

# The EAGLE data model - concept for parameterized data collection on habitat characteristics

Barbara Kosztra<sup>1</sup>, Stephan Arnold<sup>2</sup>, Michael Bock<sup>3</sup>, Gebhard Banko<sup>4</sup>, Christoph Perger<sup>5</sup>

<sup>1</sup>Institute of Geodesy, Cartography and Remote Sensing (FÖMI), Hungary  
Email: kosztra.barbara@fomi.hu

<sup>2</sup>Federal Statistical Office, Germany  
Email: stephan.arnold@destatis.de

<sup>3</sup>German Aerospace Center, Germany  
michael.bock@dlr.de

<sup>4</sup>Environment Agency Austria  
gebhard.banko@umweltbundesamt.at

<sup>5</sup>Ecosystems Services and Management, IIASA, Austria  
pergerch@iiasa.ac.at

## 1. Abstract

Increasing commitment to preserve natural values from pressure by human activities has led over the last decades to a variety of national and European initiatives with the aim to monitor changes of landscape, expressed as land cover (LC) and/or land use (LU). The variety of applications has resulted in the development of numerous classification systems to systematically describe LC/LU (many achieving an operational implementation status e.g. CORINE Land Cover, LCCS). Each of these emphasizes different aspects of land surface. Different semantic borders between class definitions hinder data exchange and restrict comparability between systems.

Recent trends in remote sensing, like free data access to opened LANDSAT archives, the launch of SENTINEL series, advances in data analysis techniques and increasing computing capacities pave the way to new opportunities in gaining knowledge about the environment. Besides long-term and dense historical time series and steadily incoming new satellite imagery, a broad variety of thematic datasets provide rich sources of information on land. The challenge of today is therefore to optimize data collection, systematically extract information from existing and available data sources (data mining) and utilize it in an efficient way to respond a broad range of application requirements. The INSPIRE directive is also pointing in the direction of interoperable data sharing and exchange of information.

The EAGLE group (Eionet Action Group on land Monitoring in Europe), nested in European Environment Agency's Eionet network sees a response to this challenge in building a new concept of land description that can help to handle the situation and utilize opportunities described above.

The EAGLE concept (Arnold et al. 2013) is based on an object-oriented data modelling approach. It describes land surface through land surface units (polygons, grid cells), which contain one or several Land Cover Components (LCC). One or many Land Use Attributes (LUA) can be attached to these components and land surface units, which then are described with further Characteristics (CH), such as spatial and temporal pattern, land management practices, bio-physical parameters, species types, ecosystem structure information a.o. The approach allows a parameterized description of land instead of classifying it to a limited number of pre-defined classes. By preserving elementary descriptive information on each single land unit, users of data are not bound by restrictive and inflexible class definitions, but are free to re-combine information to fulfil their application requirements.

The decompositional approach of EAGLE model enables it to be used

- a) for semantic analysis of class definitions,
- b) as a semantic-based translation tool between classification systems,
- c) as guideline for systematic collection of land- and habitat related information,
- d) as an analytical tool to link user requirements to existing data,
- e) as conceptual basis for a harmonized future European Land Monitoring Framework.

The EEA and Eurostat expressed interest in the potential contribution of the EAGLE concept to the long-term strategy of Copernicus land monitoring (CLC/HRL) and LUCAS. The concept has been integrated into the Copernicus work programme and already welcome in selected European Member States, assisting and fostering the harmonization of national land monitoring programmes in place. It was successfully applied for the enhancement of the CORINE Land Cover nomenclature guidelines.

The thematic content of the data model is not restricted to a specific manner of data capture; both remote sensing data and in-situ mappings and measures can be the source of information. Due to its conceptual basis and flexibility to enclose any kind of information on land surface as new model element, EAGLE model is seen to be able to respond the needs of harmonization and data exchange arising in the field of habitat monitoring. With few modifications the core EAGLE data model that is suited to serve rather general multi-purpose application can be extended to match the requirements of habitat and ecosystem monitoring.

Therefore the EAGLE data model is tested against the General Habitat Categories (GHC) system to estimate its usefulness for habitat monitoring purposes. Preliminary results has lead to the conclusion that extended with a limited number of parameters EAGLE model can be suitable particularly for

- improving habitat nomenclatures through systematic decomposition of class definitions, resulting in identification of semantic gaps/overlaps/inconsistencies within or between classes,
- identification of individual descriptors in existing habitat nomenclatures,
- translating between classes of different habitat classification systems,
- serving as a data model for collecting information on status of habitats.

In particular, the following issues are considered as most relevant subjects of ongoing research:

- combined analysis of EAGLE data model and GHC-classification system according to their contribution for the proposed essential biodiversity variables (EBV) like taxonomic diversity, net primary production, habitat structure and ecosystem functional types;
- to analyse the completeness and suitability of the data model regarding habitat characteristics/parameter relevant for the monitoring requirements of the Habitats Directive (Bock, Dees 2006);
- combined analysis of EAGLE data model and the European Nature Information System (EUNIS), which aims to facilitate the harmonized description and collection of data across Europe through the use of criteria for habitat identification.

An additional benefit for habitat description is seen in the manner the EAGLE model tackles temporal aspects of land. Beside the typical classification of ecosystems the assessment of their condition (ecosystem state) receives increasing attention as a result of the Biodiversity Strategy 2020. One target of the biodiversity strategy calls for a restoration of 15% of degraded ecosystems. Therefore the aim of every monitoring programme is shifted towards documenting the change of ecosystem condition over time. The proposed EAGLE data model

is able to differentiate between various temporal dynamics over time (a.o. frequency, duration, time interval) by using ISO's temporal schema (ISO 19108:2002) and extends these recommendations to overcome the shortcomings of existing models, and is compliant to INSPIRE Directive Annex II – Land Cover.

The oral presentation and paper aims at introducing the EAGLE concept by describing 1) the criteria behind development, 2) structure and content of the data model, 3) foreseen uses, 4) example of successful application, 5) potential benefits for habitat mapping. The authors also intend to foster further discussion between the land cover mapping communities and habitat monitoring experts to find solutions for common challenges regarding data harmonization and optimisation of data collection..

## **Acknowledgements**

The EAGLE concept in its current form is the result of a joint voluntary work of the EAGLE group.

The EAGLE group was founded upon a self-initiative of land monitoring experts from various European countries, mainly in their function as NRCs for land cover under the umbrella of EEA's Eionet. The group members work and meet on a voluntary basis, not financed by any external budget, except the home institutions seconding them to the working group meetings. Support to the group has been given by the FP7 geoland2 project and the FP7 HELM project through covering travel expenses. Application of concept for CLC nomenclature enhancement and testing of concept against GHC was financed by European Topic Centre on Spatial Information and Analysis (ETC-SIA).

The authors would like to acknowledge the contribution of all other EAGLE members, namely Tomas Soukup (Czech Republic), Markus Törmä, Elise Järvenpää (Finland), Stefan Kleeschulte, Andreas Littkopf (Germany), Gergely Maucha (Hungary), Gerard Hazeu (The Netherlands), Geir-Harald Strand (Norway), Julián Delgado Hernández, Roger Milego, César Martínez Izquierdo, Alejandro Simon Colina, Nuria Valcarcel Sanz (Spain), Charlotte Steinmeier (Switzerland), Geoff Smith (UK)..

## **References**

- Arnold S, Kosztra B, Banko G, Smith G, Hazeu G, Bock M, Valcarcel-Sanz N, 2013, The EAGLE concept - A vision of a future European Land Monitoring Framework. In: Lasaponara, Masini N., Biscione M. (eds), EARSeL Symposium proceedings 2013, "Towards Horizon 2020"
- Bock M, Dees, 2006, Feasibility of remote sensing for assessment of Annex 1 habitats for the monitoring of Natura 2000 SAC sites. A feasibility study based on assessment guidelines of the German Federal Agency for Nature Conservation. Geoland2, ONP-Training Document Annex 2