRE Data Specifications extension;
- to use these extended data model as target data model in as many as possible data harmonization processes related to energy efficiency of buildings, in order to improve data interoperability at EU level;
- to use the voidable properties of the INSPIRE data models only when the relevant information is actually not available;

- to carefully compile relevant metadata elements, such as lineage and resource locator, in order to document and share relevant data processing activities and therefore facilitate their reuse.

Concluding, the activities described in this report have been useful to better understand the role of the INSPIRE buildings datasets in support of energy efficiency policies, and in particular as a source of data for the Building Stock Observatory. Next steps would include monitoring the availability of such datasets at the level of each Member States and the analysis of their usability, in the course of INSPIRE implementation.

References

1. European Commission, Directive 2007/2/EC establishing and Infrastructure for Spatial Information in the European Community, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:en:PDF>
2. Bloem J., Boguslawski R., Borzacchiello M.T., Cipriano P., Kona A., Martirano G., Maschio I., Pignatelli F., Location data for buildings related energy efficiency policies, JRC Technical Report, 2015, Publications Office of the European Union, ISBN 978-92-79-50572-0 (pdf), <http://publications.jrc.ec.europa.eu/repository/handle/JRC96946>
3. INSPIRE Thematic Working Group Buildings, D2.8.III.2 INSPIRE Data Specification on Buildings – Technical Guidelines, 2013, European Commission Joint Research Centre, http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_BU_v3.0.pdf
4. European Commission, Energy Performance of Buildings Directive, 2010, http://eur-lex.europa.eu/legal-content/EN/ALL/;ELX_SESSIONID=FZMjThLLzfxmmMCQGp2Y1s2d3TjwD8QS3pqdkhXZbwqGwlgY9KN!2064651424?uri=CELEX:32010L0031
5. European Committee for Standardization, EN 15603:2008 - Energy performance of buildings. Overall energy use and definition of energy ratings
6. Drafting Team "Data Specifications", D2.5: Generic Conceptual Model - Version 3.4, 2014, Drafting Team "Data Specifications", http://inspire.ec.europa.eu/documents/Data_Specifications/D2.5_v3.4.pdf
7. European Commission, 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 INSPIRE Implementing Rule on interoperability of spatial data sets and services, 2010, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02010R1089-20131230&from=EN>

List of abbreviations and definitions

Acronym	Description
BU	Buildings
CP	Cadastral Parcels
DS	Data Specifications
GIS	Geographic Information System
IR	Implementing Rule
MD	Metadata
MS	Member State
NS	Network Service
UML	Unified Modelling Language
URL	Uniform Resource Locator
WFS	Web Feature Service
WMS	Web Map Service

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Figures 2, 3, 4 and 5 have been extracted from the INSPIRE Data Specification on Buildings²⁰

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http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_BU_v3.0.pdf

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