5 Data content and structure

5.1 Application schemas – Overview

5.1.1 Application schemas included in the IRs

Articles 3, 4 and 5 of the Implementing Rules lay down the requirements for the content and structure of the data sets related to the INSPIRE Annex themes.

IR Requirement
Article 4
Types for the Exchange and Classification of Spatial Objects

1. For the exchange and classification of spatial objects from data sets meeting the conditions laid down in Article 4 of Directive 2007/2/EC, Member States shall use the spatial object types and associated data types, enumerations and code lists that are defined in Annexes II, III and IV for the themes the data sets relate to.

2. Spatial object types and data types shall comply with the definitions and constraints and include the attributes and association roles set out in the Annexes.

3. The enumerations and code lists used in attributes or association roles of spatial object types or data types shall comply with the definitions and include the values set out in Annex II. The enumeration and code list values are uniquely identified by language-neutral mnemonic codes for computers. The values may also include a language-specific name to be used for human interaction.

The types to be used for the exchange and classification of spatial objects from data sets related to the spatial data theme Land Cover are defined in the following application schemas:

- LandCoverNomenclature application schema
- LandCoverVector application schema
- LandCoverRaster application schema

The application schemas specify requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc.

NOTE The application schemas presented in this section contain some additional information that is not included in the Implementing Rules, in particular multiplicities of attributes and association roles.

TG Requirement 1	Spatial object types and data types shall comply with the multiplicities defined for the attributes and association roles in this section.

An application schema may include references (e.g. in attributes or inheritance relationships) to common types or types defined in other spatial data themes. These types can be found in a sub-section called “Imported Types” at the end of each application schema section. The common types referred to from application schemas included in the IRs are addressed in Article 3.

IR Requirement
Article 3
Common Types

Types that are common to several of the themes listed in Annexes I, II and III to Directive 2007/2/EC shall conform to the definitions and constraints and include the attributes and association roles set out in Annex I.

NOTE Since the IRs contain the types for all INSPIRE spatial data themes in one document, Article 3 does not explicitly refer to types defined in other spatial data themes, but only to types defined in external data models.

Common types are described in detail in the Generic Conceptual Model [DS-D2.7], in the relevant international standards (e.g. of the ISO 19100 series) or in the documents on the common INSPIRE models [DS-D2.10.x]. For detailed descriptions of types defined in other spatial data themes, see the corresponding Data Specification TG document [DS-D2.8.x].

5.1.2 Additional recommended application schemas

In addition to the application schemas listed above, the following additional application schemas have been defined for the theme *Land Cover*:

- LandCoverExtension application schema.

These additional application schemas are not included in the IRs. They typically address requirements from specific (groups of) use cases and/or may be used to provide additional information. They are included in this specification in order to improve interoperability also for these additional aspects and to illustrate the extensibility of the application schemas included in the IRs.

Recommendation 1	Additional and/or use case-specific information related to the theme *Land Cover* should be made available using the spatial object types and data types specified in the application schema LandCoverExtension. These spatial object types and data types should comply with the definitions and constraints and include the attributes and association roles defined in this section. The enumerations and code lists used in attributes or association roles of spatial object types or data types should comply with the definitions and include the values defined in this section.

5.2 Basic notions

This section explains some of the basic notions used in the INSPIRE application schemas. These explanations are based on the GCM [DS-D2.5].

5.2.1 Notation

5.2.1.1. Unified Modeling Language (UML)

The application schemas included in this section are specified in UML, version 2.1. The spatial object types, their properties and associated types are shown in UML class diagrams.

NOTE For an overview of the UML notation, see Annex D in [ISO 19103].

The use of a common conceptual schema language (i.e. UML) allows for an automated processing of application schemas and the encoding, querying and updating of data based on the application schema – across different themes and different levels of detail.

The following important rules related to class inheritance and abstract classes are included in the IRs.

IR Requirement
Article 5
Types

(…)

2. Types that are a sub-type of another type shall also include all this type's attributes and association roles.

3. Abstract types shall not be instantiated.

The use of UML conforms to ISO 19109 8.3 and ISO/TS 19103 with the exception that UML 2.1 instead of ISO/IEC 19501 is being used. The use of UML also conforms to ISO 19136 E.2.1.1.1-E.2.1.1.4.

NOTE ISO/TS 19103 and ISO 19109 specify a profile of UML to be used in conjunction with the ISO 19100 series. This includes in particular a list of stereotypes and basic types to be used in application schemas. ISO 19136 specifies a more restricted UML profile that allows for a direct encoding in XML Schema for data transfer purposes.

To model constraints on the spatial object types and their properties, in particular to express data/data set consistency rules, OCL (Object Constraint Language) is used as described in ISO/TS 19103, whenever possible. In addition, all constraints are described in the feature catalogue in English, too.

NOTE Since "void" is not a concept supported by OCL, OCL constraints cannot include expressions to test whether a value is a *void* value. Such constraints may only be expressed in natural language.

5.2.1.2. Stereotypes

In the application schemas in this section several stereotypes are used that have been defined as part of a UML profile for use in INSPIRE [DS-D2.5]. These are explained in Table 1 below.

Table 1 – Stereotypes (adapted from [DS-D2.5])

Stereotype	Model element	Description
applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
leaf	Package	A package that is not an application schema and contains no packages.
featureType	Class	A spatial object type.
type	Class	A type that is not directly instantiable, but is used as an abstract collection of operation, attribute and relation signatures. This stereotype should usually not be used in INSPIRE application schemas as these are on a different conceptual level than classifiers with this stereotype.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
enumeration	Class	An enumeration.
codeList	Class	A code list.
import	Dependency	The model elements of the supplier package are imported.

voidable	Attribute, association role	A voidable attribute or association role (see section 5.2.2).
lifeCycleInfo	Attribute, association role	If in an application schema a property is considered to be part of the life-cycle information of a spatial object type, the property shall receive this stereotype.
version	Association role	If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general.

5.2.2 Voidable characteristics

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. This does *not* mean that it is optional to provide a value for those properties.

For all properties defined for a spatial object, a value has to be provided – either the corresponding value (if available in the data set maintained by the data provider) or the value of *void.* A *void* value shall imply that no corresponding value is contained in the source spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs.

Recommendation 2 The reason for a *void* value should be provided where possible using a listed value from the VoidReasonValue code list to indicate the reason for the missing value.

The VoidReasonValue type is a code list, which includes the following pre-defined values:

- *Unpopulated*: The property is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the “elevation of the water body above the sea level” has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be ‘Unpopulated’. The property receives this value for all spatial objects in the spatial data set.
- *Unknown*: The correct value for the specific spatial object is not known to, and not computable by the data provider. However, a correct value may exist. For example when the “elevation of the water body above the sea level” *of a certain lake* has not been measured, then the reason for a void value of this property would be ‘Unknown’. This value is applied only to those spatial objects where the property in question is not known.
- *Withheld*: The characteristic may exist, but is confidential and not divulged by the data provider.

NOTE It is possible that additional reasons will be identified in the future, in particular to support reasons / special values in coverage ranges.

The «voidable» stereotype does not give any information on whether or not a characteristic exists in the real world. This is expressed using the multiplicity:

- If a characteristic may or may not exist in the real world, its minimum cardinality shall be defined as 0. For example, if an Address may or may not have a house number, the multiplicity of the corresponding property shall be 0..1.
- If at least one value for a certain characteristic exists in the real world, the minimum cardinality shall be defined as 1. For example, if an Administrative Unit always has at least one name, the multiplicity of the corresponding property shall be 1..*.

In both cases, the «voidable» stereotype can be applied. In cases where the minimum multiplicity is 0, the absence of a value indicates that it is known that no value exists, whereas a value of void indicates that it is not known whether a value exists or not.

EXAMPLE If an address does not have a house number, the corresponding Address object should not have any value for the «voidable» attribute house number. If the house number is simply not known or not

populated in the data set, the Address object should receive a value of *void* (with the corresponding void reason) for the house number attribute.

5.2.3 Enumerations

Enumerations are modelled as classes in the application schemas. Their values are modelled as attributes of the enumeration class using the following modelling style:

- No initial value, but only the attribute name part, is used.
- The attribute name conforms to the rules for attributes names, i.e. is a lowerCamelCase name. Exceptions are words that consist of all uppercase letters (acronyms).

IR Requirement
Article 6
Code Lists and Enumerations

(…)

5) Attributes or association roles of spatial object types or data types that have an enumeration type may only take values from the lists specified for the enumeration type."

5.2.4 Code lists

Code lists are modelled as classes in the application schemas. Their values, however, are managed outside of the application schema.

5.2.4.1. Code list types

The IRs distinguish the following types of code lists.

IR Requirement
Article 6
Code Lists and Enumerations

1) Code lists shall be of one of the following types, as specified in the Annexes:
   a) code lists whose allowed values comprise only the values specified in this Regulation;
   b) code lists whose allowed values comprise the values specified in this Regulation and narrower values defined by data providers;
   c) code lists whose allowed values comprise the values specified in this Regulation and additional values at any level defined by data providers;
   d) code lists, whose allowed values comprise any values defined by data providers.

   For the purposes of points (b), (c) and (d), in addition to the allowed values, data providers may use the values specified in the relevant INSPIRE Technical Guidance document available on the INSPIRE web site of the Joint Research Centre.

The type of code list is represented in the UML model through the tagged value *extensibility*, which can take the following values:

- *none*, representing code lists whose allowed values comprise only the values specified in the IRs (type a);
- *narrower*, representing code lists whose allowed values comprise the values specified in the IRs and narrower values defined by data providers (type b);
- *open*, representing code lists whose allowed values comprise the values specified in the IRs and additional values at any level defined by data providers (type c); and
- *any*, representing code lists, for which the IRs do not specify any allowed values, i.e. whose allowed values comprise any values defined by data providers (type d).

Recommendation 3 Additional values defined by data providers should not replace or redefine any value already specified in the IRs.

NOTE This data specification may specify recommended values for some of the code lists of type (b), (c) and (d) (see section 5.2.4.3). These recommended values are specified in a dedicated Annex.

In addition, code lists can be hierarchical, as explained in Article 6(2) of the IRs.

IR Requirement
Article 6
Code Lists and Enumerations

(…)

2) Code lists may be hierarchical. Values of hierarchical code lists may have a more generic parent value. Where the valid values of a hierarchical code list are specified in a table in this Regulation, the parent values are listed in the last column.

The type of code list and whether it is hierarchical or not is also indicated in the feature catalogues.

5.2.4.2. Obligations on data providers

IR Requirement
Article 6
Code Lists and Enumerations

(….)

3) Where, for an attribute whose type is a code list as referred to in points (b), (c) or (d) of paragraph 1, a data provider provides a value that is not specified in this Regulation, that value and its definition shall be made available in a register.

4) Attributes or association roles of spatial object types or data types whose type is a code list may only take values that are allowed according to the specification of the code list.

Article 6(4) obliges data providers to use only values that are allowed according to the specification of the code list. The “allowed values according to the specification of the code list” are the values explicitly defined in the IRs plus (in the case of code lists of type (b), (c) and (d)) additional values defined by data providers.

For attributes whose type is a code list of type (b), (c) or (d) data providers may use additional values that are not defined in the IRs. Article 6(3) requires that such additional values and their definition be made available in a register. This enables users of the data to look up the meaning of the additional values used in a data set, and also facilitates the re-use of additional values by other data providers (potentially across Member States).

NOTE Guidelines for setting up registers for additional values and how to register additional values in these registers is still an open discussion point between Member States and the Commission.

5.2.4.3. Recommended code list values

For code lists of type (b), (c) and (d), this data specification may propose additional values as a recommendation (in a dedicated Annex). These values will be included in the INSPIRE code list register. This will facilitate and encourage the usage of the recommended values by data providers since the obligation to make additional values defined by data providers available in a register (see section 5.2.4.2) is already met.

Recommendation 4 Where these Technical Guidelines recommend values for a code list in addition to those specified in the IRs, these values should be used.

NOTE For some code lists of type (d), no values may be specified in these Technical Guidelines. In these cases, any additional value defined by data providers may be used.

5.2.4.4. Governance

The following two types of code lists are distinguished in INSPIRE:

- *Code lists that are governed by INSPIRE (INSPIRE-governed code lists).* These code lists will be managed centrally in the INSPIRE code list register. Change requests to these code lists (e.g. to add, deprecate or supersede values) are processed and decided upon using the INSPIRE code list register's maintenance workflows.

  INSPIRE-governed code lists will be made available in the INSPIRE code list register at *http://inspire.ec.europa.eu/codelist/<CodeListName>*. They will be available in SKOS/RDF, XML and HTML. The maintenance will follow the procedures defined in ISO 19135. This means that the only allowed changes to a code list are the addition, deprecation or supersession of values, i.e. no value will ever be deleted, but only receive different statuses (valid, deprecated, superseded). Identifiers for values of INSPIRE-governed code lists are constructed using the pattern *http://inspire.ec.europa.eu/codelist/<CodeListName>*/<value>.

- *Code lists that are governed by an organisation outside of INSPIRE (externally governed code lists).* These code lists are managed by an organisation outside of INSPIRE, e.g. the World Meteorological Organization (WMO) or the World Health Organization (WHO). Change requests to these code lists follow the maintenance workflows defined by the maintaining organisations. Note that in some cases, no such workflows may be formally defined.

  Since the updates of externally governed code lists is outside the control of INSPIRE, the IRs and these Technical Guidelines reference a specific version for such code lists.

  The tables describing externally governed code lists in this section contain the following columns:
  - The *Governance* column describes the external organisation that is responsible for maintaining the code list.
  - The *Source* column specifies a citation for the authoritative source for the values of the code list. For code lists, whose values are mandated in the IRs, this citation should include the version of the code list used in INSPIRE. The version can be specified using a version number or the publication date. For code list values recommended in these Technical Guidelines, the citation may refer to the "latest available version".
  - In some cases, for INSPIRE only a subset of an externally governed code list is relevant. The subset is specified using the *Subset* column.
  - The *Availability* column specifies from where (e.g. URL) the values of the externally governed code list are available, and in which formats. Formats can include machine-readable (e.g. SKOS/RDF, XML) or human-readable (e.g. HTML, PDF) ones.

  Code list values are encoded using http URIs and labels. Rules for generating these URIs and labels are specified in a separate table.

Recommendation 5 The http URIs and labels used for encoding code list values should be taken from the INSPIRE code list registry for INSPIRE-governed code lists and generated according to the relevant rules specified for externally governed code lists.

NOTE Where practicable, the INSPIRE code list register could also provide http URIs and labels for externally governed code lists.

5.2.4.5. Vocabulary

For each code list, a tagged value called “vocabulary” is specified to define a URI identifying the values of the code list. For INSPIRE-governed code lists and externally governed code lists that do not have a persistent identifier, the URI is constructed following the pattern *http://inspire.ec.europa.eu/codelist/<UpperCamelCaseName>*.

If the value is missing or empty, this indicates an empty code list. If no sub-classes are defined for this empty code list, this means that any code list may be used that meets the given definition.

An empty code list may also be used as a super-class for a number of specific code lists whose values may be used to specify the attribute value. If the sub-classes specified in the model represent all valid extensions to the empty code list, the subtyping relationship is qualified with the standard UML constraint "{complete,disjoint}".

5.2.5 Identifier management

IR Requirement
Article 9
Identifier Management

1. The data type Identifier defined in Section 2.1 of Annex I shall be used as a type for the external object identifier of a spatial object.
2. The external object identifier for the unique identification of spatial objects shall not be changed during the life-cycle of a spatial object.

NOTE 1 An external object identifier is a unique object identifier which is published by the responsible body, which may be used by external applications to reference the spatial object. [DS-D2.5]

NOTE 2 Article 9(1) is implemented in each application schema by including the attribute *inspireId* of type Identifier.

NOTE 3 Article 9(2) is ensured if the *namespace* and *localId* attributes of the Identifier remains the same for different versions of a spatial object; the *version* attribute can of course change.

5.2.6 Geometry representation

IR Requirement
Article 12
Other Requirements & Rules

1. The value domain of spatial properties defined in this Regulation shall be restricted to the Simple Feature spatial schema as defined in Herring, John R. (ed.), OpenGIS® Implementation Standard for Geographic information – Simple feature access – Part 1: Common architecture, version 1.2.1, Open Geospatial Consortium, 2011, unless specified otherwise for a specific spatial data theme or type.

NOTE 1 The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear and surface interpolations are performed by triangles.

NOTE 2 The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.2.7 Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

IR Requirement
Article 10
Life-cycle of Spatial Objects

(…)

3. Where the attributes beginLifespanVersion and endLifespanVersion are used, the value of endLifespanVersion shall not be before the value of beginLifespanVersion.

NOTE The requirement expressed in the IR Requirement above will be included as constraints in the UML data models of all themes.

Recommendation 6 If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.2.7.1. Validity of the real-world phenomena

The application schema(s) use(s) the attributes "validFrom" and "validTo" to record the validity of the real-world phenomenon represented by a spatial object.

The attributes "validFrom" specifies the date and time at which the real-world phenomenon became valid in the real world. The attribute "validTo" specifies the date and time at which the real-world phenomenon is no longer valid in the real world.

Specific application schemas may give examples what “being valid” means for a specific real-world phenomenon represented by a spatial object.

IR Requirement
Article 12
Other Requirements & Rules

(…)

3. Where the attributes validFrom and validTo are used, the value of validTo shall not be before the value of validFrom.

NOTE The requirement expressed in the IR Requirement above will be included as constraints in the UML data models of all themes.

5.2.8 Coverages

Coverage functions are used to describe characteristics of real-world phenomena that vary over space and/or time. Typical examples are temperature, elevation, precipitation, imagery. A coverage contains a set of such values, each associated with one of the elements in a spatial, temporal or spatio-temporal domain. Typical spatial domains are point sets (e.g. sensor locations), curve sets (e.g. isolines), grids (e.g. orthoimages, elevation models), etc.

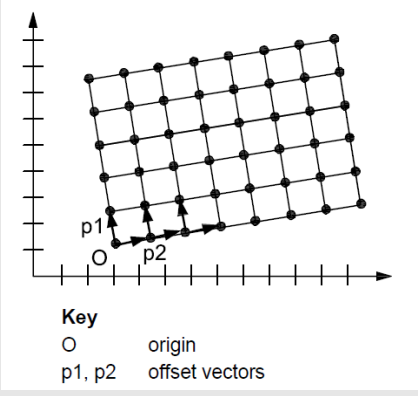
In INSPIRE application schemas, coverage functions are defined as properties of spatial object types where the type of the property value is a realisation of one of the types specified in ISO 19123.

To improve alignment with coverage standards on the implementation level (e.g. ISO 19136 and the OGC Web Coverage Service) and to improve the cross-theme harmonisation on the use of coverages in INSPIRE, an application schema for coverage types is included in the Generic Conceptual Model in 9.9.4. This application schema contains the following coverage types:

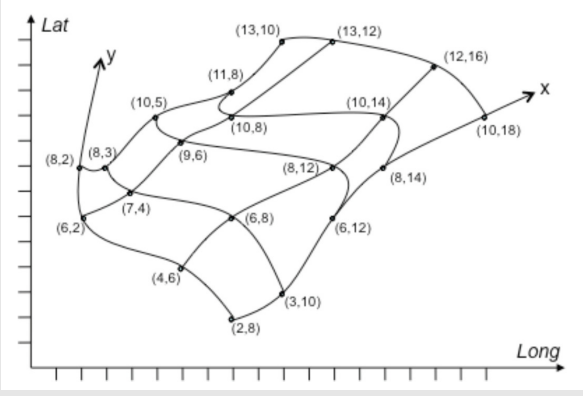
- *RectifiedGridCoverage*: coverage whose domain consists of a rectified grid – a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system (see Figure 3, left).
- *ReferenceableGridCoverage*: coverage whose domain consists of a referenceable grid – a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system (see Figure 3, right).

In addition, some themes make reference to the types TimeValuePair and Timeseries defined in Taylor, Peter (ed.), *OGC® WaterML 2.0: Part 1 – Timeseries, v2.0.0,* Open Geospatial Consortium, 2012. These provide a representation of the time instant/value pairs, i.e. time series (see Figure 4).

Where possible, only these coverage types (or a subtype thereof) are used in INSPIRE application schemas.



(Source: ISO 19136:2007)



(Source: GML 3.3.0)

Figure 3 – Examples of a rectified grid (left) and a referenceable grid (right)

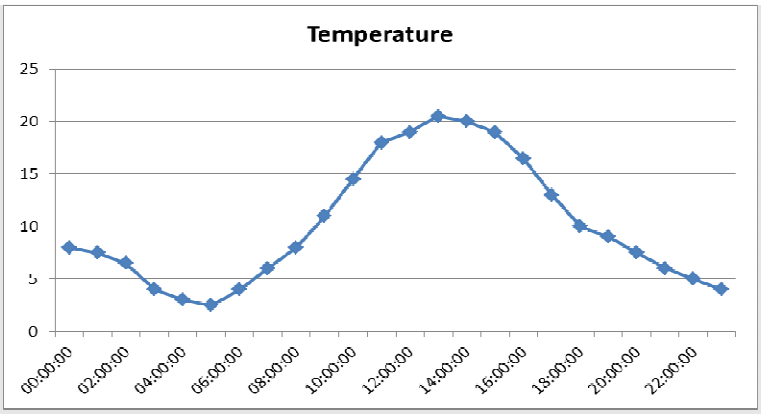


Figure 4 – Example of a time series

5.3 Application schemas for Land Cover

5.3.1 Description

5.3.1.1. Narrative description

5.3.1.1.1. Background

The following section is a narrative description of the INSPIRE Land Cover Data Model using ordinary language and simple diagrammatic illustrations instead of UML. These illustrations and the accompanying text are informal. The purpose is partly to explain the model, partly to assist readers who find UML diagrams difficult to interpret.

Land cover data provides a description of the surface of the earth by its (bio-) physical characteristics.
In the real world, this surface is populated with physical landscape elements (e.g. buildings, roads, trees, plants, water bodies etc.). Many of these elements are themselves spatial features and represented as such by other INSPIRE themes. The physical characteristics of the landscape elements combine to form the land cover of an area. Land cover is in this sense an abstraction and should be perceived as a surface characteristic rather than a collection of features. Mapping and description of land cover is therefore also different from the mapping of the individual landscape elements.

The conceptual starting point of the INSPIRE land cover data model is the “real world” and its (bio-) physical surface of the earth. The surveying, mapping and monitoring of this surface is organized through land cover survey initiatives. A land cover survey initiative is an activity, usually a long-lasting program, carried out by a mandated organization. Examples of land cover survey initiatives are the CORINE Land Cover program (CLC) implemented by the European Environmental Agency (EEA) and the LUCAS area frame survey implemented by Eurostat. Many Member States and regional authorities also conduct land cover survey initiatives serving national and regional needs for land cover information and land monitoring. The assortment of survey initiatives show that land cover can be described, classified and mapped in many different ways, justified by a multitude of applications and user requirements.

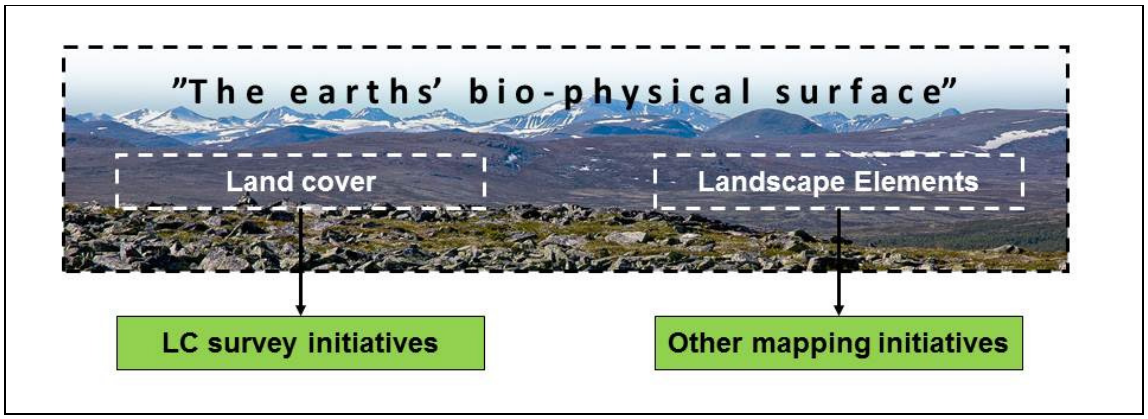


Figure 5 : Mapping and surveying of land cover is done through land cover survey initiatives. This is different from the mapping of the individual landscape elements.

Land cover survey initiatives provide a link between other aspects of the model: The real world, users, documentation and data. The "users" are the institutions, agencies, organizations or people requesting information about the land cover, thereby justifying the effort of carrying out a land cover survey.

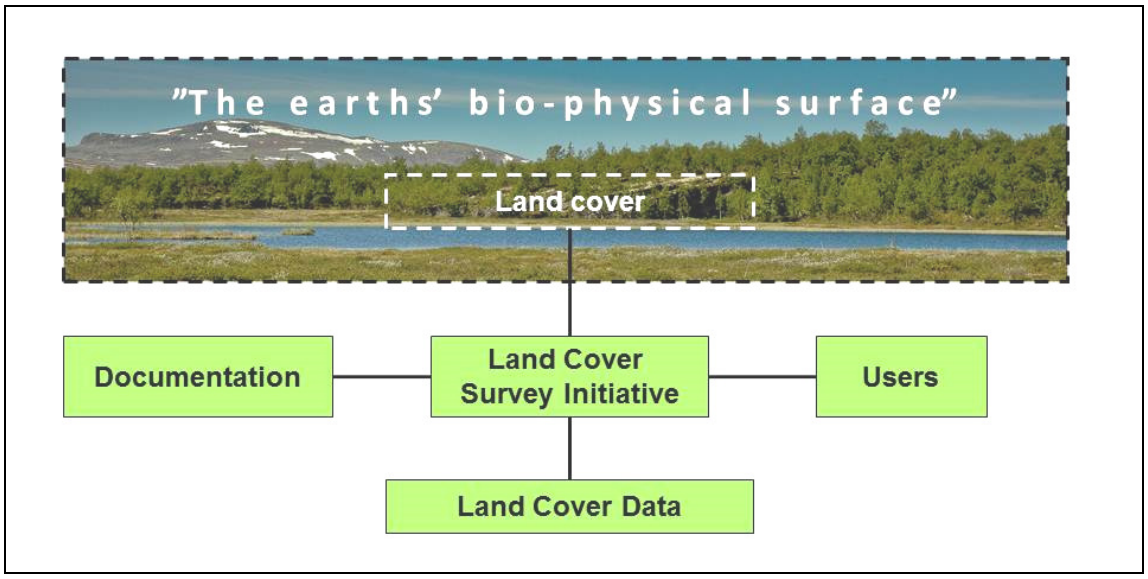


Figure 6 : A *land cover survey initiative* is the framework for land cover mapping, linking the activity to users, documentation and the actual data that are produced.

5.3.1.1.2. Mapping strategies

By far, the most common mapping strategy employed by land cover mapping initiatives is classification. The earth's surface is subdivided into a set of land cover units, presumably uniform in terms of land cover, and a land cover class (or several if mosaics are allowed) is assigned to each unit.

An alternative strategy is attribution. The land cover unit is in this case described by various attributes providing relevant information about the land cover situation. Examples are the number of buildings or length of paved roads. Attribution is not often used in combination with classification.

The third strategy is parameterization. This strategy emphasizes one particular aspect of the land cover (e.g. soil sealing or grass coverage), describing this aspect as a parameter. The land cover units for parameterization are usually, but not necessarily, raster cells. The pan-European GMES High Resolution Layers have been created as a result of this strategy.

The current development in land cover mapping and monitoring, at least at the pan-European level, is a movement towards integration of these three strategies. Land cover units created by classification are

populated with auxiliary information drawn from secondary data sources, which in turn may be created as a result of the parametric approach. The GMES High Resolution Layers are examples of parametric data sources used to populate (by attribution) the units of the CORINE Land Cover dataset, itself a product of classification.

5.3.1.1.3. Land cover documentation and code lists

Documentation is the collection of technical documents that describe the data collection methods, definitions, rules for measurement and classification, and other relevant issues explaining the content of the land cover survey. An example is the technical documentation of CORINE Land Cover. The documentation is usually available as text documents, containing indispensable background information required for proper use of the data.

One particularly important part of the documentation is a code list of the land cover nomenclature. This code list is included in the core model and therefore mandatory in INSPIRE. The code list can have any format found appropriate by the data provider. The primary use of a code list is to check that a code found in a land cover data set is valid, and to use the code list as a lookup table to find the textual legend associated with a code. Multi-lingual code lists are recommended in order to support the reuse of data across Europe. Introducing portrayal rules (eg RGB codes) in the code list will promote visual harmonization.

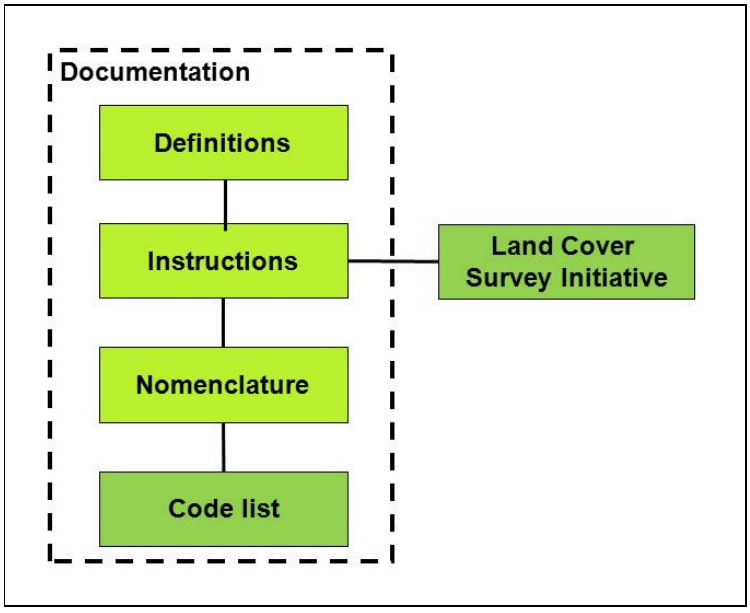


Figure 7 : The documentation of a land cover survey initiative consists of definitions (possibly including a classification system), survey instructions and a nomenclature. The nomenclature should be expressed as a code list and made available in INSPIRE.

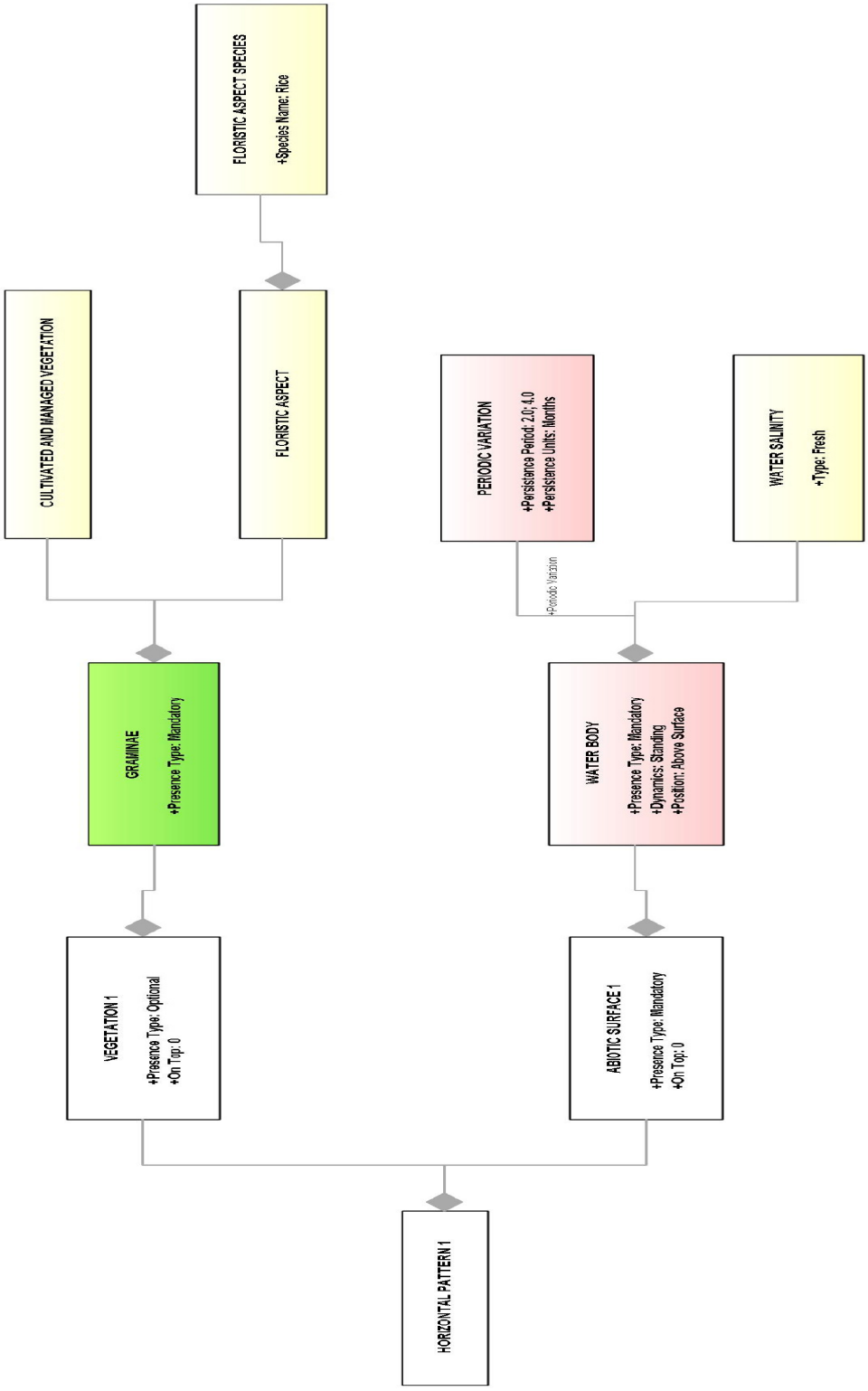


Figure 8 : Description of CORINE Land Cover class 213 *Rice field* using ISO 19144-2 Land Cover Meta Language (LCML).

Documentation interpretable by computers, allowing applications to convert data between different classification systems automatically help to improve interoperability. This level of harmonization is outside the scope of INSPIRE. Consequently, the data specification does not require machine-readable code

lists. It is still recommended to establish machine-readable documentation. It is also recommended to include portrayal rules and a formal definition of the codes. The formal description can either be done by using the Land Cover Meta Language (LCML) defined by ISO standard (ISO 19144-2) or by using a Feature Catalogue as described in ISO 19109 and 19110 (Geographic information - Rules for application schema & Methodology for feature cataloguing).

5.3.1.1.4. Geometry

The data produced by a land cover survey initiative consists of one or more land cover datasets. A land cover dataset is simply a collection of observation units where the land cover has been observed and measured. These observation units are called land cover units in the data specification.

Conceptually, the geometry of a land cover dataset is a partition (in a mathematical sense) of the earth surface and should therefore be represented as a coverage (ISO 19123). The experience is, however, that the land cover mapping community is unable to handle coverage structures. Simple feature points and polygons together with raster structures are therefore, as a pragmatic alternative, used as the geometrical representation of land cover units in this data specification.

The land cover unit is the “geometry of a land cover observation”. When a CORINE Land Cover polygon is classified, it implies that a land cover observation is carried out, and the geometry of this observation is the polygon which the observation is attached to. When the field surveyors determine the land cover at a LUCAS survey point they make an observation, and the geometry of this observation is the point. Land cover units are thus the geometrical building blocks of the land cover data specification.

Polygons are included in the model because many land cover mapping initiatives are using this representation. Most notable is the pan-European CORINE Land Cover program. Points are included in the model because this is an observation method used in statistical surveys of land cover. An example is the LUCAS area frame survey conducted by Eurostat. Finally, the data model includes raster as geometry in order to allow representation of the GMES High Resolution Layers at the pan-European level and land cover data developed from satellite imagery at the national level.

Due to the use of simple feature polygons in the data model, the specification also introduces certain geometrical restrictions: Polygons are not allowed to overlap and gaps must be controlled. Controlled gaps imply that the user must be able to distinguish between areas where information is unavailable (eg due to cloud cover in aerial photographs) and areas not covered by the mapping initiative.

The land cover of a land cover unit is observed on a particular observation date. The observation date is the acquisition date of the aerial photo or satellite image in cases where remote sensing is the observation method. For field surveys, the observation date is the date of the visit in the field. Each land cover unit can be observed several times (e.g. sample points visited every year). This is represented in the core data model by allowing several *observed situations* to be assigned to each land cover unit. There is no limit to how many temporal situations that can be attached to each land cover unit in order to represent a sequence of changes.

The geometry of a particular land cover dataset is static. It does not change. A change in the geometry, created because a polygon is split or because two polygons are merged, must be represented by a new land cover dataset. Spatial data management, and therefore also the business model for management of changes in data set geometry, is the responsibility of the data owner.

The recommended strategies for representing land cover change are (a) to use a fixed geometry and change only the land cover code from one observation date to another; (b) to delineate land cover change features (which are valid only between two reference dates) ; or (c) to use sample points.

The data model

The core model (see also figure above) proposed for the INSPIRE implementing rules represents a land cover data set consisting of a collection of land cover units. The land cover unit can be a point, a polygon or a raster cell. The land cover data set is also associated with a code list with legal land cover codes and their names (e.g. the CORINE Land Cover code list). A land cover code from the code list is assigned to each land cover unit.

The core model furthermore allows several codes to be assigned to each land cover unit (in order to represent mosaics). It is also, in this case, possible to attach a “Covered percentage” to each code in the mosaic. Finally, the core model allows the observation to be attached to an observation date, and several observation dates to be attached to each land cover unit. The observation date is included because it provides important metadata at the observation level and also because it allows representation of land cover change.

The data specification does not prescribe or recommend any particular land cover nomenclature for use in INSPIRE. There is a multitude of different ways to describe land cover. This is partly due to the wide range of aspects of the environment embraced by land cover, but also due to the many different uses of land cover data. There is only one "real world" but many different descriptions of this world depending on the aims, methodology and terminology of the observer. It is therefore a misguided approach to enforce a single classification system as the common classification system for Europe.

The approach taken by this data specification is instead to allow several different land cover nomenclatures to coexist in the context of INSPIRE. The owners of the various code lists are, however, encouraged to document their code lists by using the upcoming ISO standard 19144-2 Land Cover Meta Language or by using a feature catalogue (ISO 19109 and 19110) and provide access to this documentation through a web link for interoperability.

The extended data model, included in the data specification as an informative annex, provides mechanisms for attribution of the land cover units, parameterization and for use of multiple nomenclatures. Since the core model is a subset of the extended model, data providers implementing the extended model are also implicitly INSPIRE compliant.

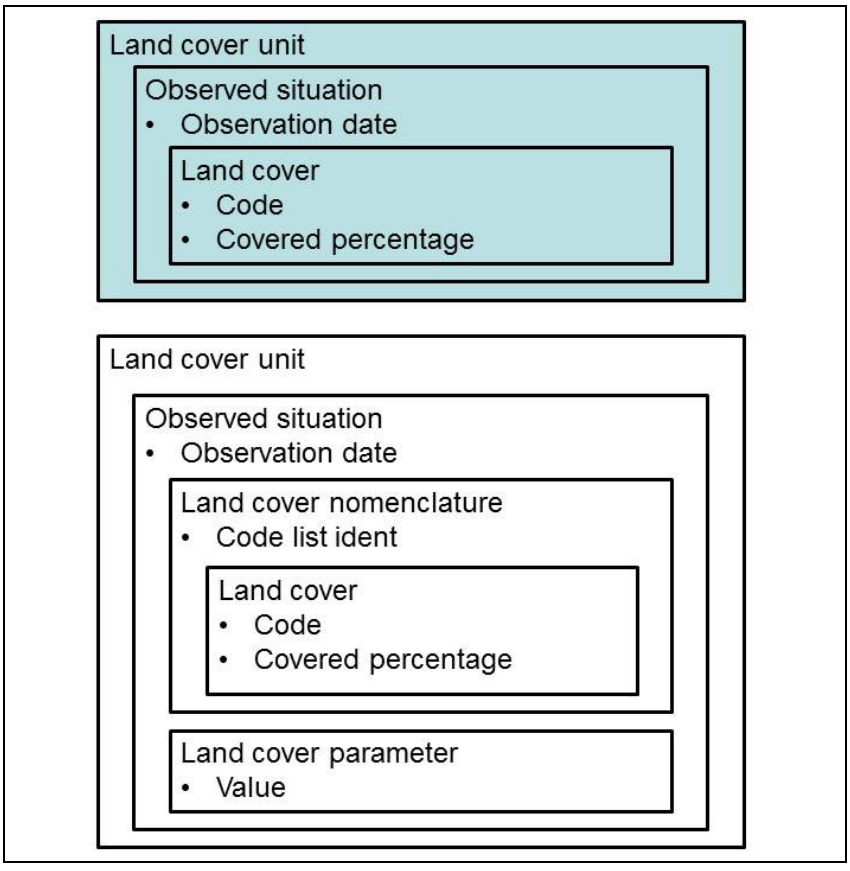


Figure 9 : Land cover description. Core model (top) and extended model (bottom)

5.3.1.2. UML Overview

To represent all the information presented in the narrative description above, Land Cover data shall be modeled through one of the two core applications schemas presented in Figure 10:

- ***LandCoverVector*** defines a vector representation (i.e. points or surfaces) to support Land Cover data.
- ***LandCoverRaster*** defines a raster representation to support Land Cover data.

These two application schemas build the Core of the LC model. They are separated for technical reason but support bacically the same needs and use cases. Only two differences are made for technical reasons (for implementation) :

- only one classification code is allowed per raster cell for the raster representation (multiple codes are allowed in the vector representation in order to follow LC changes).
- no mosaic description allowed for the raster representation.

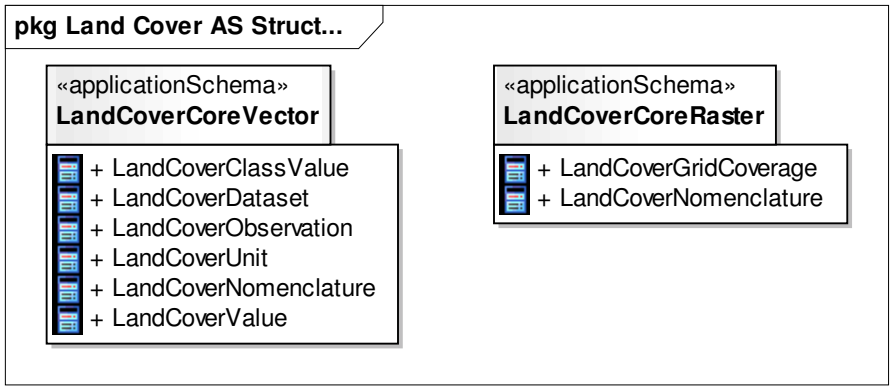


Figure 10 – UML package diagram: Overview of the structure defined for mandatory Land Cover Application Schemas

As described before, these two models are independent and support two different Land Cover data representations. To implement INSPIRE LC specification, one of those shall be chosen:

TG Requirement 2	Data compliant with this data specification shall implement ***LandCoverVector*** or ***LandCoverRaster*** application schema.

Land Cover data are covered by an ISO Standard (ISO 19144-1 – Classification Systems) which is based on ISO 19123 - Coverages. In ISO 19144-1, Land Cover data are represented by a set of non-overlapping polygons modeled by the class CL_ClassifiedSurface (subtype of a CV_DiscreteSurfaceCoverage). This approach was initially recommended by the Thematic Working Group but due to technical difficulties to implement coverages, it was decided to represent Land Cover data in INSPIRE with separate vector and raster representations, closer to CORINE and other available datasets. From a conceptual point of view, the *LandCoverVector* application schema (with geometries restricted to surfaces) supports the same information as provided by a coverage model based on ISO 19144-1.

A third application schema is also included in this specification: LandCoverExtended. This application schema defines extensions on the LandCoverVector model to support additional use cases. This application schema makes it possible to support more than one nomenclature and also to use parameters to describe Land Cover.

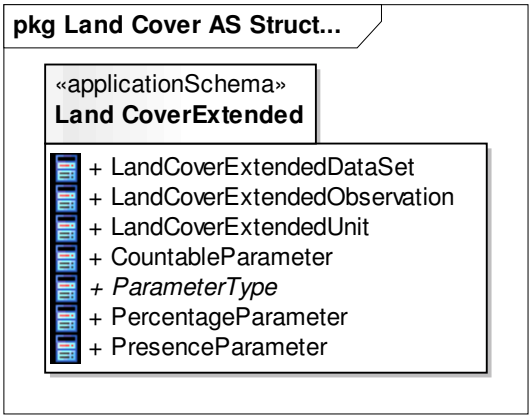


Figure 11 – UML package diagram: Overview of the Extended Land Cover Application Schemas

5.4 Application schema LandCoverNomenclature

5.4.1 Description

5.4.1.1. Narrative description

This application schema defines common components used by *LandCoverVector* and *LandCoverRaster* applciations schemas.

5.4.1.2. UML Overview

This application is based on ISO standards and the Generic Conceptual Model developed by INSPIRE to share common concepts:

- ISO 19144-2 for defining nomenclature with the LCML language.
- General Conceptual Model – Base Types for INSPIRE identifier and other common shared concepts.

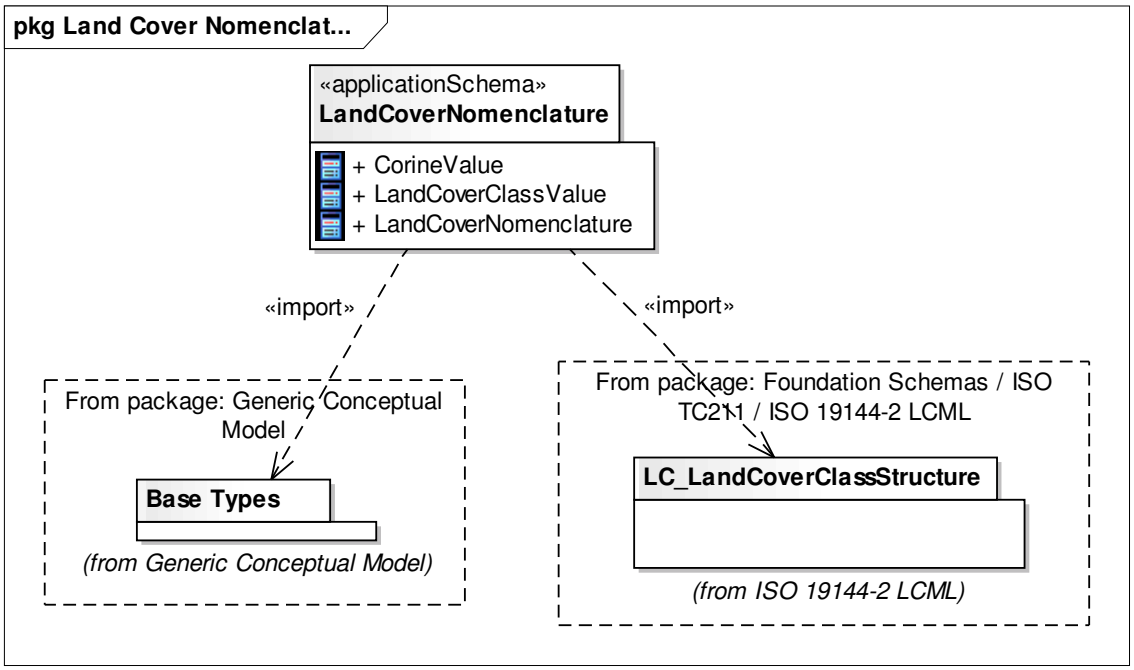


Figure 12 – UML package diagram: LandCoverVector dependencies

This application schema contains five UML classes:
- LandCoverClassValue
- LandCoverNomenclature

NOTE : CorineValue represents Corine nomenclature as an example of LandCoverClassValue codelist.

5.4.1.2.1. LandCoverNomenclature

A *LandCoverNomenclature* specifies information provided for correct understanding and interpretation of the classification codes contained in the data set.

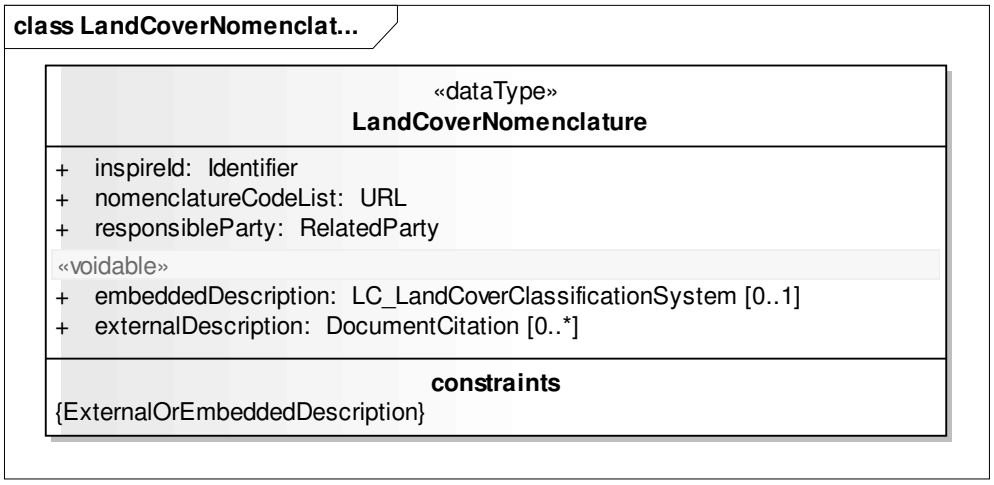


Figure 13 – UML class diagram: LandCoverNomenclature

nomenclatureCodeList
this attribute references the code list attached to the nomenclature. This code list makes links between codes and values (the code being “112” and the value “discontinuous-urban-fabric” if the nomenclature is CORINE).

responsibleParty
this attribute specifies which party (or organisation) defines and is responsible for the nomenclature. It allows giving contact and/or organisation name.

embeddedDescription
it allows using ISO 19144-2 (LCML metalanguage) to provide a description of the classification system with this common metalanguage. LC_LandCoverClassificationSystem is the root class from ISO 19144-2 to instantiate a definition of a nomenclature with LCML.

externalDescription
this attribute allows to provide a set of URL pointing to the documentation (specification or other document) describing the classification system used and the nomenclature used. These URL can be used to point multiple documents, for example in different languages.

TG Requirement 3	Each nomenclature used by a Land Cover Data set shall be described by at least one of the two attribute *externalDescription* or *embeddedDescription*.

IR Requirement
Annex III, Section 2.6
Theme-specific Requirements

If an onlineDescription attribute is provided for a LandCoverNomenclature data type, the referenced online description shall define, for each class, at least a code, a name, a definition and a RGB value to be used for portrayal. If the online description describes the nomenclature for a LandCoverGridCoverage object, an integer grid code shall also be provided for each class. This code shall be used in the range of the LandCoverGridCoverage to represent the corresponding class.

NOTE the grid code is the value used to effectively store classifications in raster formats. Values are consecutive (1, 2, 3), each representing a LC class. For more details, see CORINE Table in Annex E. The following table is an extract with class definitions.

Table 6 : Example of CORINE Nomenclature description

GRID_CODE	CLC_CODE	LABEL/Name	DEFINITION	RGB
1	111	Continuous urban fabric	Most of the land is covered by structures. Buildings, roads and artificially surfaced area cover almost all the ground. Non-linear areas of vegetation and bare soil are exceptional.	230-000-077
2	112	Discontinuous urban fabric	Most of the land is covered by structures. Buildings, roads and artificially surfaced areas associated with vegetated areas and bare soil, which occupy discontinuous but significant surfaces.	255-000-000

For interoperability purposes, it is recommended to provide documentation about the nomenclature in English. Documentation is useful to the widest community of users if it is written in English.

Recommendation 1 The documentation of the particular national land cover nomenclature should be documented in English, if available (through attribute “externalDescription”). If this is not yet the case, an effort should be made to provide this information.

5.4.1.2.2. LandCoverClassValue

This is an empty code list allowing each data provider to define its own code list for classifying Land Cover objects (points or surfaces). This is done by putting “any” value for the extensibility tag and leaving the vocabulary tag empty.

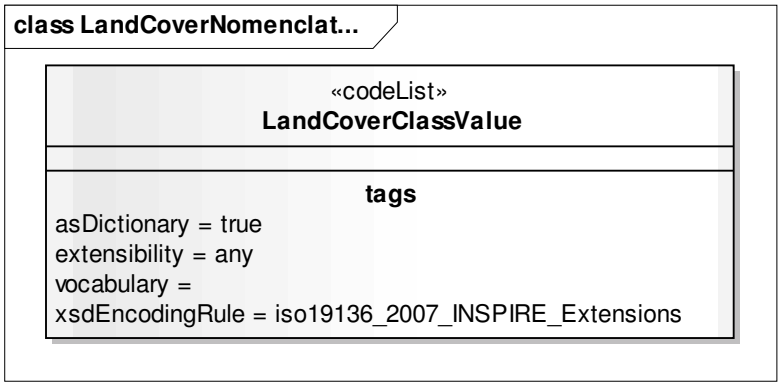


Figure 14 – UML class diagram: LandCoverClassValue

This code list defines a mapping between codes and values and allows retrieval of Land Cover classification values through their code. CORINE Land Cover code list is an example for this code list.

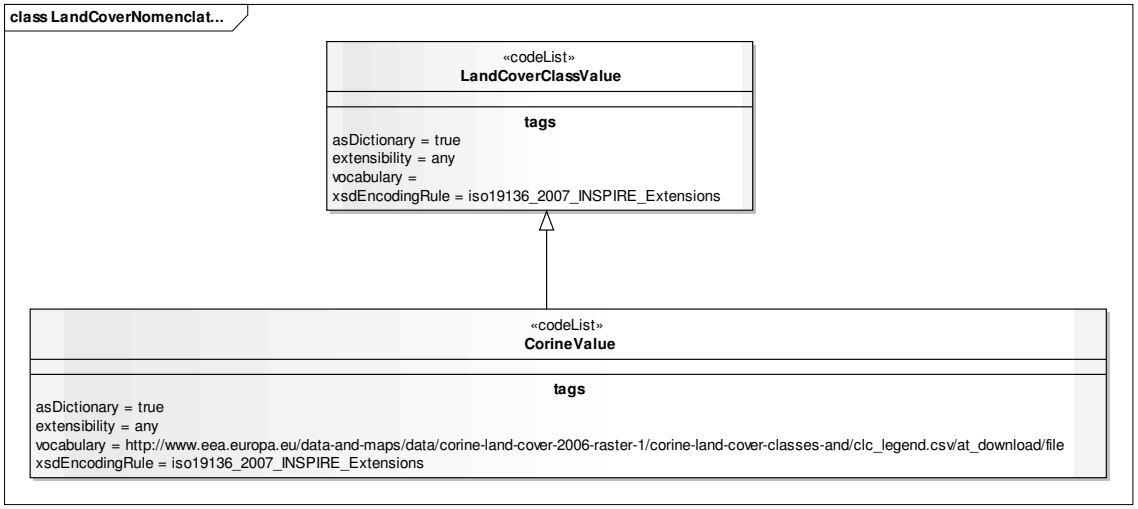


Figure 15 – UML class diagram: CORINEValue

For example, the following code list for CORINE LC data set would begin with:

Table 7 : example of LandCoverClassValue code list

111	Continuous urban fabric
112	Discontinuous urban fabric
121	Industrial or commercial units
122	Road and rail networks and associated land
123	Port areas
…	…

NOTE The complete code list for CORINE 2000 and CORINE 2006 can be found in Annex E.

5.4.2 Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema LandCoverNomenclature
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
CorineValue	LandCoverNomenclature	«codeList»
LandCoverClassValue	LandCoverNomenclature	«codeList»
LandCoverNomenclature	LandCoverNomenclature	«dataType»

5.4.2.1. Data types

5.4.2.1.1. LandCoverNomenclature

LandCoverNomenclature

Name: Land Cover Nomenclature
Definition: Information about reference national, institutional or local Land Cover nomenclature.
Description: Land Cover Nomenclature allows to reference nomenclatures documentation and associated code list, and to define them through an external reference or included within the data according 19144-2.
Stereotypes: «dataType»

Attribute: embeddedDescription

Name: embedded Description
Value type: LC_LandCoverClassificationSystem
Definition: An embedded encoding of the classification system according to ISO 19144-2.
Multiplicity: 0..1
Stereotypes: «voidable»

Attribute: inspireId

Name: inspireId
Value type: Identifier
Definition: External object identifier of the spatial object.
Description: NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity: 1

Attribute: nomenclatureCodeList

Name: nomenclatureCodeList
Value type: URI
Definition: An http URI pointing to the code list attached to the nomenclature used.

LandCoverNomenclature	
Multiplicity:	1

Attribute: externalDescription

Name:	externalDescription
Value type:	DocumentCitation
Definition:	Document describing the nomenclature used in this data set.
Multiplicity:	0..*
Stereotypes:	«voidable»

Attribute: responsibleParty

Name:	responsible party
Value type:	RelatedParty
Definition:	Party responsible for the development and/or maintenance of the nomenclature.
Description:	The responsible party could be EEA, a national or local mapping agency, ...
Multiplicity:	1

Constraint: ExternalOrEmbeddedDescription

Natural language:	The embedded description or the external desciption shall be provided.
OCL:	

5.4.2.2. Code lists

5.4.2.2.1. CorineValue

CorineValue	
Name:	Corine Land Cover code list
Definition:	Corine Land Cover code list governed by EEA.
Extensibility:	any
Identifier:	http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-1/corine-land-cover-classes-and/clc_legend.csv/at_download/file
Values:	The allowed values for this code list comprise any values defined by data providers. *Annex C* includes recommended values that may be used by data providers.

5.4.2.2.2. LandCoverClassValue

LandCoverClassValue	
Name:	Land Cover Class Value
Definition:	Land cover code list or classification.
Description:	An empty code list that act as a container for Corine, other european, national or local code list for LC nomenclature.
Extensibility:	any
Identifier:	http://inspire.ec.europa.eu/codelist/LandCoverClassValue
Values:	The allowed values for this code list comprise any values defined by data providers.

5.4.2.3. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.4.2.3.1. DocumentCitation

DocumentCitation	
Package:	Base Types 2
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	Citation for the purposes of unambiguously referencing a document.

5.4.2.3.2. Identifier

Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.4.2.3.3. LC_LandCoverClassificationSystem

LC_LandCoverClassificationSystem	
Package:	LC_LandCoverClassStructure
Reference:	Geographic information - Classification systems -- Part 2: Land Cover Meta Language (LCML) [ISO 19144-2:2012]

5.4.2.3.4. RelatedParty

RelatedParty	
Package:	Base Types 2
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	An organisation or a person with a role related to a resource.
Description:	NOTE 1 A party, typically an individual person, acting as a general point of contact for a resource can be specified without providing any particular role.

5.4.2.3.5. URI

URI	
Package:	basicTypes
Reference:	Geographic information -- Geography Markup Language (GML) [ISO 19136:2007]

5.4.3 Externally governed code lists

The externally governed code lists included in this application schema are specified in the tables in this section.

5.4.3.1. Governance, availability and constraints

Code list	Governance	Version	Availability	Formats	Subset
LandCoverClassValue	N/A	N/A	Empty code list	N/A	
CORINEValue	EEA	version 2006	http://www.eea.europa.eu/data-and-maps/data/CORINE-land-cover-2006-raster-1/CORINE-land-cover-classes-and/clc_legend.csv/at_download/file	CSV	

The values of CORINEValue external code lists are included in Annex E for information.

5.4.3.2. Rules for code list values

Code list	Identifiers	Identifier examples	Labels
CORINEValue	code 111 could be referenced as	*http://www.eea.europa.eu/data-and-maps/data/CORINE-land-cover-2006-raster-1/CORINE-land-cover-classes-and/clc_legend/111*	Continuous urban fabric (Label 3 of CSV file)

5.5 Application schema LandCoverVector

5.5.1 Description

5.5.1.1. Narrative description

This application schema defines how Land Cover data can be supported by a vector representation. All requirements of this section apply therefore in the case of Land Cover data being supported by points or polygons.

5.5.1.2. UML Overview

This application is based on ISO standards and the Generic Conceptual Model developed by INSPIRE to share common concepts:

- ISO 19103 for base types as date and time, numerics.
- ISO 19017 for the geometry (points and surfaces).
- ISO 19115 for some metadata elements (extents).
- LandCoverNomencature application schema.

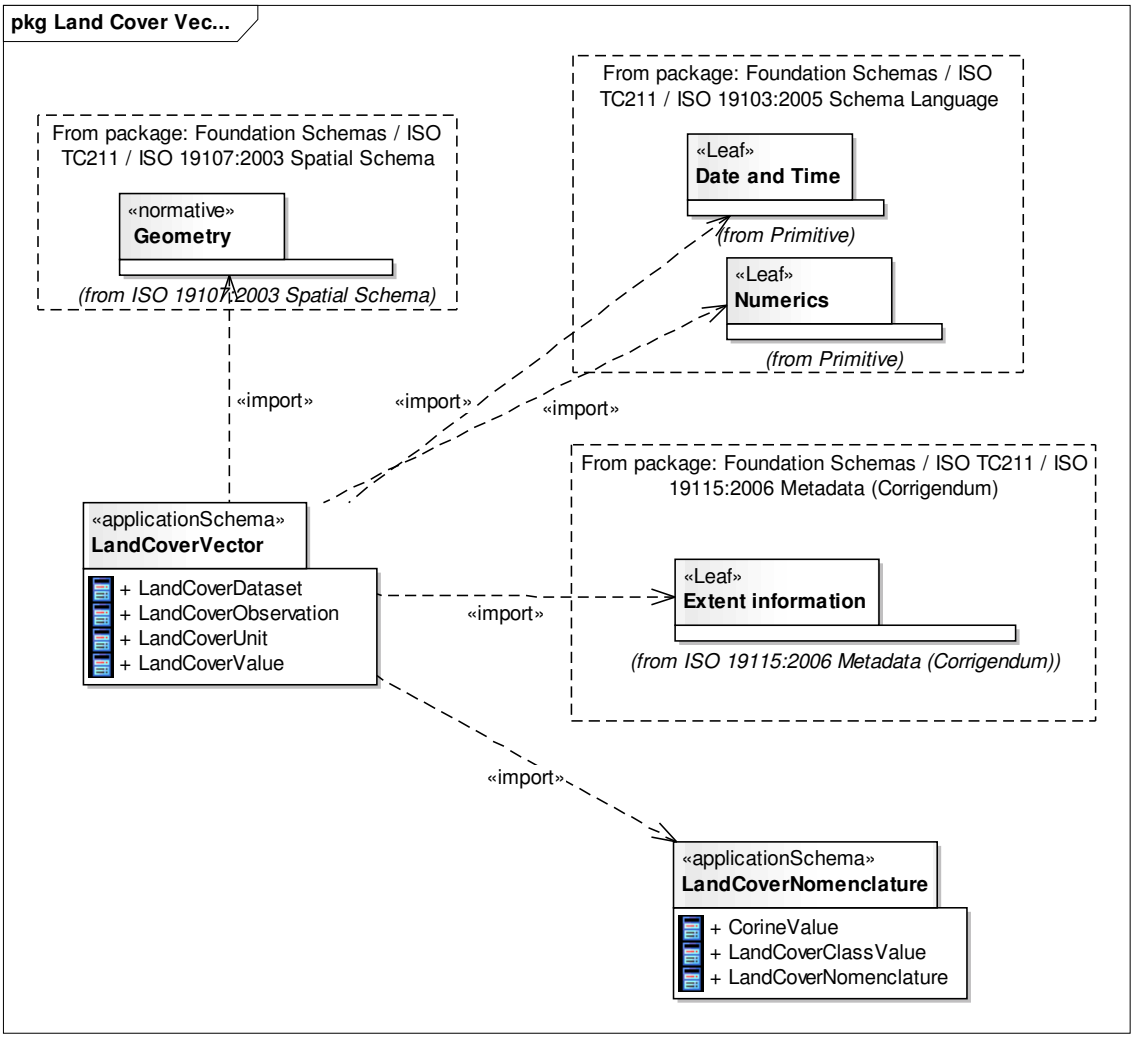


Figure 16 – UML package diagram: LandCoverVector dependencies

This application schema contains four UML classes:

- LandCoverData set
- LandCoverUnit
- LandCoverObservation
- LandCoverValue

5.5.1.2.1. LandCoverData set

The *LandCoverVector* application schema models LC data sets (*LandCoverData set* in the schema) as collections of *LandCoverUnit*. A *LandCoverUnit* has a geometry (restricted to point or surface) and supports the Land Cover information through the attribute *landCoverObservation*.

NOTE The term “surface” is used instead of “polygon” for conformity with ISO 19107 standard. A GM_Polygon can not exist on its own and shall be part of a GM_Surface. The generic 2D geometry object for 2D is a surface (GM_Surface), according to ISO Standard. Conceptually, the difference is that a surface can be an aggregation of patches.

TG Requirement 4	A Land Cover data set shall have only one type of geometry (i.e. points or surfaces). It is not allowed to mix both within the same data set.

The attribute *geometry* of a *LandCoverUnit* is a *GM_Object*, which is the ISO 19107 supertype for all geometry objects. It is restricted to *GM_Point* or *GM_Surfaces* for LC needs.

Additionally, in this core, only one nomenclature (*nomenclatureDocumentation*) is allowed for each data set.

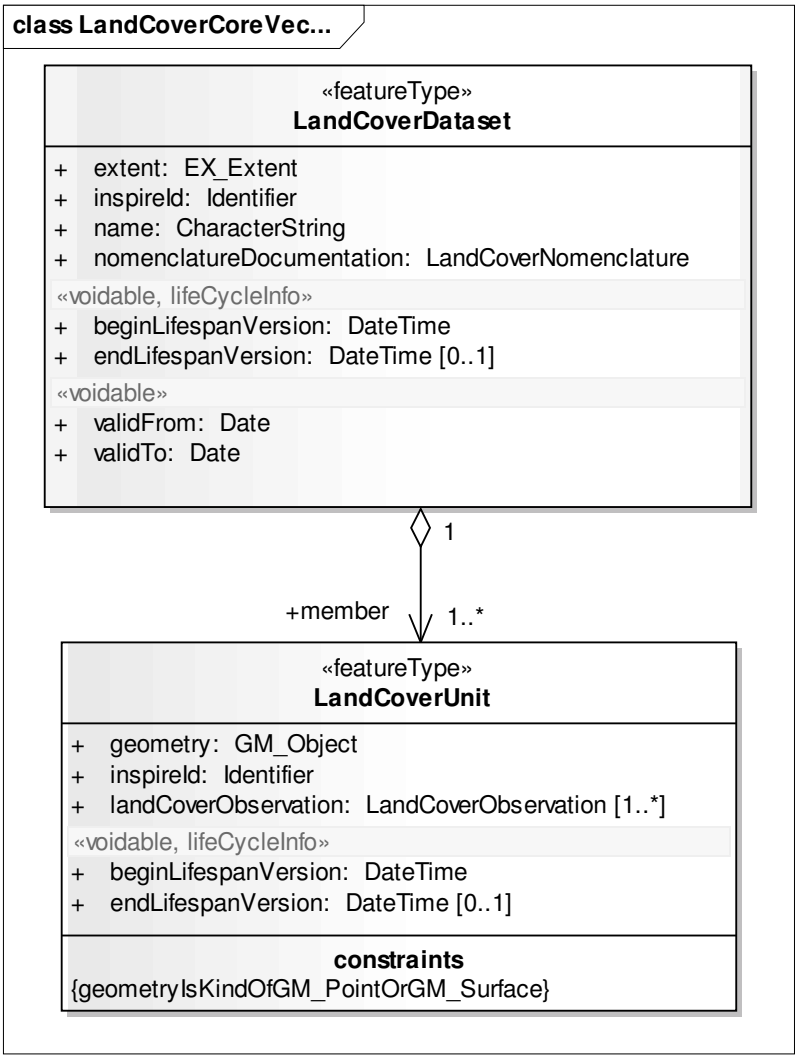


Figure 17 – UML class diagram: Land Cover Data set for vector representations

name
the name of the data set. This name can be the name of the region, a geographic identifier. There is no constraint about its structure.

inspireId
the inspire identifier. It allows to reference spatial objects (features) if needed and follow their lifecycle.

extent
The extent allows describing the temporal, vertical and geographic extent of the data set.

Recommendation 2 Each LandCoverData set should at least provide a realization of EX_GeographicExtent through the *extent* attribute. This EX_Geographic Extent

should be consistent with the all the geometries provided by the *LandCoverUnit* instances (i.e. *LandCoverUnit* shall be included in the EX_Geographic Extent).

According [ISO 19115], EX_GeographicExtent can be realized through a bounding polygon, a geographic boundingbox or a geographic description (e.g. name of a region …).

nomenclatureDocumentation
this attribute allows to provide documentation on the nomenclature used in the data set. Please note that the core model supports only one nomenclature per data set. This nomenclature can be CORINE, another european nomenclature, a national one or any other LC nomenclature. It is modelled with the UML class *LandCoverNomenclature* described in a following section.

5.5.1.2.2. LandCoverUnit

The LandCoverUnit represents a section of space which is classified. It can correspond for example to a CORINE polygon.

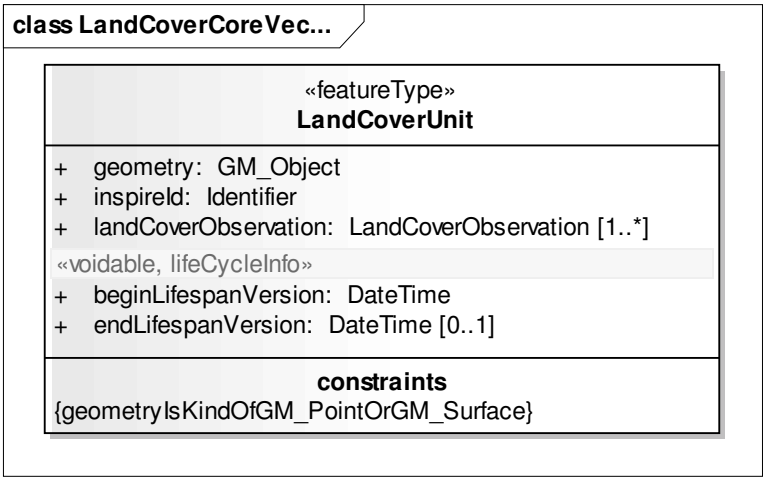


Figure 18 – UML class diagram: LandCoverUnit

Each LandCoverUnit is defined by:

- a *geometry* which is restricted to Points (for example LUCAS sample points) or Surfaces (for example a CORINE LC polygon), through the OCL constraint "geometryIsKindOfGM_PointOrGM_Surface".
- one or more *landCoverObservation* which allows description of the unit from a Land Cover point of view. This attribute then supports the semantic information.

The capacity of a LandCoverUnit to support multiple observations allows changes on the same LandCoverUnit and then to make temporal analysis.

5.5.1.2.3. LandCoverObservation

The landCoverObservation is described by the class *LandCoverObservation*:

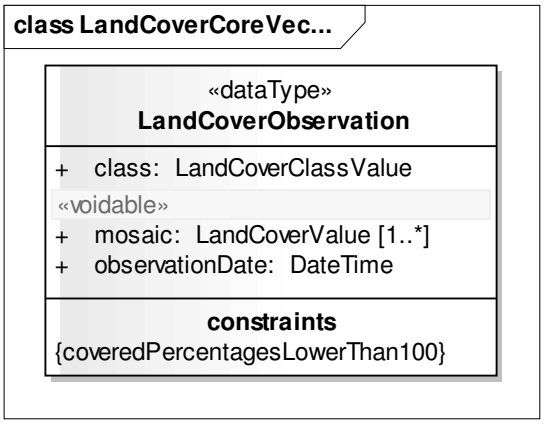


Figure 19 – UML class diagram: LandCoverObservation

The *LandCoverObservation* class defines following attributes:

- *class* attribute allows one classification code resulting from a classification process. It can be CORINE code (111, 112, 223, …), IGBP code or other code corresponding to a national, institutional or local nomenclature. Values are defined in the code list defined by the class LandCoverClassValue.
- *observationDate* allows to provide temporal information about when the data was acquired.
- *mosaic* allows more precise description of the Land Cover through a collection of classification values, each associated to a percentage (each being expressed with integers between 0 and 100). The sum of all these percentages shall be lower than 100. This is checked by the OCL constraint "coveredPercentagesLowerThan100".

The *observationDate* and the *mosaic* are voidable; it means that they shall be provided if they exist or are easily computable.

All Land Cover information (class and mosaic) are defined according the nomenclature described and referenced by nomenclatureDocumentation attribute provided at the data set level.

5.5.1.3. Consistency between spatial data sets

Land cover data are described as an abstraction of the physical and biophysical cover of the earth's surface. Despite the fact that Land Cover is a transverse theme it has no real connections with other INSPIRE models, so there is no specific consistency rule with other spatial data sets.

5.5.1.4. Geometry representation

IR Requirement
Annex III, Section 2
Theme-specific Requirements

The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

TG Requirement 5	The spatial representation of a LandCoverData set shall be a set of non-overlapping geometry objects (points or surfaces).

Comment: Land cover information can also be attached to lines (transects) as part of sampling schema but then mostly by registration of points where the land cover is changing (eg LUCAS). Lines are therefore considered to be out of scope.

5.5.1.5. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 7	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.5.1.5.1. Different types of dates

One important aspect on Land Cover information is its changing quality over time. Therefore, it refers to a particular situation. A second aspect specific to Land Cover is that it may have a different appearance within one year subject to seasonal or other variations. This dependence can affect the accurate thematic interpretation and classification of particular classes in a given data set and in consequence, also the detection of real land cover change.

Having in mind the two above-mentioned issues, there are several date types to be considered in describing the landscape from the *Land Cover* point of view. Some of these date types are important when it comes to the comparison of two or more different situations of land cover. On the basis of diverse available date types, the data user is able to extract and assess land cover change information from imagery or other data sources. The following shows a list of date types along the process of land cover data capture and delivery.

a) event date:

The point of time or short period, when a certain type of land cover occurs in reality, is seen as the event date, e.g. storm damage or clear cut in forest areas, beginning of a construction site, finishing of a construction site, creation of a new coastline by enclosing former salt marshes with a dike. The event date would be the most exact information about the point of time when a certain land cover change appears in reality. The monitoring of land cover aims more at different timelines. Also it is rather unlikely to have such information on the event date available for the majority of land cover objects. The storage of the event date for every single case may appear as not feasible and therefore is considered as not mandatory but voidable.
If nevertheless required, the event date can be modelled as voidable attribute

- validFrom: The point of time when the phenomenon started to exist in the real world
- validTo: The point of time from when on the phenomenon no longer exists in the real world.

b) observation date:

The observation date is considered as the point of time or situation when the land cover information source, which is used for land cover data capture, is recorded. Usually the observation date is equal to the acquisition date of the aerial or satellite image (remote sensing data) used for mapping a particular spatial unit (polygon). Because many images are used in each survey, the actual date can vary from one polygon to another within the same data set. The acquisition date of the recorded imagery would then be attached to every single spatial unit (point/polygon) e.g. according to the geographic extend of the imagery scenes ("footprints"). The observation date can also be the point of time when the land cover information is captured on the ground by a field surveyor. The land cover object in a particular data set can have different observation dates if several information sources were combined to capture the land cover information (e.g. multi-temporal satellite imagery). The observation date is usually different from the event date. This information is recorded by the observationDate attribute (on classes LandCoverClass, LandCoverMosaic and ParameterType).

c) reference date:

A reference year or reference date is a (more or less exact) moment, a period of time or a certain time window when the information in a complete data set is assumed to be valid. The time window for the acquisition of a number of satellite scenes or aerial images within a reference period can range between a few days to several months or even years. For example, CLC2006 has the reference year 2006. However, the satellite imagery collection "IMAGE2006", which was used as the information source, was recorded in the time interval between the years 2005 - 2007. Reference dates come into play, when data sets of greater dimension (regional, country or pan-european level) on land cover shall be compared to derive the land cover changes, which occurred during a certain time interval, e.g. between the two reference years of CLC2006 and CLC2012.

d) edit date:

The point of time when a spatial unit is edited in the data set can be modelled as

- *beginLifespanVersion*: Date and time at which the version of the spatial object was inserted or changed in the spatial data set.
- *endLifespanVersion*: Date and time at which the version of the spatial object was superseded or retired in the spatial data set.

*e) **release date/date of last revision**:*

Point of time, when data set (collection of obtained land cover information) is completed and finished. The release date can be considered as the closure of the last data set editing or revision before making the data available to the customers or to the public through online services such as a web map service (WMS).It can also follow after a publishing date and represent the updating or correction of a data set, which then again is published afterwards.

*f) **publishing date**:*

The Point of time when a data set is made available to the public through a data provider and/or declared as valid and put into force for the first time. After a publishing date several release dates may follow, which can represent an updated version of the beforehand published data set.

TG Requirement 6	"Temporality information on Land Cover data" shall be provided by the followings date types if available: the observation date (b), the edit date (d).

The observation date (b) shall be provided at the coverage level (=data set) through external metadata with lineage information (dateTime of the observation/acquisition processStep) or at the feature level (through the dedicated attribute observationDate in class *LandCoverObservation*.
The edit date (d) shall be provided through the temporal attributes *beginLifespanVersion* and *endLifespanVersion* at the data set level (*LandCoverData set*) and object level (*LandCoverUnit*).

Recommendation 8	Temporality information on Land Cover (reference date (c), and the release date (e)) should be provided through metadata elements at the coverage level.

For temporal reference, the Metadata Inspire Regulation requires to provide at least one of the metadata elements "temporal extent", "date of publication", "date of last revision", "date of creation".

The Land Cover specification recommends to provide the reference date (c) at coverage level (=data set) through the external metadata element Temporal reference / date of creation (see Chapter 8) and the release date (e) at the coverage level (=data set) through the external metadata element Temporal reference / date of publication (see Chapter 8).

5.5.1.5.2. Land cover changes

The current model embodies coverages, which themselves contain one to many spatial units. Over time these spatial units may change their geometry compared to each other from data set to data set, or they may be fixed and keep their geometric extend (regular grid) and only change their thematic land cover information. To represent land cover changes, there are two ways.
One is analytical: The user makes a differentiating overlay between two coverages of different reference dates, he creates the land cover change himself as a result of this overlay.
Second is historical: For each fixed spatial unit the land cover information is obtained according to one to many observation dates over time and assigned to the spatial unit. LUCAS points or grid cells in general are examples of fixed spatial units where land cover data can be “observed” or “measured” at different points in time on the same spot.
A special case is a data set which contains changing information, e.g. the CORINE Land Cover Change data set 2000 - 2006. It does not have a reference year. It rather can be seen as a coverage with “short time” fixed spatial units and two separate situations (observation dates), one referring to the first and the second to the later observation date, which is represented at the polygon level.

5.5.2 Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema LandCoverVector
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
LandCoverDataset	LandCoverVector	«featureType»
LandCoverObservation	LandCoverVector	«dataType»
LandCoverUnit	LandCoverVector	«featureType»
LandCoverValue	LandCoverVector	«dataType»

5.5.2.1. Spatial object types

5.5.2.1.1. LandCoverDataset

LandCoverDataset

Name: Land Cover Data set
Definition: A vector representation for Land Cover data.
Description: This representation allows Land Cover data being supported by a vector geometry.
Stereotypes: «featureType»

Attribute: inspireId

Name: inspireId
Value type: Identifier
Definition: External object identifier of the spatial object.
Description: NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity: 1

Attribute: beginLifespanVersion

Name: beginLifespanVersion
Value type: DateTime

LandCoverDataset

Definition: Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity: 1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Name: endLifespanVersion
Value type: DateTime
Definition: Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity: 0..1
Stereotypes: «voidable,lifeCycleInfo»

Attribute: extent

Name: extent
Value type: EX_Extent
Definition: Contains the extent of the data set.
Description: NOTE Extents may be specified in space, time or space-time.
Multiplicity: 1

Attribute: name

Name: name
Value type: CharacterString
Definition: Name of the Land Cover data set.
Multiplicity: 1

Attribute: nomenclatureDocumentation

Name: nomenclatureDocumentation
Value type: LandCoverNomenclature
Definition: Information about the nomenclature used in this data set.
Multiplicity: 1

Attribute: validFrom

Name: validFrom
Value type: Date
Definition: The time when the phenomenon started to exist in the real world.
Multiplicity: 1
Stereotypes: «voidable»

Attribute: validTo

Name: validTo
Value type: Date
Definition: The time from which the phenomenon no longer exists in the real world.
Multiplicity: 1
Stereotypes: «voidable»

Association role: member

Name: element
Value type: LandCoverUnit
Definition: A Land Cover Unit being part of the data set.
Description: A Land Cover dataset is a collection of LandCover units, each one being called an element.
Multiplicity: 1..*

5.5.2.1.2. LandCoverUnit

LandCoverUnit

LandCoverUnit	
Name:	Land Cover Unit
Definition:	An individual element of the LC dataset represented by a point or polygon.
Description:	Every unit support Land Cover information.
Stereotypes:	«featureType»

Attribute: inspireId

Name:	inspireId
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: beginLifespanVersion

Name:	beginLifespanVersion
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Name:	endLifespanVersion
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: geometry

Name:	geometry
Value type:	GM_Object
Definition:	Spatial representation of the Land Cover unit.
Description:	NOTE Restricted to point or surface.
Multiplicity:	1

Attribute: landCoverObservation

Name:	landCoverObservation
Value type:	LandCoverObservation
Definition:	Land cover information at a specific time and place.
Multiplicity:	1..*

Constraint: geometryIsKindOfGM_PointOrGM_Surface

Natural language:	geometries shall be points or surfaces
OCL:	inv: self.geometry->forAll(l | l.oclIsKindOf(GM_Surface) or l.oclIsKindOf(GM_Point))

5.5.2.2. Data types

5.5.2.2.1. LandCoverObservation

LandCoverObservation	
Name:	Land Cover Observation
Definition:	Land Cover information interpreted at a specific time and place.
Stereotypes:	«dataType»

LandCoverObservation

Attribute: class

Name:	class
Value type:	LandCoverClassValue
Definition:	The assignment of a land cover class to a land cover unit through a classification code identifier
Description:	The identifier, eg 1.1.1, 1.1.2, ... (for CORINE LC classes) allow to access to the value and the definition or narrative description of the corresponding class.
Multiplicity:	1

Attribute: mosaic

Name:	mosaic
Value type:	LandCoverValue
Definition:	List of classification values describing into details a land cover unit, associated with percentages.
Multiplicity:	1..*
Stereotypes:	«voidable»

Attribute: observationDate

Name:	observationDate
Value type:	DateTime
Definition:	The observation date associated of an observation.
Description:	Defines the observation date of the classification value. It could be the date of an aerial/satellital acquisition or of an update on the field. The observation date allows the user to have accurate date of when each value was observed in the real word. In a database, not all polygon informations are necessarily updated at the same time.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: coveredPercentagesLowerThan100

Natural language:	The sum of all coveredPercentage attributes attached to each LandCoverObservation shall be lower or equal to 100
OCL:	inv:mosaic.coveredPercentage.sum() <= 100

5.5.2.2.2. LandCoverValue

LandCoverValue

Name:	Land Cover Value
Definition:	Generic class supporting Land Cover value and percentage.
Stereotypes:	«dataType»

Attribute: class

Name:	class
Value type:	LandCoverClassValue
Definition:	Assignment of a land cover spatial object to a land cover class through a classification code identifier.
Description:	The identifier, eg 1, 1.1.2, ... (for CORINE LC classes) allow to access to the value and the definition or narrative description of the corresponding class.
Multiplicity:	1

Attribute: coveredPercentage

Name:	Covered percentage
Value type:	Integer
Definition:	Fraction of the LandCoverUnit being concerned with the classification value.
Multiplicity:	1
Stereotypes:	«voidable»

5.5.2.3. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.5.2.3.1. CharacterString

CharacterString	
Package:	Text
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.5.2.3.2. Date

Date	
Package:	Date and Time
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.5.2.3.3. DateTime

DateTime	
Package:	Date and Time
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.5.2.3.4. EX_Extent

EX_Extent	
Package:	Extent information
Reference:	Geographic information -- Metadata [ISO 19115:2003/Cor 1:2006]

5.5.2.3.5. GM_Object

GM_Object (abstract)	
Package:	Geometry root
Reference:	Geographic information -- Spatial schema [ISO 19107:2003]

5.5.2.3.6. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.5.2.3.7. Integer

Integer	
Package:	Numerics
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.5.2.3.8. LandCoverClassValue

LandCoverClassValue	
Package:	LandCoverNomenclature
Reference:	INSPIRE Data specification on Land Cover [DS-D2.8.II.2]
Definition:	Land cover code list or classification.
Description:	An empty code list that act as a container for Corine, other european, national or local code list for LC nomenclature.

5.5.2.3.9. LandCoverNomenclature

LandCoverNomenclature	
Package:	LandCoverNomenclature
Reference:	INSPIRE Data specification on Land Cover [DS-D2.8.II.2]
Definition:	Information about reference national, institutional or local Land Cover nomenclature.
Description:	Land Cover Nomenclature allows to reference nomenclatures documentation and associated code list, and to define them through an external reference or included within the data according 19144-2.

5.5.3 Externally governed code lists

The externally governed code lists included in this application schema are specified in the tables in this section.

5.5.3.1. Governance, availability and constraints

Code list	Governance	Version	Availability	Formats	Subset
LandCoverClassValue	N/A	N/A	Empty code list	N/A	
CORINEValue	EEA	version 2006	*http://www.eea.europa.eu/data-and-maps/data/CORINE-land-cover-2006-raster-1/CORINE-land-cover-classes-and/clc_legend.csv/at_download/file*	CSV	

The values of CORINEValue external code lists are included in Annex E for information.

5.5.3.2. Rules for code list values

Code list	Identifiers	Identifier examples	Labels
CORINEValue	code 111 could be referenced as	*http://www.eea.europa.eu/data-and-maps/data/CORINE-land-cover-2006-raster-1/CORINE-land-cover-classes-and/clc_legend/111*	Continuous urban fabric (Label 3 of CSV file)

5.6 Application schema LandCoverRaster

5.6.1 Description

5.6.1.1. Narrative description

This application schema defines how Land Cover data can be supported by a raster representation. All requirements of this section apply therefore in the case of Land Cover data being supported by rectified grid coverage as defined by ISO 19123 standard.

5.6.1.2. UML Overview

This application schema is based on ISO standards and the Generic Conceptual Model developed by INSPIRE to share common concepts:

- ISO 19103 for base types as Integer.
- ISO 19115 for some metadata elements (extents, citations …).
- General Conceptual Model – Base Types for coverages.

Note : Coverages are also used by other INSPIRE themes (Orthoimagery, Land Use, Elevation ,…)

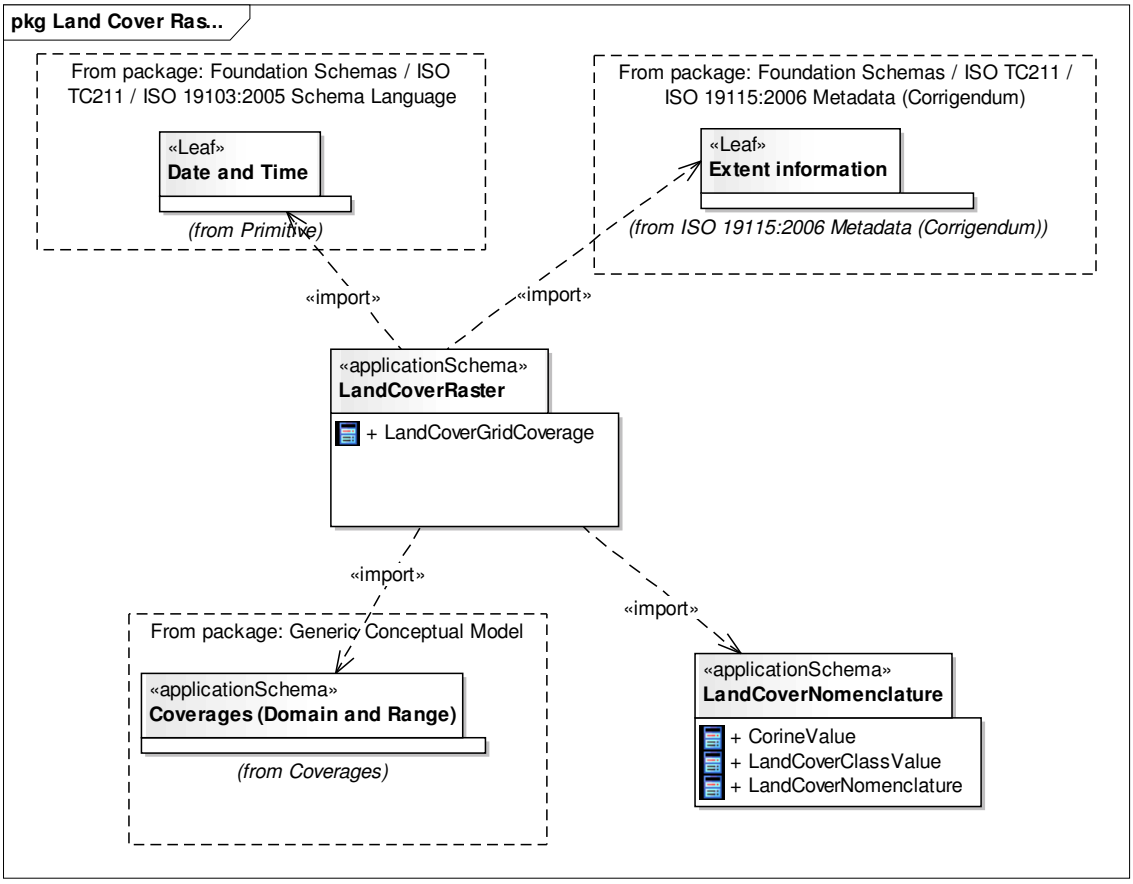


Figure 20 – UML package diagram: Overview of the LandCoverRaster application schema

The application schema LandCoverRaster contains one classe:

- *LandCoverGridCoverage* which defines how a grid coverage can support Land Cover information.

This class are detailed in the next subsection.

NOTE *CorineValue gives an example of an instantiated code list*.

5.6.1.2.1. LandCoverGridCoverage

The LandCoverRaster application schema models LC data as rectified grid coverages (in the sense of ISO 19123). This coverage supports the same set of attributes as the LandCoverData set (Land Cover Vector application schema) but has some restrictions compared to the vector model: It does not support all the semantic information provided by the LandCoverInformation:

1. There is no observation date.
2. There is no mosaic.

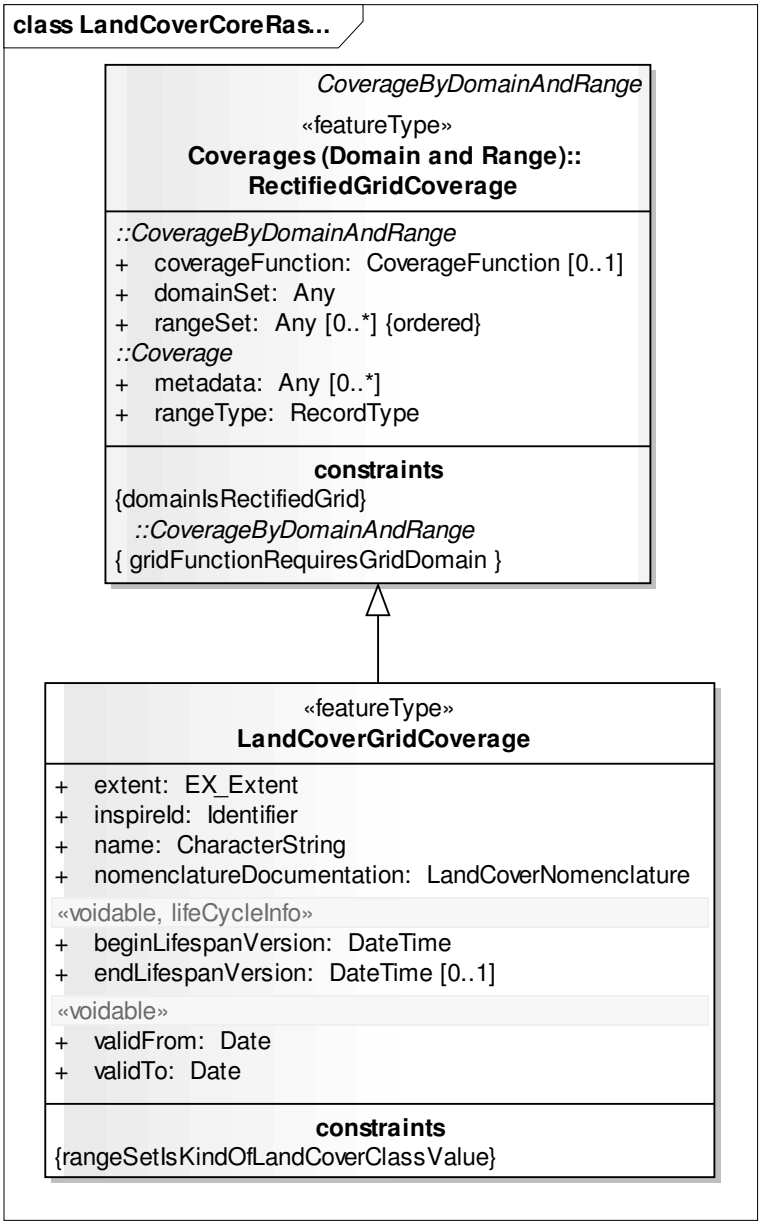


Figure 21 – UML class diagram: LandCoverRaster / LandCoverGridCoverage

Only the equivalent of the information *classValue* found in the Vector representation *(i.e. the reference to a code list through the type LandCoverClassValue)* is then supported by the raster representation of LC data (see figure above, with "rangeSetIsKindOfLandCoverClassValue" constraint). The rangeSet of the raster allows attaching a single classification code, resulting from a classification process, to each raster cell. These can be Corine codes, IGBP codes or other codes corresponding to a national, institutional or local nomenclature.

These restrictions are linked to the formats used to encode rectified grid coverages (as Geotiff) which only support one value per pixel.

5.6.1.3. Consistency between spatial data sets

Land cover data are described as an abstraction of the physical and biophysical cover of the earth's surface. Despite the fact that Land Cover is a transverse theme it has no real connections with other INSPIRE models, so there is no specific consistency rule with other spatial data sets.

5.6.1.4. Geometry representation

IR Requirement
Annex III, Section 2
Theme-specific Requirements

The value domain of spatial properties used in this specification shall be restricted to the Simple Feature spatial schema as defined by EN ISO 19125-1.

NOTE The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear.

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in EN ISO 19125-1).

5.6.1.5. Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

Recommendation 9	If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.6.1.5.1. Different types of dates

Different types of dates are described in section 5.3.1.6.1 above. The following requirement and recommendation using concepts from section 5.3.1.6.1 applies to the LandCoverRaster model.

NOTE 5.3.1.6 applies to raster as well. The only difference is that observation date is removed from LCUnit, but this is anyways voidable

TG Requirement 7	**"**Temporality information on *Land Cover"* data shall be provided by the followings date types: the observation date (b), the edit date (d).

The observation date (b) shall be provided at the coverage level (=data set) through metadata with lineage information (dateTime of the observation/acquisition processStep).

The edit date (d) shall be provided through the temporal attributes *beginLifespanVersion* and *endLifespanVersion* at the data set level (*LandCoverData set*).

Recommendation 10 Temporality information on Land Cover (reference date (c), and the release date (e)) should be provided through metadata elements at the coverage level.

For temporal reference, the Metadata Inspire Regulation requires to provide at least one of the metadata elements “temporal extent”, “date of publication”, “date of last revision”, “date of creation”.
The Land Cover specification recommends to provide the reference date (c) at coverage level (=data set) through the external metadata element Temporal reference / date of creation (see Chapter 8) and the release date (e) at the coverage level (=data set) through the external metadata element Temporal reference / date of publication (see Chapter 8).

5.6.2 Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema LandCoverRaster
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
LandCoverGridCoverage	LandCoverRaster	«featureType»

5.6.2.1. Spatial object types

5.6.2.1.1. LandCoverGridCoverage

LandCoverGridCoverage	
Name:	Land Cover Grid Coverage
Subtype of:	RectifiedGridCoverage
Definition:	A raster representation for Land Cover data.
Description:	This representation allows Land Cover data being supported by rectified grid coverage (ISO 19123).
Stereotypes:	«featureType»

Attribute: inspireId

Name:	inspireId
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1

Attribute: beginLifespanVersion

Name:	beginLifespanVersion
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was inserted or changed in the spatial data set.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: endLifespanVersion

Name:	endLifespanVersion
Value type:	DateTime
Definition:	Date and time at which this version of the spatial object was superseded or retired in the spatial data set.

LandCoverGridCoverage	
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»

Attribute: extent

Name:	extent
Value type:	EX_Extent
Definition:	Contains the extent of the data set.
Description:	NOTE Extents may be specified in space, time or space-time.
Multiplicity:	1

Attribute: name

Name:	name
Value type:	CharacterString
Definition:	Name of the Land Cover coverage.
Multiplicity:	1

Attribute: nomenclatureDocumentation

Name:	nomenclatureDocumentation
Value type:	LandCoverNomenclature
Definition:	Information about the nomenclature used in this coverage.
Multiplicity:	1

Attribute: validFrom

Name:	validFrom
Value type:	Date
Definition:	The time when the phenomenon started to exist in the real world.
Multiplicity:	1
Stereotypes:	«voidable»

Attribute: validTo

Name:	validTo
Value type:	Date
Definition:	The time from which the phenomenon no longer exists in the real world.
Multiplicity:	1
Stereotypes:	«voidable»

Constraint: rangeSetIsKindOfLandCoverClassValue

Natural language:	The values in the range set are restricted to Integer
OCL:	inv: rangeSet->forAll(v | v.oclIsKindOf(LandCoverNomenclature::LandCoverClassValue))

5.6.2.2. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.6.2.2.1. CharacterString

CharacterString	
Package:	Text
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.6.2.2.2. Date

Date	
Package:	Date and Time
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.6.2.2.3. DateTime

DateTime	
Package:	Date and Time
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.6.2.2.4. EX_Extent

EX_Extent	
Package:	Extent information
Reference:	Geographic information -- Metadata [ISO 19115:2003/Cor 1:2006]

5.6.2.2.5. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.6.2.2.6. LandCoverNomenclature

LandCoverNomenclature	
Package:	LandCoverNomenclature
Reference:	INSPIRE Data specification on Land Cover [DS-D2.8.II.2]
Definition:	Information about reference national, institutional or local Land Cover nomenclature.
Description:	Land Cover Nomenclature allows to reference nomenclatures documentation and associated code list, and to define them through an external reference or included within the data according 19144-2.

5.6.2.2.7. RectifiedGridCoverage

RectifiedGridCoverage	
Package:	Coverages (Domain and Range)
Reference:	INSPIRE Data Specifications – Base Models – Coverage Types, version 1.0 [DS-D2.10.2]
Definition:	Coverage whose domain consists of a rectified grid
Description:	A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system. NOTE This type can be used for both discrete and continuous coverages.

5.6.3 Externally governed code lists

The externally governed code lists included in this application schema are specified in the tables in this section.

5.6.3.1. Governance, availability and constraints

Code list	Governance	Version	Availability	Formats	Subset
LandCoverClassValue	N/A	N/A	Empty code list	N/A	

CorineValue	EEA	version 2006	http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-1/corine-land-cover-classes-and/clc_legend.csv/at_download/file	CSV	

The values of CorineValue external code lists are included in Annex E for information.

5.6.3.2. Rules for code list values

Code list	Identifiers	Identifier examples	Labels
CorineValue	code 111 could be referenced as	*http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-1/corine-land-cover-classes-and/clc_legend/111*	Continuous urban fabric (Label 3 of CSV file)

5.7 Application schema LandCoverExtension

5.7.1 Description

5.7.1.1. Narrative description

This application schema extends “LandCoverVector” models and allows:

- multiple nomenclatures, each described at the data set level.
- description of LandCoverUnits with different types of parameters.

Please note that this application schema is not normative and gives an example on how the Vector model can be extended for more complex Land Cover data.

5.7.1.2. UML Overview

The following diagram shows the extended data set “LandCoverData set” and the extend LC units “LandCoverUnits”:

- “LandCoverData set” extends LandCoverData set (from LandCoverVector AS) by adding the attribute nomenclatureDocumentationExtended, allowing to describe extra nomenclatures
- LandCoverUnits extends LandCoverUnit (from LandCoverVector AS), by adding
    - landCoverObservationExtended which support the same semantic as landCoverObservation but having a reference to a LandCoverNomenclature (as there are more than one nomenclature used).
    - parametricDescription which allows describing Land Cover Units with parameters. Three types of parameters are proposed here: presence (Yes/No), percentage and count. These categories are just examples and each data provider can define its own extended model and its own types of parameters.

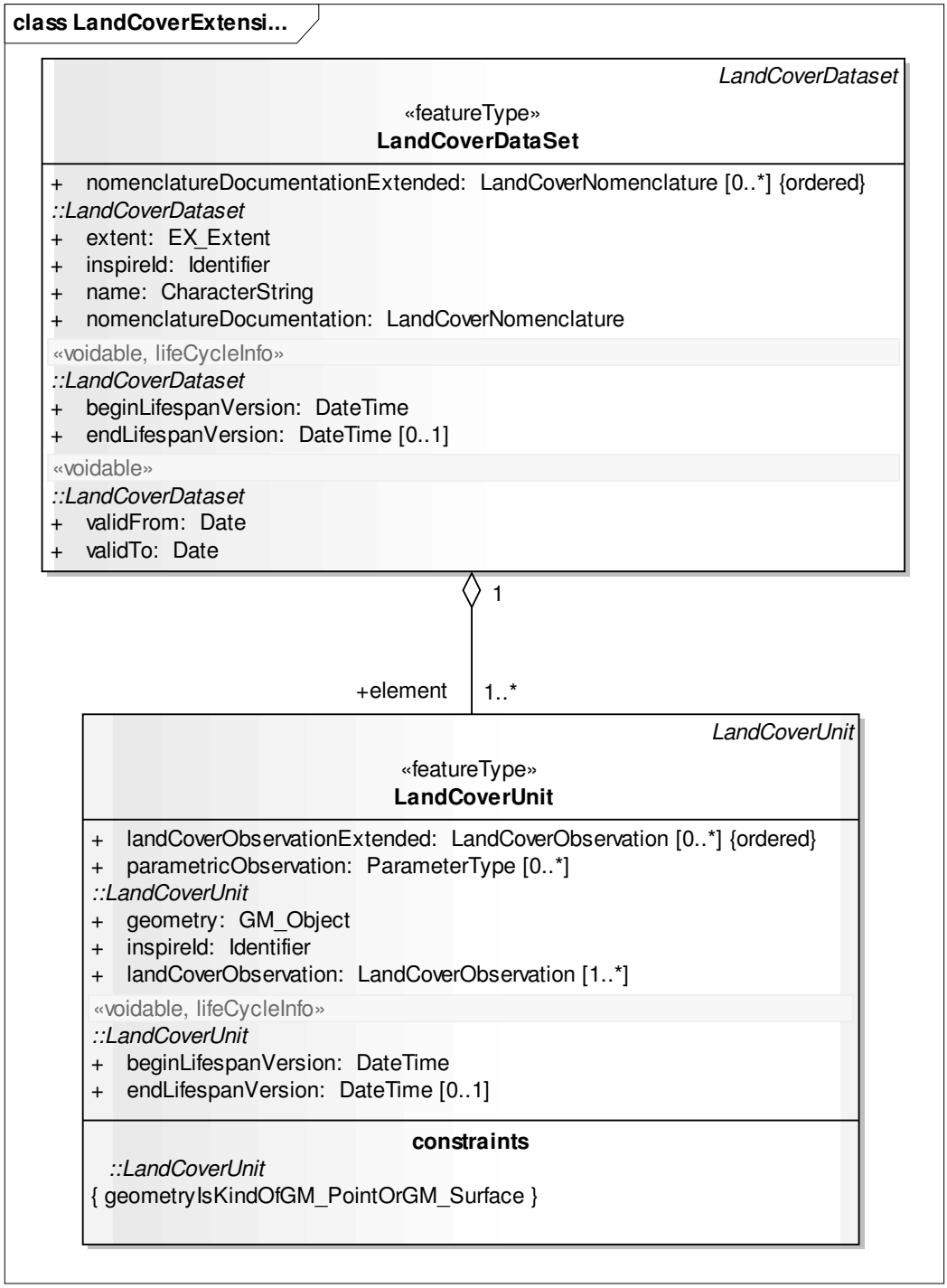


Figure 22 – UML class diagram: Overview of the LandCoverExtension application schema

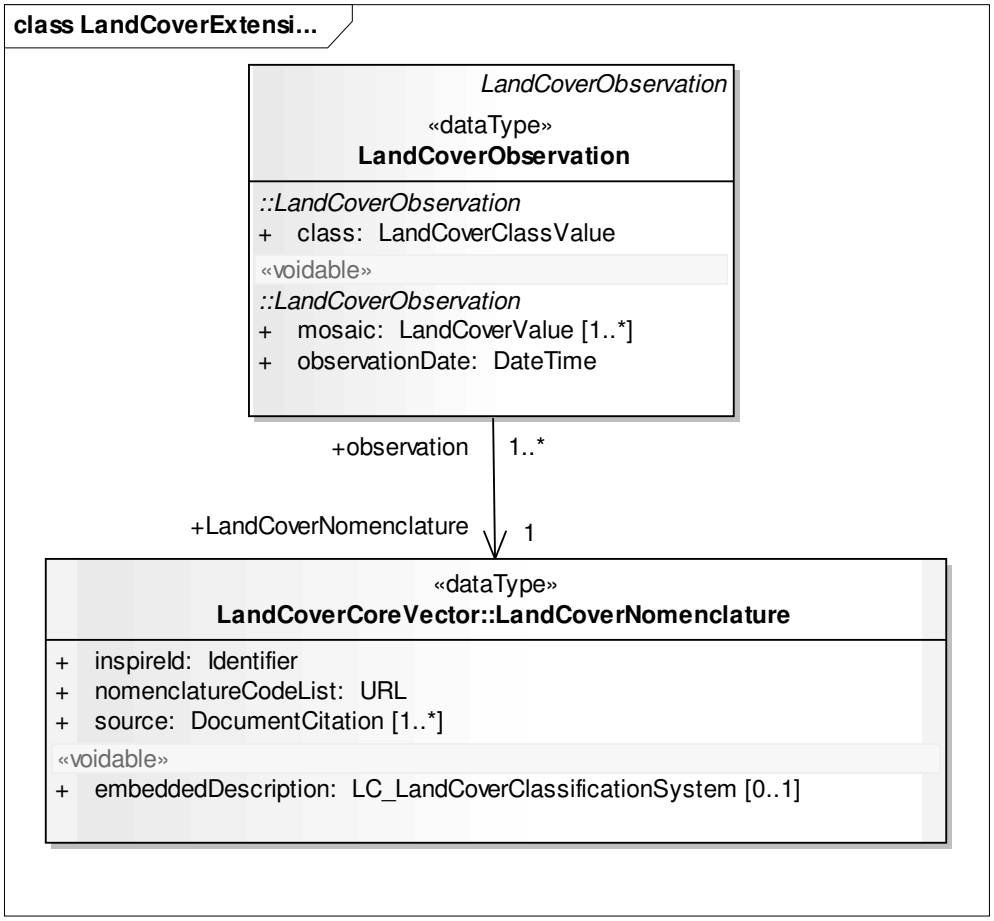


Figure 23 – UML class diagram: LandCoverExtension - LandCoverObservation

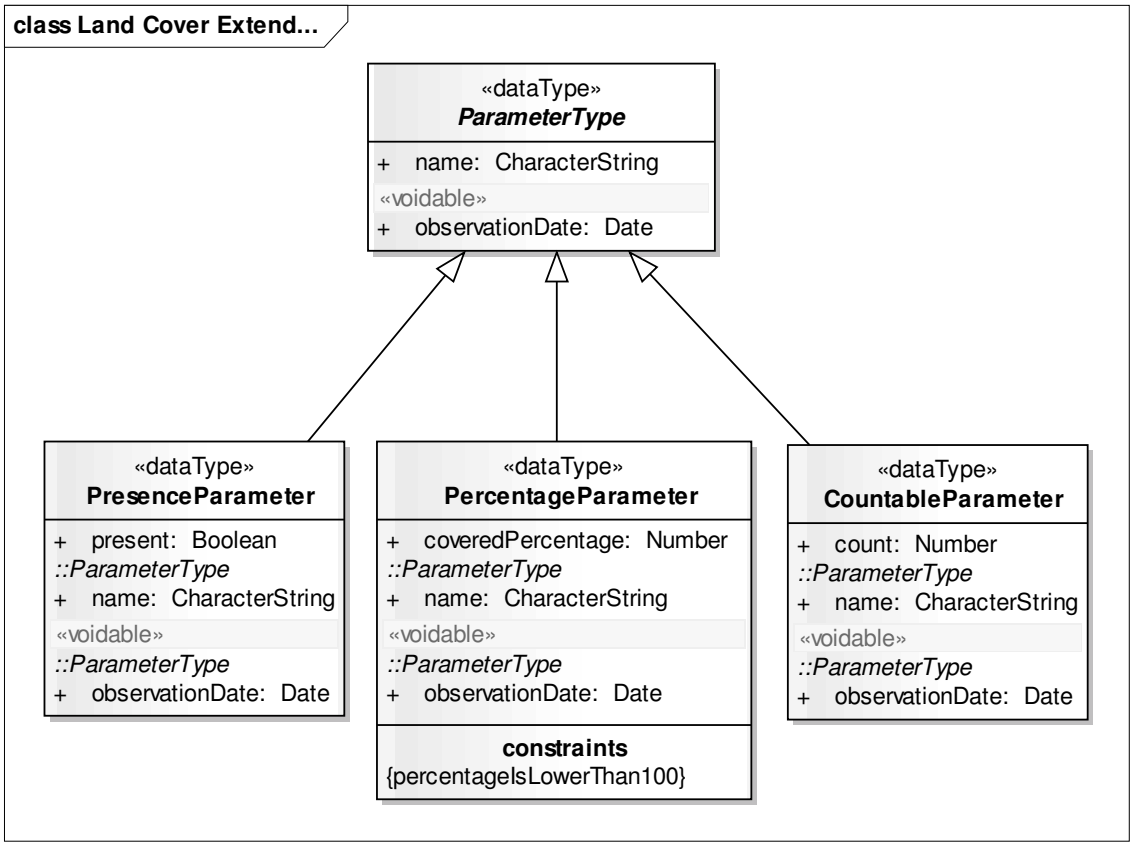


Figure 24 – UML class diagram: LandCoverExtension – ParameterType

When extending LandCoverVector application schema, same requirements apply, in particular sections 5.3.1.3 to 5.3.1.6. These sections are not repeated here.

5.7.2 Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema LandCoverExtension
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
CountableParameter	LandCoverExtension	«dataType»
LandCoverDataSet	LandCoverExtension	«featureType»
LandCoverObservation	LandCoverExtension	«dataType»
LandCoverUnit	LandCoverExtension	«featureType»
ParameterType	LandCoverExtension	«dataType»
PercentageParameter	LandCoverExtension	«dataType»
PresenceParameter	LandCoverExtension	«dataType»

5.7.2.1. Spatial object types

5.7.2.1.1. LandCoverDataSet

LandCoverDataSet
Name: Land Cover Extended Dataset Subtype of: LandCoverDataset

LandCoverDataSet	
Definition:	A vector representation for Land Cover data which extends the Core Vector model.
Description:	This representation allows Land Cover data being supported by a vector geometry. It adds support for parameter description and multiple nomenclatures within the same dataset.
Stereotypes:	«featureType»

Attribute: nomenclatureDocumentationExtended

Name:	nomenclatureDocumentationExtended
Value type:	LandCoverNomenclature
Definition:	Information about extra nomenclatures used in this dataset.
Multiplicity:	0..*

Association role: element

Name:	Element
Value type:	LandCoverUnit
Definition:	Elements of the data set.
Multiplicity:	1..*

5.7.2.1.2. LandCoverUnit

LandCoverUnit	
Name:	Land Cover Extended Unit.
Subtype of:	LandCoverUnit
Definition:	An individual element of the LC dataset represented by a point or polygon.
Description:	Every unit support Land Cover information.
Stereotypes:	«featureType»

Attribute: landCoverObservationExtended

Name:	landCoverObservationExtended
Value type:	LandCoverObservation
Definition:	Land cover information at a specific time and place and linked to additional nomenclatures.
Multiplicity:	0..*

Attribute: parametricObservation

Name:	parametricObservation
Value type:	ParameterType
Definition:	A description of Land Cover Units trough specific parameters.
Multiplicity:	0..*

5.7.2.2. Data types

5.7.2.2.1. CountableParameter

CountableParameter	
Name:	CountableParameter
Subtype of:	ParameterType
Definition:	Parameter describing a Land Cover Object aspect that can be counted.
Description:	A countable parameter could be a number (a number of landscape elements covering the land cover object for example. ie number of trees, buildings, ...), a distance (average height of buildings, ...), ..
Stereotypes:	«dataType»

Attribute: count

Name:	count
Value type:	Number
Definition:	The number associated to the parameter used to describe a Land Cover Object.
Multiplicity:	1

5.7.2.2.2. LandCoverObservation

LandCoverObservation	
Name:	Land Cover Extended Observation.
Subtype of:	LandCoverObservation
Definition:	Land Cover extended information interpreted at a specific time and place, according a nomenclature.
Stereotypes:	«dataType»
Association role: LandCoverNomenclature	
Name:	Land Cover Nomenclature
Value type:	LandCoverNomenclature
Definition:	Land Cover Nomenclature referenced by an extended observation.
Multiplicity:	1

5.7.2.2.3. ParameterType

ParameterType (abstract)	
Name:	ParameterType
Definition:	Parameter describing a Land Cover Object with landscape elements.
Description:	A parameter could be the presence of landscape elements (trees, buildings, sand, ...), their number or the percentage of a parameter describing the Land Cover Object (i.e; percentage of soil sealing).
Stereotypes:	«dataType»
Attribute: name	
Name:	name
Value type:	CharacterString
Definition:	The name of the parameter used to describe a Land Cover Object.
Multiplicity:	1
Attribute: observationDate	
Name:	observationDate
Value type:	Date
Definition:	The observation date associated to a description.
Multiplicity:	1
Stereotypes:	«voidable»

5.7.2.2.4. PercentageParameter

PercentageParameter	
Name:	PercentageParameter
Subtype of:	ParameterType
Definition:	Parameter describing a Land Cover Object which is described according a percent coverage.
Description:	A parameter describing the Land Cover Object (i.e; percentage of soil sealing).
Stereotypes:	«dataType»
Attribute: coveredPercentage	
Name:	coveredPercentage
Value type:	Number
Definition:	The percent value used to describe the area covered and associated to the parameter used to describe a Land Cover Object.
Multiplicity:	1
Constraint: percentageIsLowerThan100	
Natural language:	the coveredPercentage is lower or equal to 100
OCL:	inv: coveredPercentage <= 1000

5.7.2.2.5. PresenceParameter

PresenceParameter	
Name:	PresenceParameter
Subtype of:	ParameterType
Definition:	Presence or absence of a parameter describing a Land Cover Object.
Description:	A parameter could be the presence of landscape elements (trees, buildings, sand, ...).
Stereotypes:	«dataType»

Attribute: present

Name:	present
Value type:	Boolean
Definition:	The boolean value indicating the presence/absence of a specific characteristic / landscape element within a Land Cover Object.
Multiplicity:	1

5.7.2.3. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.7.2.3.1. Boolean

Boolean	
Package:	Truth
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.7.2.3.2. CharacterString

CharacterString	
Package:	Text
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.7.2.3.3. Date

Date	
Package:	Date and Time
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.7.2.3.4. LandCoverDataset

LandCoverDataset	
Package:	LandCoverExtension
Reference:	INSPIRE Data specification on Land Cover [DS-D2.8.II.2]
Definition:	A vector representation for Land Cover data.
Description:	This representation allows Land Cover data being supported by a vector geometry.

5.7.2.3.5. LandCoverNomenclature

LandCoverNomenclature	
Package:	LandCoverNomenclature
Reference:	INSPIRE Data specification on Land Cover [DS-D2.8.II.2]
Definition:	Information about reference national, institutional or local Land Cover nomenclature.
Description:	Land Cover Nomenclature allows to reference nomenclatures documentation and associated code list, and to define them through an external reference or included within the data according 19144-2.

5.7.2.3.6. Number

Number (abstract)	
Package:	Numerics
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]