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| Service Contract 55828 based on the restricted procedure No EEA/MDI/14/009 following a call for expression of interest EEA/SES/13/005-CEI  **Final Report** |
| Assistance to the EEA in the production of the new CORINE Land Cover (CLC) inventory, including the support to the harmonisation of national monitoring for integration at pan-European level |
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| 30. December 2014  Version 1.0 |
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Table of Contents

[1 Project background 2](#_Toc434241975)

[2 Task 1: Explanatory Documentation 4](#_Toc434241976)

[3 Task 2: Fine-tuning 5](#_Toc434241977)

[3.1 Collection of fine-tuning proposals 5](#_Toc434241978)

[3.2 Fine-tuning process 6](#_Toc434241979)

[3.3 Proposal for mechanism for continued fine-tuning 6](#_Toc434241980)

[4 Task 3: Data Model 7](#_Toc434241981)

[4.1 EAGLE Vector Model 7](#_Toc434241982)

[4.2 EAGLE Raster Model 7](#_Toc434241983)

[4.3 Data Model documentation 8](#_Toc434241984)

[4.4 Optional: GML-Schema 8](#_Toc434241985)

[5 Project administration 10](#_Toc434241986)

# Project background

With a view to the implementation of a future-oriented approach the EEA has requested support in developing a pan-European land cover concept to underpin policies at local to pan-European scales. This new concept shall allow better integration and harmonisation of national and regional land cover mapping activities.

To this end the EEA put out a call for expression of interest (CEI) to provide assistance to the EEA in the production of the new CORINE Land Cover (CLC) inventory, including the support to the harmonisation of national monitoring for integration at pan-European level (EEA/SES/13/005-CEI). The call represents a framework contract against which a number of contracts would be released to for projects which deal with one or more topics in this field.

Much of the EEA’s requirement is related to the work that has been undertaken over the last few years by the EAGLE group (Eionet Action Group on Land monitoring in Europe). The EAGLE Group was set up in 2009 by subset of Eionet (European Environment Information and Observation Network) NRCs (National Reference Centres) on land cover and other interested parties as a response to the growing need to discuss solutions for better integration and harmonization of national mapping activities within European land monitoring initiatives (i.e. CLC). The conceptual work is done at a technical level, independently from any political or industry preferences, following the concept of a bottom-up approach. EAGLE has been formed as a group of volunteers some 4 years ago and developed the current status of the EAGLE data model and matrix. Central to this work has been the EAGLE concept for decomposition of often mixed land cover / land use definitions into separate components which better describe the classes, allow comparison and translation and increase the power and use of land monitoring data.

The objectives of this specific contract (SC 55828) are to fine-tune, finalise and document the EAGLE concept and to develop a final consolidated version of the UML data model.

The three main tasks are therefore:

1. Development of explanatory documentation for the EAGLE concept as in its current draft development status;
2. Fine tuning of the draft EAGLE data model/matrix;
3. UML (Unified Modelling Language) model for the EAGLE concept.

The current report is the final report of this undertaking. The detailed outcomes of the work (i.e. documentation, matrix, UML data model) are provided as exhaustive, standalone documents in annex to this report.

The task outcomes are the result of collaborative work of the different members of the EAGLE working group which has been compiled by the individual task leaders. The following persons contributed to the project outcomes:

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| --- | --- | --- |
| ***Name*** | ***Affiliation*** | ***Task involvement*** |
| Stefan Kleeschulte | GeoVille | Project coordination |
| Stephan Arnold | Natural person | Task 1 leader |
| Barbara Kosztra | FÖMI | Task 2 leader |
| Gebhard Banko | EAA | Task 3 leader |
| Nuria Valcárcel | IGN Spain | Contributor |
| Julián Delgado | IGN Spain | Contributor |
| Xalo Fernandez | IGN Spain | Contributor |
| Christoph Perger | FOTEC | Contributor |
| Gerard Hazeu | Alterra | Reviewer |
| Pavel Milenov | ReSAC | Contributor |
| Geoff Smith | Specto Natura | Contributor / reviewer |
| César Martínez Izquierdo | UAB | Contributor / reviewer |
| Roger Milego Agràs | UAB | Reviewer |
| Emanuele Mancosu | UMA | Contributor / reviewer |
| Dania Abdu Malak | UMA | Reviewer |
| Elise Järvenpää | SYKE | Reviewer |
| Lena Hallin-Pihlatie | SYKE | Reviewer |
| Markus Törmä | SYKE | Reviewer |
| Geir-Harald Strand | NFLI | Reviewer |
| Charlotte Steinmeier | WSL | Reviewer |

# Task 1: Explanatory Documentation

*Task lead: Stephan Arnold, Frankfurt, Germany.*

*Deliverable: (a) printable explanatory documentation in PDF format, (b) 2 hard copies of explanatory documentation*

The EAGLE concept embodies the EAGLE matrix and the EAGLE data model as the two outcomes of the EAGLE groups work, as well as the conceptual idea of its application. To help the user understand the concept, an explanatory documentation has been written.

This documentation was created in close relation with task 2 fine tuning of the data model and task 3 UML data model. The content between the EAGLE matrix and the UML data model has been synchronized. The explanatory documentation contains the thematic and semantic definitions of the model elements and their meaning in the larger context of the model.

The documentation consists of four parts:

1. an introduction to the topic with background and scope,
2. the hierarchically structured explanation of the Land Cover Components, the Land Use Attributes and the Characteristics,
3. a brief explanation of how to use the matrix and
4. the relation with other existing standards and nomenclatures (distributed along the document).

It should be mentioned that this documentation only tackles the thematic definitions of the model elements. The UML model itself is explained separately in the outcomes of task 3 (see Chapter 4 - Task 3: Data Model).

The explanatory documentation is available in textual form in PDF file format:

* T1\_APPENDIX 1: EAGLE\_ConceptExplDocumentation\_v2.3 (0,3 MB)

# Task 2: Fine-tuning

*Task lead: Barbara Kosztra, FÖMI, Budapest, Hungary.*

*Deliverable: (a) A new version of data model in matrix notation (Excel sheet), (b) documentation of changes in a descriptive format.*

The purpose of this task was to fine-tune the content and structure of the EAGLE matrix and model, based on proposals collected from a number of sources and events and by considering various user requirements.

The starting point of the work was the EAGLE data model (matrix and UML chart) as available on the EAGLE website (http://sia.eionet.europa.eu/EAGLE/Outcomes/MATRIX\_20130619\_v03\_download.xls,

dated 19.06.2013).

The results provided as deliverables of Task 2 are

* ***The new version of data model in matrix notation***(T2\_APPENDIX 1 :EAGLE\_MATRIX\_20141230\_v01.xlsx)
* ***A list of thematic changes applied to the matrix***   
  (T2\_APPENDIX 2: EEA\_MDI\_14\_009\_d5\_fine\_tuning\_changes\_MATRIX\_v01.doc)

Changes to matrix are not highlighted in the excel sheet, only in the document. Changes made to the UML model structure are documented separately as part of Task 3 deliverable.

## Collection of fine-tuning proposals

Fine-tuning changes were based on feedback and proposals from:

* earlier meetings of the EAGLE group
* NRC meetings
* ETC/SIA meetings
* conferences/workshops where EAGLE model was presented
* FP7 HELM project meetings
* deliverables of FP7 HELM project Tasks 3.2 (Common needs and requirements), Task 4.3 (Data model), Task 5.1 (European actors) and HELM final report (booklet)
* stakeholder criteria collection (DG AGRI, DG REGIO, INSPIRE, EUROSTAT, ESA)
* implementation of ETC/SIA Task 261\_1\_1 of IP 2013 (enhancement of CLC nomenclature guidelines)
* implementation of ETC/SIA Task 181\_2 of IP 2014 (Assessment of Eagle model for habitat mapping: GHC (General habitat Categories) CLCLCCS)
* testing of matrix against CLC
* iterative consultation process of fine-tuning proposals collection as part of current call, including testing of matrix with view on
  + CLC
  + UK Broad Habitat Categories
  + UNFCCC Kyoto Protocol reporting requirements
  + LPIS information requitements
  + meetings organized as part of current call
* Madrid, 12-14 November 2014 –Task 1,2,3 meeting
* Frankfurt, 10-12 December 2014 – Task 1,2 meeting

Matrix/model modifications proposals were collected and integrated to the internally set up ‘Comment Resolution Table’. The table is used for the collection of comments and tracking their working status, with information on inter alia their source, thematic field, proposed change, resolution, status of implementation. Altogether **188 proposals for modification of model/matrix were collected** during the above procedures.

## Fine-tuning process

The **EAGLE matrix has been modified in 89 cases**, which are summarized in document EEA\_MDI\_14\_009\_d5\_fine\_tuning\_changes\_MATRIX\_v01.doc. Modifications include renaming, removal, addition, moving and subdivision of matrix segments / elements.

Regarding thematic harmonization of the EAGLE model and the related INSPIRE themes general principle applied was to align matrix and model where possible and divert from INSPIRE themes´ specifications only where necessary for EAGLE user requirements. For the moment – and in line with this principle – only those EAGLE modifications to HILUCS are taken over to UML model that are necessary for expressing CLC classes. (However all are included to matrix block LUA.) Where found necessary, INSPIRE thematic clusters are planned to be approached proposing modification of relevant themes as part of the currently ongoing INSPIRE maintenance process.

It has to be noted that during the implementation of the task not all open issues regarding matrix and model could be closed. The applicability of modelling solutions and thematic content (integrated code lists) is subject to testing during upcoming steps of the proof-of-concept procedure. As result of these next steps, the fine-tuning procedure and the consequential updating of documentation are foreseen to continue.

## Proposal for mechanism for continued fine-tuning

Proposals for a mechanism for continued fine tuning have been discussed. On the longer term technically two solutions were seen allowing the involvement of the user community in further developing the data model.

* + ***Wiki-like web page with editing possibility.*** As the group prefers to keep control over all modifications of the data model, it has to be carefully organized when giving access to the public to comment on the model. Depending on the requisite of timely reactions and up-to-dateness, this option requires constant management and supervision of the editing. A Wiki-like webpage can however be of benefit as storage place of (illustrative) explanatory material, accessible also from outside (e.g. from documentation) via hyperlinks.
  + ***Website*** containing fixed documentation, with additionally a separate user-friendly tool for provision of feedback (detached from fixed document). Location of the website is still to be discussed.

# Task 3: Data Model

*Task lead: Gebhard Banko, EAA, Vienna, Austria*

*Deliverables: (a) updated printable UML-chart in PDF format, (b) machine readable UML model programmed with software such as Rational Rose, Enterprise Architect or similar.*

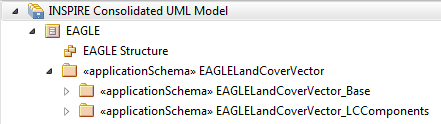
The EAGLE Data model has been further developed and aligned with matrix elements as well as European and international standards. Wherever possible the EAGLE code lists were taken over from INSPIRE themes and, in case of code-lists extended with EAGLE attributes. Wherever possible the EAGLE model followed as well ISO-Standards (19144-1 and 19144-2).

The Data model was transformed from a purely UML-notation in MS Visio to a fully integrated Enterprise Architect version. In a first step only the Vector-Model was developed, as this model is the rather complex model using a range of relationships between feature types. The Raster model is developed as derivative of the INSPIRE land cover raster model and represents a “light” version of the EAGLE data model – due to the restrictions of the INSPIRE raster data format and model.

## EAGLE Vector Model

The EAGEL vector model includes a complete new structure and division in different packages, depending on the nature of feature types:

* Sub-packages:
  + BASE
    - Represents the core elements with INSPIRE land cover
  + Land Cover Components
    - To develop any thematic element



Main changes in thematic content are the addition of a feature type “Spatial composition” that allows multiple hierarchical groupings and aggregation of land cover components within a land cover unit. This concept reflects more or less the horizontal pattern defined in LCML.

Regarding the vertical pattern defined in LCML, the EAGLE group agreed that this class is not needed for modeling European land monitoring objects. However the only exception is the temporal restricted occurrence of certain features above another land cover component (e.g. water – flood, snow, etc.). This has been modeled using a simple “overlay” attribute that can exist for a certain period in time.

## EAGLE Raster Model

One of the requirements for EAGLE data model is to make possible the representation of raster data. There are fundamental datasets in this format (i.e. Copernicus High Resolution Layers, Global Land Cover, etc.) and the proposed EAGLE data model should facilitate and help dealing with this issue.

EAGLE data model is aligned with INSPIRE specifications on land cover and land use and ISO standards, for this reason the raster development in EAGLE must follow the INSPIRE proposed features and attributes, established from ISO 19123 standard about coverages.

EAGLE adds some attribution at level of land cover coverage to describe it in the same way that vector datasets: metadata, level of detail and possibility of reflexive relationships between coverages.

In order to reproduce adequately the main coverage attributes defined by ISO 19123, EAGLE documentation offers some description of them and key guidelines about their implementation for the most common raster datasets examples. Particular aspects of ISO coverages encoding are not dealt in the present document.

## Data Model documentation

The data model is available as Enterprise Architect file format:

* T3\_APPENDIX 1: EAGLE\_model\_v2.3.eap (51 MB)

The textual documentation of the data model in the INSPIRE requested format is available as Word-file:

* T3\_APPENDIX 2: EAGLE\_datamodel\_documentation\_v2.3.docx (1,5 MB)
  + NOTE : As the documentary work accomplished in task 1.1 and 1.2 is finished in parallel the textual documentation will be updated and copied from the deliverables of theses tasks (mainly fields: comments, definitions and notes)

The graphical data model is alternatively available as WORD-file and RTF-file :

* T3\_APPENDIX 3a: DM\_grafics\_v2.3\_EAGLE.RTF (10 MB)
* T3\_APPENDIX 3b : DM\_grafics\_v2.3\_EAGLE.docx (1 MB)

A narrative description of the data model is available in WORD-format:

* T3\_APPENDIX 4: DataModelDesc.docx (1,1 MB)

The data model is temporarily published under:

* <http://www.perger.net/EAGLE/>

## Optional: GML-Schema

As the model structure is currently optimized for human understanding and reading the GML-export will not work straight forward. The structure of the packages (vector, raster, base, data types, land cover components) is logical for human reading, however it will need some additional iterations to derive a machine-readable valid GML-Schema.

The GML-Schema that is exported from Enterprise Architect needs additionaly editing e.g. via XMLSpy (<http://www.altova.com/xmlspy.html>) and for demonstration purposes a GML-Schema itself (pure code) is not explicatory. It needs to be instanced at least to demonstrate the usefulness of specific aspects in the model. The spatial composition is a first candidate how to explain the theoretic and practical concepts using explicatory figures in parallel with GML-Code.

A draft example of such a enhanced documentation is given in

* T3\_APPENDIX 5: Illustrative\_Examples\_Datamodel\_SpatialComposition.pptx (1,5 MB)

# Project administration

With respect to project administration the following activities have been carried out:

* Drafting of a partnership agreement.
* Signature of partnership agreements with all participating organizations.
* Request of advance payment from EEA.
* Forward of advance payment upon receipt of invoice from partners.
* Collection of travel cost statements from partners for reimbursement.
* Clarification of procedure for adding new partners to the consortium.
* Submission of interim report.
* Reimbursement of travel related cost.
* Follow-up of individual tasks and timely delivery of results.
* Request of final payment from EEA.
* Submission of final report (this report).

Meetings:

* A physical meeting of project partners was organised at IGN-Spain in Madrid
  + 12 Nov: task 3 only
  + 13 & 14 Nov: joint meeting of all tasks
* A physical meeting of task 1 and task 2 leaders to streamline the task interdependencies and discussion of open issues
  + 10 – 13 Dec: joint meeting