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Second edition

**Geographic information —
Classification systems —**

**Part 2:
Land Cover Meta Language (LCML)**

*Information géographique — Systèmes de classification —
Partie 2: Métalangage pour l'occupation des sols (LCML)*

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Contents

	Page
Foreword.....	vi
Introduction.....	viii
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviated terms	1
3.1 Terms and definitions.....	1
3.2 Abbreviated terms.....	4
4 Conformance	4
4.1 Conformance requirements and testing.....	4
4.2 Conformance classes.....	4
4.3 Conformance class 1 — Description of a Land Cover classification system.....	4
4.4 Conformance class 2 — Comparison of Land Cover classification systems.....	4
5 Notation	4
6 Context	5
7 Conceptual basis	7
7.1 Definition adopted for Land Cover.....	7
7.2 Geometric aspects of classification.....	7
7.3 Relationship to Land Use.....	8
7.4 LCML approach to class definition.....	8
7.4.1 LCML basic principle.....	8
7.4.2 Land cover classification system design criteria.....	8
7.4.3 General rules for classification.....	9
7.4.4 Land cover metalanguage-elements.....	9
7.4.5 Layering.....	9
7.4.6 Packages.....	9
8 LCML objects	10
8.1 Overview of LCML objects.....	10
8.2 Relation to ISO 19144-1.....	11
8.3 Composition of a LC_LandCover object.....	11
8.4 Elements of the LCML metamodel.....	12
8.5 High level structure.....	12
8.5.1 High level structure subtypes.....	12
8.5.2 High level structure classes.....	12
8.6 Land Cover Meta Language object structure.....	13
8.6.1 Land Cover Meta Language object structure subtypes.....	13
8.6.2 Land Cover Meta Language object structure classes.....	16
8.7 LC_Element.....	24
8.7.1 LC_Element subtypes.....	24
8.7.2 LC_Element classes.....	25
8.8 LC_VegetationElement.....	25
8.8.1 LC_VegetationElement subtypes.....	25
8.8.2 LC_VegetationElement classes.....	25
8.9 LC_GrowthForm.....	26
8.9.1 LC_GrowthForm subtypes.....	26
8.9.2 LC_GrowthForm classes.....	27
8.10 LC_WoodyGrowthForm.....	28
8.10.1 LC_WoodyGrowthForm subtypes.....	28
8.10.2 LC_WoodyGrowthForm classes.....	29
8.11 LC_HerbaceousGrowthForm.....	32
8.11.1 LC_HerbaceousGrowthForm subtypes.....	32
8.11.2 LC_HerbaceousGrowthForm classes.....	32

8.12	LC_LichenAndMoss	34
8.12.1	LC_LichenAndMoss subtypes	34
8.12.2	LC_LichenAndMoss classes	34
8.13	LC_AbioticElement	35
8.13.1	LC_AbioticElement subtypes	35
8.13.2	LC_AbioticElement classes	35
8.14	LC_ArtificialSurfaceElement	36
8.14.1	LC_ArtificialSurfaceElement subtypes	36
8.14.2	LC_ArtificialSurface classes	36
8.15	LC_NaturalSurfaceElement	36
8.15.1	LC_NaturalSurfaceElement subtypes	36
8.15.2	LC_NaturalSurfaceElement classes	37
8.16	LC_WaterBodyAndAssociatedSurfaceElement	37
8.16.1	LC_WaterBodyAndAssociatedSurfaceElement subtypes	37
8.16.2	LC_WaterBodyAndAssociatedSurfaceElement classes	38
8.17	LC_BuiltUpSurface	41
8.17.1	LC_BuiltUpSurface subtypes	41
8.17.2	LC_BuiltUpSurface classes	42
8.18	LC_NonBuiltUpSurface	43
8.18.1	LC_NonBuiltUpSurface subtypes	43
8.18.2	LC_NonBuiltUpSurface classes	44
8.19	LC_RocksSurfaceElement	45
8.19.1	LC_RocksSurface subtypes	45
8.19.2	LC_RocksSurfaceElement classes	45
8.20	LC_SoilSandDepositsSurfaceElement	46
8.20.1	LC_SoilSandDepositsSurfaceElement subtypes	46
8.20.2	LC_SoilSandDepositsSurfaceElement classes	47
8.21	LC_ClassCharacteristic	50
8.21.1	LC_ClassCharacteristic subtypes	50
8.21.2	LC_ClassCharacteristic classes	51
8.22	LC_LandCoverElementCharacteristic	53
8.22.1	LC_LandCoverElementCharacteristic subtypes	53
8.22.2	LC_LandCoverElementCharacteristic classes	54
8.23	LC_GrowthFormCharacteristic	55
8.23.1	LC_GrowthFormCharacteristic subtypes	55
8.23.2	LC_GrowthFormCharacteristic classes	57
8.24	LC_NameAttributionCriteria	59
8.24.1	LC_NameAttributionCriteria subtypes	59
8.24.2	LC_NameAttributionCriteria classes	60
8.25	LC_CultivatedAndManagedVegetationCharacteristic	61
8.25.1	LC_CultivatedAndManagedVegetationCharacteristic subtypes	61
8.25.2	LC_CultivatedAndManagedVegetationCharacteristic classes	62
8.26	LC_ArtificialSurfaceCharacteristic	65
8.26.1	LC_ArtificialSurfaceCharacteristic subtypes	65
8.26.2	LC_ArtificialSurfaceCharacteristic classes	66
8.27	LC_WaterAndAssociatedSurfaceCharacteristic	67
8.27.1	LC_WaterAndAssociatedSurfaceCharacteristic subtypes	67
8.27.2	LC_WaterAndAssociatedSurfaceCharacteristic classes	68
8.28	LC_ValueObject permitted numeric values	69
8.28.1	LC_ValueObject general description	69
8.28.2	LC_ValueObject types	71
9	Extension of the LCML	74
9.1	Extension process	74
9.2	Registration of extensions	74
9.3	Backward compatibility through registration	75
Annex A (normative) Abstract test suite		76

Annex B (informative) The relationship of the LCML to the General Feature Model of ISO 19109	78
Annex C (informative) Examples of the use of LCML	81
Annex D (informative) Glossary of Land Cover meta-elements	112
Annex E (informative) Backward compatibility	131
Annex F (informative) The vertical and horizontal characterization of Land Cover features	134
Bibliography	144

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287, *Geographic Information*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement), and in collaboration with the Food and Agriculture Organization of the United Nations (UN FAO).

This second edition cancels and replaces the first edition (ISO 19144-2:2012), which has been technically revised.

The main changes are as follows:

- This revision of ISO 19144-2:2012 has divided the original International Standard into additional parts.
- Material from ISO 19144-2:2012, Clause 9, on registration has been removed and is intended to be included in ISO 19144-4¹⁾.
- Material related to Land Use has been removed and is intended to be included in ISO/TS 19144-3²⁾.
- The high-level model has been changed to promote the attribute of *cover and element Spreading Geometry* to the LC_Element level with the addition of the new attribute, *density*.
- Various changes have been made to certain types and classes (see [Annex E](#)).
- Several of the definitions from ISO 19144-2:2012 have been improved in a backward compatible manner and UML and textual errors in the previous model have been corrected.

1) Under preparation. Stage at the time of publication: ISO/PWI 19144-4:2023.

2) Under preparation. Stage at the time of publication: ISO/AWI TS 19144-3:2023.

- A new [Annex E](#) has been added describing the changes to ISO 19144-2:2012 in more detail and addressing backward compatibility.

A list of all parts in the ISO 19144 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Efficient assessment of Land Cover and the ability to monitor change are fundamental to the sustainable management of natural resources, environmental protection, food security and successful humanitarian programmes. Such information is also required to help with raising levels of nutrition, improving agricultural productivity, enhancing the lives of rural populations and contributing to the sustainable growth of the world economy. However, in the past, policymakers and planners have not had access to reliable and comparable Land Cover data, both for lower-income countries and sometimes also at the regional and global levels.

Access has been limited by two factors: lack of mapping activities and lack of commonality between systems. The solution has been to carry out separate regional mapping projects using national or regional Land Cover classification systems. However, it has been difficult to compare or to exchange information between current systems.

The aim of this document is to enable the comparison of information from existing classification systems in a meaningful way without replacing them. The aim is to complement the development of future classification systems that can offer more reliable collection methods for particular national or regional purposes by allowing them to be described in a consistent manner.

A critical factor in implementing such global activities is the availability of an international standard for documentation of Land Cover classification systems. This then provides a reliable basis for interaction without replacing the increasing number of national, regional and global Land Cover mapping and monitoring activities. This enables comparisons of Land Cover classes to be made regardless of mapping scale, Land Cover type, data collection method or geographic location.

Another critical factor is the availability of a common reference for Land Cover classification systems. This document provides a metalanguage expressed as a UML model that allows different Land Cover classification systems to be described.

This document establishes a metalanguage for a set of objects and rules (language) to describe Land Cover features based on physiognomy that can be part of different Land Cover Legends (nomenclature). This provides a framework for comparing different systems and nomenclatures such as CORINE, Africover, Anderson (USGS), Global Map and national systems, without replacing them. This is not a description of a nomenclature, nor is it a description of a specific set of classes.

An additional part of the ISO 19144 series (ISO/TS 19144-3³⁾) addresses Land Use aspects. Land Use by human activity is different from Land Cover. Land Cover is based on the physiognomic aspects of the plants and other elements covering the observed surface of the Earth. Land Use identifies the human activities, such as agriculture, mining or other actions taken by humans to modify the Earth cover. Land use is primarily defined in terms of human economic functions which result in a series of different human activities. In this context, Land Cover defines biophysical Earth objects on which human activities take place. The two types of classifications are closely related and in some Classification Systems they are sometimes mixed. The Land Use Metalanguage described in ISO 19144-3 can be used alone to simply describe Land Use, or it can be combined with the Land Cover Metalanguage to be able to describe classification systems that have mixed aspects of both Land Cover and Land Use.

Another part of the ISO 19144 series (ISO 19144-4⁴⁾) is intended to include a description of the registration and implementation aspects for Land Cover Land Use Classification. This allows code lists and other details used in the Land Cover and Land Use systems to be registered. Code lists allow attribute values and other characteristics to be open-ended and registration allows these elements to be defined.

EXAMPLE Soil types can make use of the UN FAO soil classification list of soil types,^[45] or the more recent World Reference Base for Soil Resources,^[59] or the USDA soil taxonomy^[60] or the European Soils Bureau legend.^[19]

3) Under preparation. Stage at the time of publication: ISO/AWI TS 19144-3:2023.

4) Under preparation. Stage at the time of publication: ISO/PWI 19144-4:2023.

Appropriate references to externally managed lists or lists established particularly for the ISO 19144 series can be registered. In addition, whole classification systems described using the Land Cover or Land Use parts of the ISO 19144 series (i.e. this document and ISO 19144-3) can be registered.

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In this document UML attributes names are given in *italics*.

In accordance with the ISO/IEC Directives, Part 2, 2018, Rules for the structure and drafting of International Standards, in International Standards the decimal sign is a comma on the line. However, the General Conference on Weights and Measures (Conférence Générale des Poids et Mesures) at its meeting in 2003 passed unanimously the following resolution:

“The decimal marker shall be either a point on the line or a comma on the line.”

In practice, the choice between these alternatives depends on customary use in the language concerned. In the technical areas of geodesy and geographic information it is customary for the decimal point always to be used, for all languages. That practice is used throughout this document.

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Geographic information — Classification systems —

Part 2: Land Cover Meta Language (LCML)

1 Scope

This document specifies a Land Cover Meta Language (LCML) expressed as a UML metamodel that allows different Land Cover classification systems to be described based on the physiognomic aspects. This document recognizes that a number of Land Cover classification systems exist. It provides a common reference structure for the comparison and integration of data for any generic Land Cover classification system, but does not intend to replace those classification systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19109, *Geographic information — Rules for application schema*

ISO 19103, *Geographic information — Conceptual schema language*

ISO 19123-1, *Geographic information — Schema for coverage geometry and functions Part 1: Fundamentals*

ISO 19144-1, *Geographic information — Classification systems — Part 1: Classification system structure*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19144-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

NOTE 1 The technical terms applying to plant physiognomy, and terms from other disciplines used to establish the classifiers in the classification system are not defined in this document.

NOTE 2 The term "class" is used in the ISO 19144 series to represent a construct in a classification system. However, the term has several meanings in other contexts, including in the UML modelling language. Where possible, attributes or other identifiers are needed to distinguish between the various use of the term "class".

3.1.1

abstract test suite

ATS

set of conformance classes that define tests for all requirements of a specification

Note 1 to entry: Evidence of conformance to all or part of a standard, awarded for passing one or more of the conformance test classes specified in that standard.

[SOURCE: ISO 19105:2022, 3.3]

3.1.2

area of incidence

substratum area entirely topped by the entire Land Cover Meta Language (LCML) basic element itself or by its canopy effect

3.1.3

area of pertinence

area where a specific Land Cover Meta Language (LCML) element extends

3.1.4

characteristic

<classification> distinguishing qualitative attribute of a metalanguage basic element

3.1.5

class

<UML> description of a set of objects that share the same attributes, operations, methods, relationships, and semantics

[SOURCE: ISO 19103:2015, 4.7]

3.1.6

class

<classification> result of a classification process as part of a classification system which subdivides concepts within a given topic area

3.1.7

cover

<classification> area of incidence of a Land Cover Meta Language (LCML) basic element over the substratum in the area of pertinence of the basic element

3.1.8

element portioning

<classification> percent value of the area of pertinence of a single Land Cover Meta Language (LCML) basic element when two or more LCML basic elements are considered in the same stratum

Note 1 to entry: The sum of the whole portioning values for all elements considered within a stratum must always be equal to 100 %.

Note 2 to entry: Element portioning is distinct from strata portioning.

3.1.9

grid

<coverage> covering of a multi-dimensional region using quadrilateral shapes (in the 2D case) or their n -dimensional generation (in the n D case) with no overlaps and gaps

[SOURCE: ISO 19123-1:2023, 3.1.28, modified — Notes 1 and 2 have been removed.]

3.1.10

land cover

observed (bio)physical cover on the Earth's surface

Note 1 to entry: Land cover is distinct from land use.

[SOURCE: UN FAO, 2005, *LCCS — Land Cover Classification System — Classification concepts and user manual*]^[44]

3.1.11**land cover metalanguage**

LCML

logical general model used to describe the characteristics of land cover features used as classifiers and the more specific rules that constitute a particular classification system

3.1.12**land use**

arrangements, activities and inputs people undertake in a certain land cover type to maintain it or produce change

EXAMPLE “Recreation area” is a land use term that can be applicable to different land cover types, e.g. sandy surfaces such as a beach; a built-up area such as a pleasure park; woodlands; etc.

Note 1 to entry: The definition of land use in this way establishes a direct link between land cover and the actions of people in their environment. Multiple land uses can coexist at the same location (e.g. forestry and recreation), contrary to land cover classes that are mutually exclusive.

[SOURCE: UNFAO. 2005, *LCCS — Land Cover Classification System — Classification concepts and user manual*]^[44]

3.1.13**point cloud**

collection of data points in 3D space

[SOURCE: ISO/TS 19130-2:2014, 4.51]

3.1.14**physiognomy**

<classification> general appearance of an object or terrain, without reference to its underlying or scientific characteristics

3.1.15**property**

<classification> distinguishing additional physiognomic attribute of a metalanguage basic element

3.1.16**strata portioning**

<classification > percent value expressing the portion by which a stratum comprises a part of the whole, where the aggregate of multiple related strata is constrained so that the sum of all of the related strata (projected in orthogonal plane) equals 100 %

Note 1 to entry: This allows the expression of situations where elements that are obscured by other elements cannot be seen, for example, the inability to see beneath the tree canopy in views from some types of satellite imagery.

Note 2 to entry: Strata portioning is distinct from element portioning.

3.1.17**triangulated irregular network**

TIN

tessellation composed of triangles

[SOURCE: ISO 19123-1:2023, 3.1.50]

3.2 Abbreviated terms

CEC	Commission of the European Communities
CORINE	Coordination of Information on the Environment (EU)
LCCS	Land Cover Classification System
TDS	total dissolved solids
UML	unified modeling language
UNFAO	United Nations Food and Agriculture Organization
UNFAO LCCS	UNFAO Land Cover Classification System
XML	Extensible Markup Language
XSD	XML Schema

4 Conformance

4.1 Conformance requirements and testing

Conformance to this document consists of alignment with the requirements established in [4.2](#), [4.3](#), [4.4](#), [9.2](#) and [9.3](#). The abstract test suite given in [Annex A](#) describes the applicable methodology for testing conformance to these requirements.

4.2 Conformance classes

Two conformance classes are identified in this document, one for the description of a Land Cover classification system and the other for the comparison between two or more Land Cover classification systems.

4.3 Conformance class 1 — Description of a Land Cover classification system

Requirement 1: The description of Legends or Land Cover Application Schema using this document shall consist of a set of UML classes with associated attributes that correspond to instantiations of the metalanguage classes described in [Clause 8](#) or the extended metalanguage classes described through the mechanism described in [Clause 9](#).

NOTE The levels of instantiation between the Land Cover Meta Language and a Land Cover Classification System and Application Schema and the relation to the ISO geographic information General Feature Model of ISO 19109 is described in [Annex B](#).

4.4 Conformance class 2 — Comparison of Land Cover classification systems

Requirement 2: The process of comparison of two Land Cover classification systems shall be performed by developing descriptions of the two Land Cover classification systems, each in accordance with Requirement 1, and then identifying the differences on a class-by-class basis. This can be repeated for more than two Land Cover classification systems under comparison.

NOTE The level of detail of the comparison is dependent on the use case.

5 Notation

The conceptual schema specified in this document is described using Unified Modeling Language (UML), in accordance with ISO 19103.

Several model elements used in this schema are defined in other ISO geographic information standards, in particular ISO 19123-1 and ISO 19103. By convention within ISO/TC 211, names of UML classes, with the exception of basic data type classes, include a three-letter prefix that identifies the International Standard and the UML package in which the UML class is defined. UML classes defined in this document have the three-letter prefix of "LC_". Examples in this document have the three-letter prefix "EL_". The classes in the meta model in [Annex B](#) use the prefix "LM_". [Table 1](#) lists the other International Standards and packages in which UML classes used in this document have been defined.

Table 1 — Sources of externally defined UML classes

Prefix	International Standard	Package
CL	ISO 19144-1	Classification system structure
CV	ISO 19123-1	Coverage geometry

The stereotype <<metalanguage>> is used throughout this document to identify metalanguage objects that compose the LC_LandCoverClassDescriptor. As illustrated in [8.5.1](#), LC_LandCoverClassDescriptor and its components are at a higher level of abstraction than the LC_LandCoverClass that form a Land Cover Classification System, which are at the Application Schema level. A Legend as described in ISO 19144-1 is the simplest type of Application Schema.

The stereotype <<metalanguage>> applies to a class whose instances are other classes that are described by the metalanguage class.

The term "class" is an English word with a dictionary definition. However, it also has several meanings within the ISO 19144 series, dependent upon context. Classification is a process and the results of a classification process is a "class". The term "class" (<classification>; [3.1.6](#)) is used in the ISO 19144 series to represent a construct in a classification system. However, the term "class" has several other meanings in other contexts. A classification system consists of a set of classes subdividing the concepts within a given topic area. There is an unavoidable conflict with the terminology when a modelling language such as UML is used to describe a classification system metalanguage such as the LCML. The UML modelling language uses the term "class" (<UML>; [3.1.5](#)) as a construct in an object-oriented programming or data modelling paradigm, as the template for an object. That is, a UML class describes the properties associated with the instances of the class called objects. The term "class" is used in normal practice in both modelling and classification, and it is unreasonable for either modelling or classification to avoid the term. The term "Item Class" is also used in the process of registration, identifying the item that is registered. This term occurs in other parts of the ISO 19144 series. Adjectives have been used in this document where possible to reduce this confusion. For example, UML classes can be called "UML classes" and classification system classes can be called "classification classes" or "legend classes". At times, a UML class describes a classification class and it is possible to dispense with the adjective since both meanings of "class" are equivalent in the context. The conflict results from the fact that there is a deep relationship between data modelling and classification as used in other domains.

There is a similar related potential conflict with the associated terms of "attribute" and "object". Adjectives have been used where possible, but at times it is necessary to derive the meaning from the context. Other terms where there is a potential for confusion are the terms "element", "component", "characteristic" and especially "attribute". The use of these terms is potentially confusing as they have different meanings in different contexts. These terms come from different places and all that can be controlled is their usage in the ISO 19144 series. Care is taken to use adjectives with these terms to help to clarify their meaning.

6 Context

The purpose of this document is to define a common reference structure for the description and comparison of Legends or Application Schema for any generic Land Cover classification system. The approach has been to define an LCML expressed as a UML model that allows different Land Cover classification systems to be described. This approach provides a rigorous logical framework for the description of any Land Cover classification system. This will improve the harmonization and