

Annex B

(informative)

Use cases

This annex describes the use cases that were used as a basis for the development of this data specification. TWG Land Cover did consider three use cases developed by members of the expert group (UC 1 – 3 below). During the process, EEA provided additional use cases. One of these use cases were already covered by the group, and another six (UC 4 – 9 below) also mention land cover data. These use cases are:

1. Land cover information used in monitoring linked to EU agricultural policy (IACS)
2. Use of LC and LCC (Land Cover Change) data for Greenhouse Gas Inventory Reporting obligations (UNFCCC& Kyoto Protocol)
3. Land cover information in land and ecosystem accounting (LEAC)
4. Air quality: Air pollutant emissions
5. Land take by transport infrastructure
6. Fragmentation of land and forest
7. Regional accessibility of markets and cohesion
8. Drinking water quality
9. Water accounts

Use case 1 requires a data model supporting the exchange of land cover polygon data using a number of different nomenclatures, where each nomenclature is well-documented and comparison of the data is possible. The proposed data model fully supports the requirements in this use case.

Use case 2 requires a data model supporting the exchange of land cover polygon data using a number of different nomenclatures, where each nomenclature is well-documented. Comparison of the data is not required since analysis is carried out at the national level. The proposed data model fully supports the requirements in this use case.

Use case 3 requires a data model supporting the exchange of land cover polygon data encoded using the CORINE Land Cover nomenclature. Gridded data are mentioned in the use case, but gridding is part of the analysis – not of the data exchange. The proposed data model fully supports the requirements in this use case.

Use cases 4, 5 and 6 require a data model supporting the exchange of gridded land cover data encoded using the CORINE Land Cover nomenclature. The proposed data model fully supports the requirements in these use cases.

Use cases 7, 8 and 9 probably require a data model supporting the exchange of high resolution land cover polygon or grid data showing imperviousness, greenery and open water (the use case is not specific). The data may be similar to the High Resolution Layers (HRL) produced in the context of GMES. The use cases may also require exchange of land cover polygon data using various nomenclatures. The proposed data model does, in any case, fully support the anticipated requirements in these use cases.

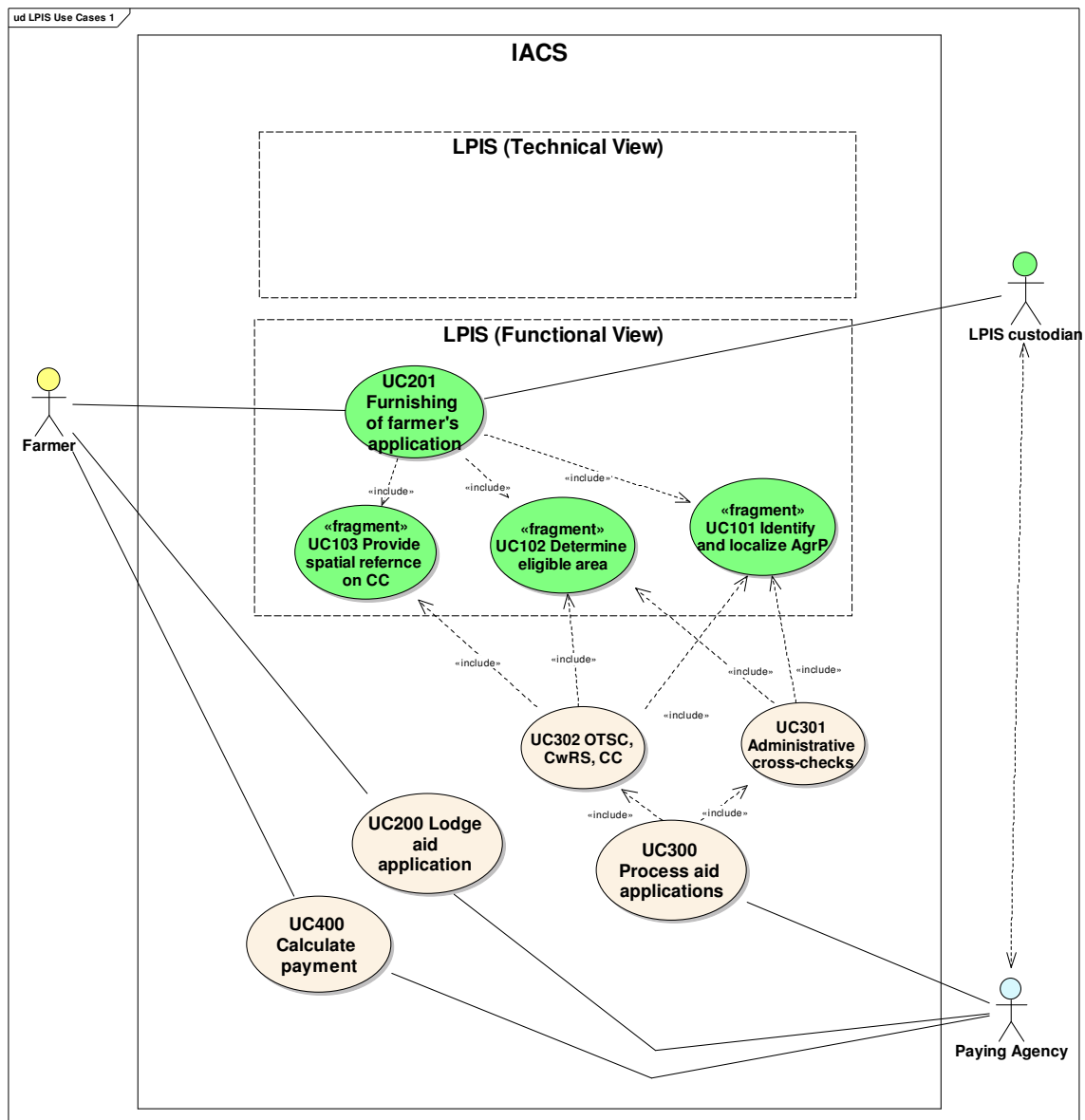
B.1 Land cover information used in monitoring linked to EU agricultural policy (IACS)

B.1.1 Detailed, structured description

Use Case Description	
Name	Determination of maximum eligible hectare
Priority	High

Use Case Description	
Description	Delineating (masking) eligible (=agricultural) land (arable/permanent crops/permanent grassland/household gardens) at a scale better than 1/10,000. Minimum mapping unit 0.1 ha.
Pre-condition	n/a
Flow of Events – Basic Path	
1	Acquire suitable imagery and/or topographic documents
2	Make a national inventory of agricultural land
3	Quantify the maximum eligible hectares inside by delineation at 1/5000
4 annual	Present this information to the farmer (=Pre-printed form, including maps)
5 annual	Collect farmer declaration regarding lands used
6 annual	Perform administrative control (crosscheck) with LPIS (including MEA)
7 annual	Perform an on the spot check for a sample of $\geq 5\% + 1\%$ of the farmers
8 annual	Determine area for payment and pay
9 continuous	Update your LPIS in time for the next year, using: <ul style="list-style-type: none"> • OTSC results • Newly available imagery • Any available third party land cover / land use changes
Flow of Events – Alternative Paths	
Step m.	n/a
Step m+1.	
Post-condition	Annual monitoring required
Data source: LPIS	
Description	LPIS – eligible layer: for quality reporting coded under LCCS
Data provider	Every MS
Geographic scope	All land on the “agricultural holding” of the farmers requesting EU aid (regardless of the land itself is benefitting of aid or not)
Thematic scope	Agriculture, land administration, land cover, land use, orthoimagery et al
Scale, resolution	Better than 1/10,000 (from 2014: better than 1/5,000)
Delivery	Not applicable
Documentation	Council Regulation 2009R73 (art 17) LPIS core model (LCM). 2004 discussion document <i>Each MS has its own LPIS specifications.</i>

B.1.2 UML use case diagram



B.1.3 Narrative explanation

Introduction

The primary goal of the common agricultural policy (CAP) is to provide an income support to farmers. Under the WTO green box conditions, the support is de-coupled from production and based solely on agricultural areas. Support is further subject to cross-compliance, the respect of basic standards concerning the environment, food safety, animal and plant health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental condition. This requires as system to administrate agricultural land.

In contrast to e.g. environmental Directives, which need transposition into national law, a common policy Regulation lays down common rules to be directly applied by all Member States. The key CAP support rules are specified Council Regulation 2009/73.

Defining land

Most Member States implement the single payment scheme (SPS) where support is granted to farmers upon activation of a payment entitlement per eligible hectare to the amounts fixed therein. "Eligible hectare" is specified as *any agricultural area of the holding and any area planted with short rotation coppice that is (predominantly) used for an agricultural activity* (art 34.a) and defines "agricultural area" as *any area taken up by arable land, permanent pasture or permanent crops*. (art 2.h). Permanent pasture' means *land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or longer*. To this end, 'grasses or other herbaceous forage' means *all herbaceous plants traditionally found in natural pastures or normally included in mixtures of seeds for pastures or meadows in the Member State (whether or not used for grazing animals* (1120R2009 art 2.c).

The Member States that joined the EU in 2004 and 2007 could implement a transitional single area payments scheme (SAPS) without entitlements which links eligibility of payments to 'utilised agricultural area' or *the total area taken up by arable land, permanent grassland, permanent crops and kitchen gardens* (art 124)

This set of definitions of eligible hectares relates to land cover concepts. Even in "pasture" the pastoral use is explicitly stated as irrelevant, only the grass/herbaceous cover matters. A land use dimension is introduced whenever a farmer declares land in his annual support application.

Managing agricultural land through LPIS

It is obvious that determining the eligible hectares is a key element as this quantifies the potential for payment. The agricultural area registered in the LPIS acts as a reference to help the farmer correctly activate his entitlements via cartographic documents and must allow the administration to detect double declaration of any given agricultural parcel (via the so called administrative cross-check).

Areas recorded in the LPIS should be precise up to 1000 m²; however, areas are declared by the farmer and controlled by inspectors with a precision of 100m². In practice, MS start from 25cm to 50cm GSD imagery to operate and maintain their LPIS mapping.

The full functionality of the resulting spatial database called LPIS is 3-fold:

1. Identify land (unambiguous geo-location) (similar to cadastral application)
2. Quantify eligible hectares therein (i.e. a land cover delineation)
 - * as supportive information for the farmer's declaration
 - * as financial safety feature for the administrative controls
3. Administrate declarations on land (i.e. land use recording).

"Production block" LPIS systems combine the functions of identification and delineation of agricultural land into a single layer where the blocks are defined either by their visible physical boundaries or as the continuous agricultural land declared by one farmer. Alternatively, Member States can recover their cadastral or topographic map to identify the land management units and must then determine the potential eligibility with the help of a separate land cover mask.

It makes good sense to approach the delineated mask from a land cover perspective rather than from eligibility viewpoint as eligibility rules change frequently. Since the start of LPIS, olive groves, vineyards and landscape features were introduced to the payment schemes. In the near future, the "greening of the CAP" may require the separate accounting of permanent grassland and these landscape features.

The pan-european dimension comes from the common requirements and procedures to guarantee equal treatment of all European farmers. Each Member State is accountable for the proper implementation of the rules but must demonstrate this to the European Institutions. The transfer of know-how and sharing of tools between the Member States is an added bonus.

Illustrations

<u>Permanent crops:</u>	Vite - Olivo - Agrumi - Mandorlo - Serre stabili
<u>Permanent grassland:</u>	Pascoli - Pascolo magro 50% - Pascolo magro 20% - Arboreto + erbacee
<u>Arable land:</u>	Seminative
<u>Other:</u>	Manufatti - Boschi - Piu specie arboree - Acque - Aree non-coltivabili - Tare



Figure 25 - : 1/2,000 Land cover delineation for assessing eligibility (by AGEA, Italy, 2009)

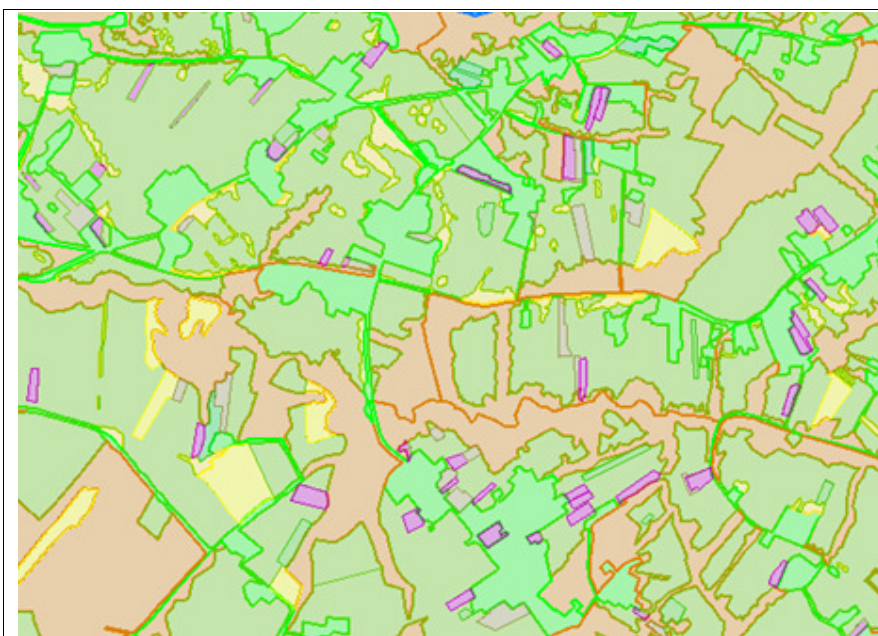


Figure 26: "farmer's" production blocks; units of continuous pure agricultural land declared by a single farmer.

From Figure 25 to Figure 30, the background images are not those used for the land cover delineation, evidencing some unprocessed land cover changes that have occurred.



Figure 27: "physical" production blocks; units of pure agricultural land delineated by permanent visible physical boundaries (hedges, fences, roads,,...) and permanent cultivation patterns.

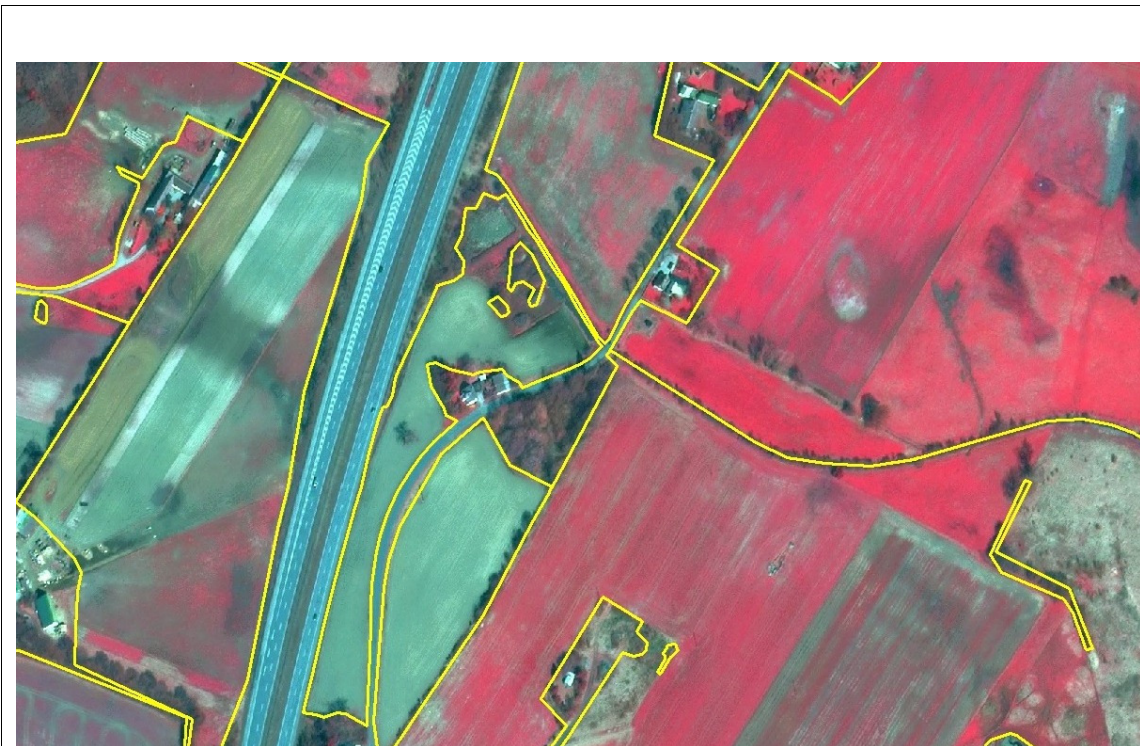


Figure 28: "physical" production blocks; units of pure agricultural land delineated by permanent visible physical boundaries (hedges, fences, roads,,...) and permanent cultivation patterns.



Figure 29: "cadastral" reference parcels; cadastral parcels (red lines) with delineation of agricultural land therein (magenta lines).

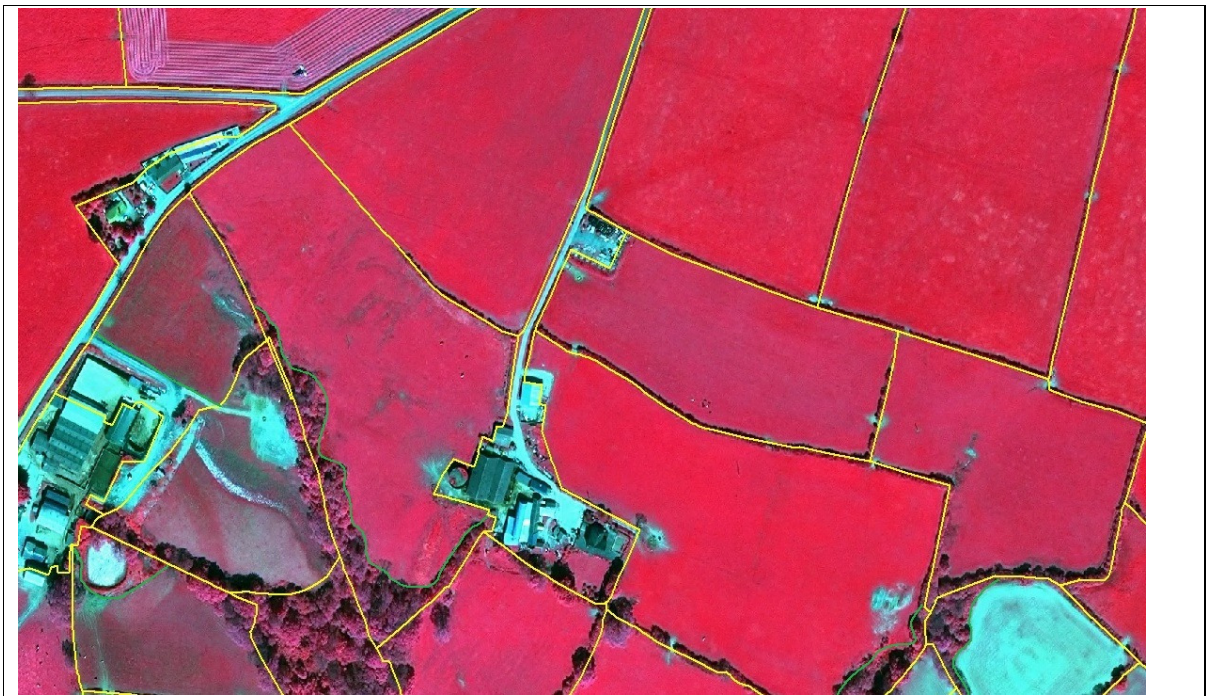
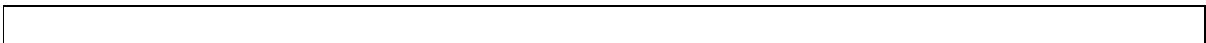


Figure 30: "topographical" reference parcels; units of land derived from selected topographical map features (yellow line) with delineation of agricultural land (green line) therein.

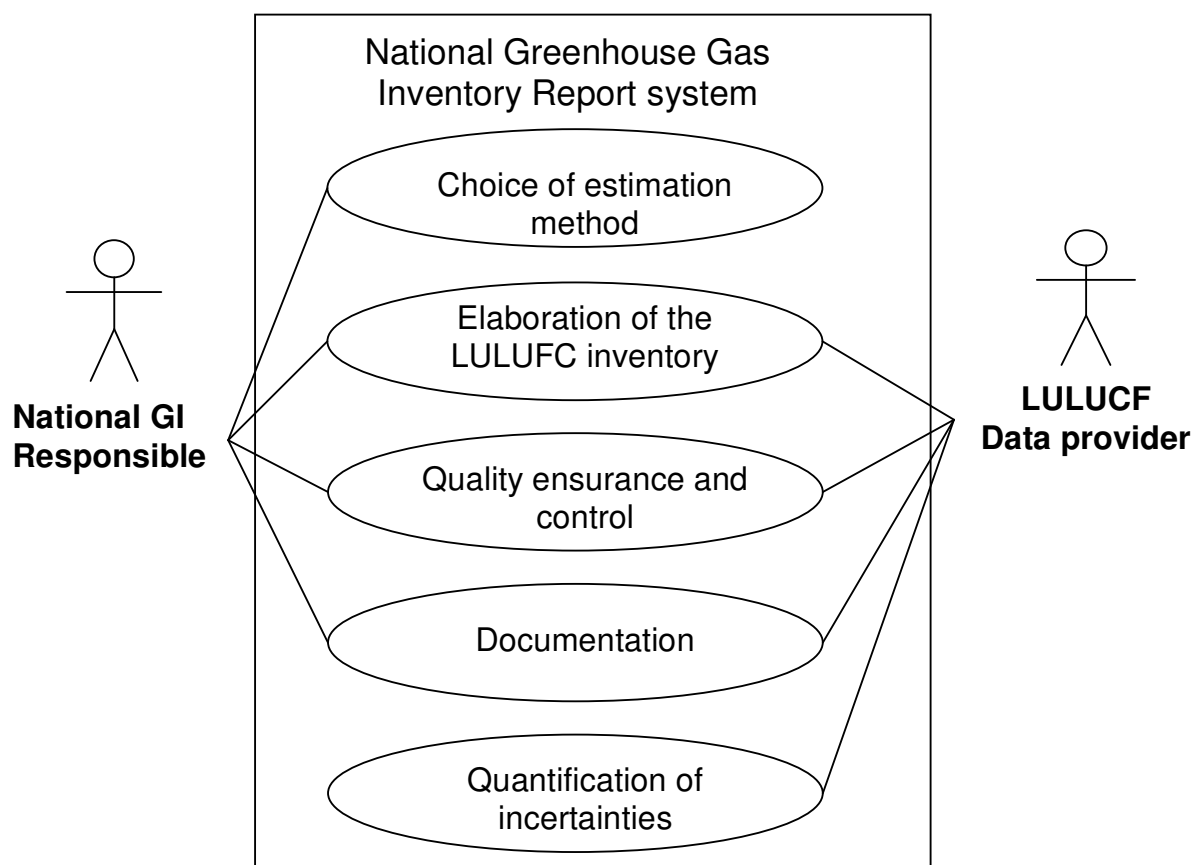


B.2 Use of Land Cover and Land Cover Change data for Greenhouse Gas Inventory Reporting obligations (UNFCCC& Kyoto Protocol)

B.2.1 Detailed, structured description

Use Case Description	
Name	Use of LC and LCC data for Greenhouse Gas Inventory Reporting obligations (UNFCCC& Kyoto Protocol)
Priority	High
Description	This Use Case describes shortly the use of National and International Land Cover and Land Cover Changes databases in National GI according to the obligations of UN's FCCC and Kyoto protocol. Land use, land-use change and forestry (LULUCF) is defined by the UN Climate Change Secretariat as "A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities".
Pre-condition	
Flow of Events – Basic Path	
Step 1.	Choice of estimation method
Step 2	Elaboration of the LULUCF inventory
Step 3	Quality ensurance and control
Step 4	Documentation
Step 5	Quantification of incertainties
Data source: <Name> [repeat per data source]	
Description	National Land Cover & Use, Forest, Crops Inventories; Agricultural and Forest Surveys
Data provider	Mapping agencies, National Forest & Agriculture Institutions, NRC on Land Cover, NCR on Land Use & Spatial Planning.
Geographic scope	Global, National
Thematic scope	Land Cover, Land Use
Scale, resolution	1:100.000 to 1:10.000; MMU from 0,1 to 1 ha
Delivery	
Documentation	Good Practice Guidance for Land Use, Land-Use Change and Forestry http://www.ipcc-nggip.iges.or.jp/public/gpoglulucf/gpoglulucf.html

B.2.2 UML use case diagram



B.2.3 Narrative explanation

This Use Case describes shortly the use of National and International Land Cover and Land Cover Changes databases in National GI according to the obligations of UN's FCCC and Kyoto protocol. Land use, land-use change and forestry (LULUCF) is defined by the UN Climate Change Secretariat as "A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities".

The term 'Land Use' can be considered as relating to the two Inspire themes Land Cover and Land Use, because there is a mixture of land cover and land use concepts and terms, especially when considering land 'use' changes categories.

Considering the different categories in land use and land use changes for GI according to IPCC, for each country is necessary to select the most appropriate method for identifying and representing land areas as consistently as possible in inventory calculations. These categories and subcategories (not considering specific categories, according to these general ones which can be defined for an specific country), as described in the Good practices guidelines for Land Use, Land-Use Change and Forestry, are:

- ☐ Forest land (FL)
- ☐ Cropland Grassland (CL)
- ☐ Wetlands (WL)
- ☐ Settlements (SL)
- ☐ Other land (OL)

And the subsequent subcategories in Land Use Changes:

FF	= forest land remaining forest land	LF	= lands converted to forest land
GG	= grassland remaining grassland	LG	= lands converted to grassland
CC	= cropland remaining cropland	LC	= lands converted to cropland
WW	= wetlands remaining wetlands	LW	= lands converted to wetlands

SS	=	settlements remaining settlements	LS	=	lands converted to settlements
OO	=	other land remaining other land	LO	=	lands converted to other land

The six Land Use categories are considered by IPCC as top level categories, able to be applied in most countries, accommodating differences in different land classification systems based on land cover characteristics, land use characteristics, or a combination of both. Land management is a key criterion for discriminating subcategories, but the disparity of land management national practices make it in practice impossible to discriminate the land cover concepts from the land use concepts in the definitions of these five main categories. According to IPCC Guidelines, each country should establish and apply specific definitions, indicating explicitly those land cover and/or land use concepts used in their accounting systems.

The way to proceed in each country will be (step by step)

- Choice of estimation method within the context of the IPCC Guidelines:. There are three possibilities:
 - Use of Basic Land Use data, which can or can not cover the whole territory. It is recommended to have an account of the land data for the different Land Use categories, one for each reference year, but without further explanation of land use changes from one category to another.
 - Survey of Land Use and Land Use change: provides a national or regional-scale assessment of not only the losses or gains in the area of specific land categories but what these changes represent. Tracking land-use changes in this explicit manner will normally require estimation of initial and final land-use categories, as well as of total area of unchanged land by category. The final result of this approach can be presented as a non-spatially explicit land-use change matrix.
 - Use of geographically explicit land use data. Approach 3 is comprehensive and relatively simple conceptually but data intensive to implement. The target area is subdivided into spatial units such as grid cells or polygons appropriate to the scale of land-use variation and the unit size required for sampling or complete enumeration. The spatial units must be used consistently over time or bias will be introduced into the sampling. The spatial units should be sampled using pre-existing map data (usually within a Geographic Information System (GIS)) and/or in the field and the land uses should be observed or inferred and recorded at the time intervals required. Observations may be from remote sensing, site visits, oral interviews, or questionnaires. Sampling units may be points, or areas from 0.1 ha to a square kilometre or more, depending on the sample design. Units can be sampled statistically on a sparser interval than would be used for the complete coverage, chosen at regular or irregular intervals, and can be concentrated in areas where land-use change is expected. Recorded data could be of land use at a point or within a sampling unit on each occasion but could also include land-use change data within a sampling unit between the sampling years.
- LULUCF inventory, according to the selected approach for each country.
- Quality assurance and quality control procedures to provide cross-checks during the inventory compilation;
- Data and information to be documented, archived and reported to facilitate review and assessment of inventory estimates;
- Quantification of uncertainties at the source or sink category level and for the inventory as a whole, so that resources available can be directed toward reducing uncertainties over time, and the improvement can be tracked.

Example: Heterogeneous data sources for LULUFC:

Corine Land Cover-CLC: CLC1990, CLC2006

Biomass: National Forest Inventory

Forest Fires: National Fire Inventory

Areas/Land use: Several sources (forestation, deforestation, farming, etc → expert group)

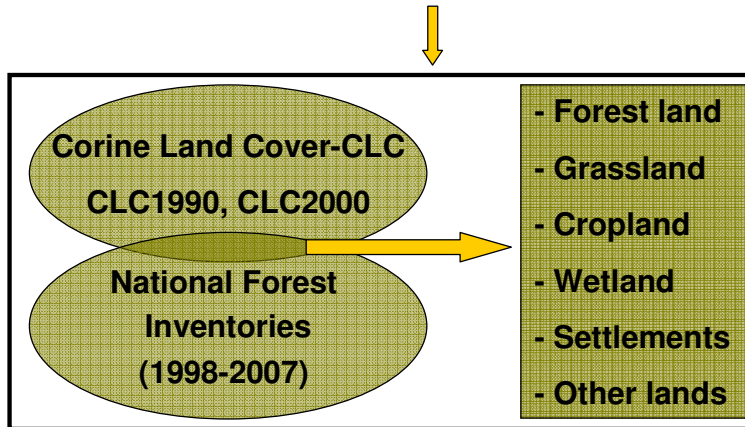


Figure 1: LULUFC Inventory under the Convention. Example of estimation method using option 3 - geographically explicit land use data (CORINE Land Cover, National Forest Inventory and other national sources)

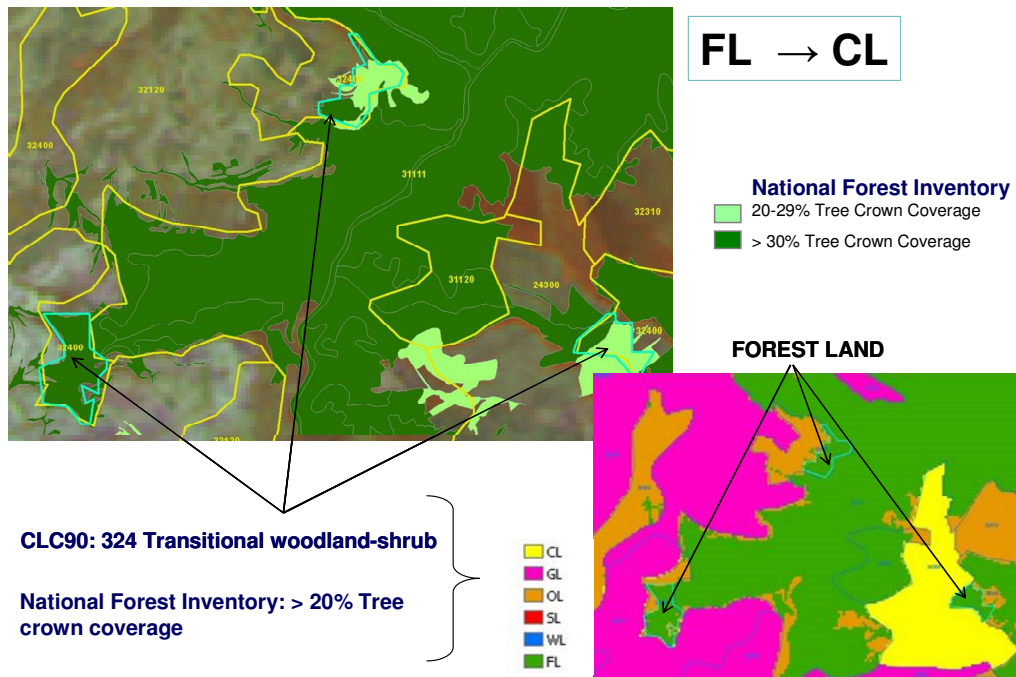


Figure 2: LULUCF Inventory under the Convention. Example of estimation method using option 3 - geographically explicit land use data. Combination of CORINE Land Cover and National Forest Inventory for obtaining land use changes from Forest Land (FL) areas to Cro

In addition, *GPG-LULUCF* provides guidance related to the specific features of the LULUCF sector on consistent representation of land areas, sampling for area estimates and for estimating emissions and removals, verification, and guidance on how to complement the Convention reporting for the LULUCF sector to meet the supplementary requirements under the Kyoto Protocol.

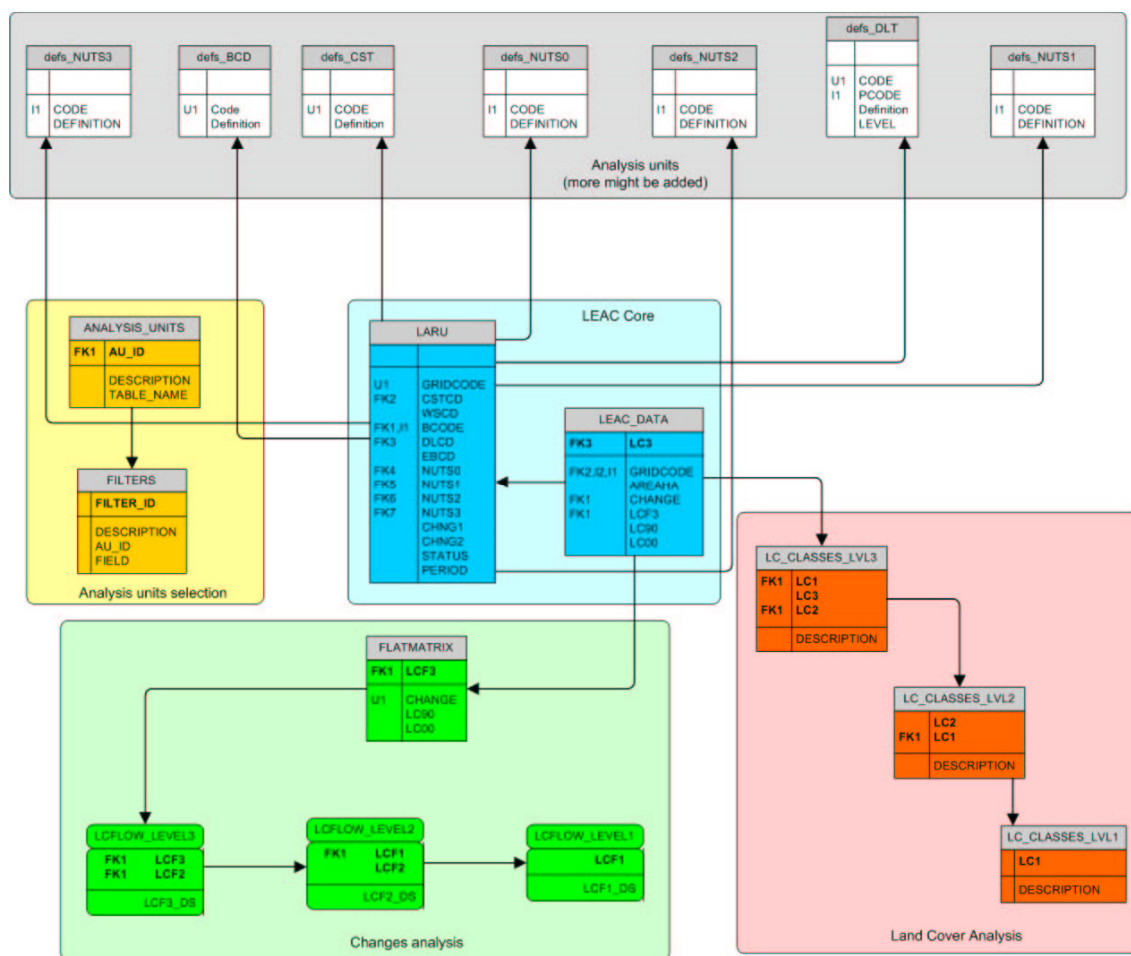
B.3 Land cover information in land and ecosystem accounting (LEAC)

B.3.1 Detailed, structured description

Use Case Description	
Name	Land and Ecosystem Accounting (LEAC) - support revision and implementation of UNSD-SEEA (System of Economic and Environmental Accounting) Handbook
Priority	high
Description	<p>Implementation land and ecosystem related issues into the system of statistical accounting.</p> <p>LEAC is based on voluntary contributions of Member States to UNSD (UN Statistical Division) Reporting</p>
Pre-condition	Land accounting requires regular mapping of land-cover in a pre-defined classification system (e.g. CORINE classification) and a system to detect the changes in land-cover classes per spatial unit. E.g. CORINE and CORINE updates are used to detect land-cover changes in Europe (LEAC). Ecosystem accounting can either directly use land-cover change and attribute relevant information (e.g. change in carbon stock due to change in landcover class) or use land-use information attributed to certain land-cover classes (e.g. arable land) for further detailed analysis.
Flow of Events – Basic Path	
Step 1.	Collection of input LC change data, identification of territorial reference units
Step 2.	Classification of LC changes into land Cover Flows
Step 3.	Rasterization of reference units according to the standard European 1km x 1km reference grid
Step 4.	Intersection of LC change data with the reference grid
Step 5.	Establishing of a relational database between Land Analytical and Reporting Units (LARU-s) and Land Cover changes / flows. The relate item is the Reference Grid Code
Step 6.	Results from land and ecosystem accounting are normally delivered as matrix tables, published in reports and on websites. In principle accounts can also be published as spatial explicit maps.
Data sources:	
Description	CORINE Land Cover change data
Data provider	EEA
Geographic scope	Countries involved into CLC change mapping ("Europe")
Thematic scope	Risk exposure
Scale, resolution	5ha MMU vector data
Delivery	EEA dataservice
Documentation	Meta data and product description

Description	Territorial units
Data provider	various
Geographic scope	Europe
Thematic scope	Administrative / physical boundaries, statistical units
Scale, resolution	Vector data, different scales
Delivery	various
Documentation	Meta data and product description

B.3.2 UML use case diagram



Extended LEAC data model¹⁸ - potential development of the method for LEAC Core module

B.3.3 Narrative explanation

Objectives¹⁹

¹⁸ Environmental Accounting - Methodological guidebook. 2005. ETC-LUSI report. <http://www.eea.europa.eu/themes/landuse/interactive/land-and-ecosystem-accounting-leac>

Why ecosystem accounts?

Ecosystem Accounts are tools that we can use to describe systematically how the quantity and quality of ecosystems, and the ecological structures and processes that underpin them, change over time. Ultimately they can help us understand the costs of such change to people, either in monetary terms or in terms of risks to their health or livelihood. The goal is to supply scientific support with proper tools to policy-makers.

What is land and ecosystem accounting?

Since 2002, ETC-LUSI, together with EEA, is working on an accounting methodology for land use and ecosystem, the LEAC method (Weber, 2007). The accounts aim to reflect on critical stock and flows of natural capital (ecosystem functions). EEA/ETC-LUSI views an ecosystem as a "life-support system", visually shaped by land-cover and strongly conditioned by land-use. Land in spatial terms is viewed as multifunctional unit providing space and supporting a range of benefits to humans and biodiversity. Four ecosystem subjects are considered: Land-use, water-use, primary productivity and biodiversity.

How are these stock and flows produced?

Land cover accounts (1990-2000-2006) are derived from CORINE Land Cover change data. The EEA (No 11/2006) report "Land accounts for Europe 1990-2000" presents the first application of the LEAC method, demonstrating detailed characterisation (including quantitative estimations) of major land-use patterns and changes in EU – the urban, agricultural, forest and semi-natural land-cover classes.

How are the accounts explored?

ETC-LUSI has developed different tools to query land cover data and land cover changes information among other datasets in two different years (1990 and 2000; 2000 and 2006). These tools work with an on line Analytical Processing (OLAP) database, accessible through the Internet. The database is structured in accordance to a multi-dimensional approach for retrieving land cover using different analytical reporting units (LARU), however the system it is not closed for other kind of data (population, nature protection, transportation, water assets,...).

Why is the LEAC tool useful?

It allows an efficient processing and retrieval of data on continental scale and to perform spatial-based queries without Geographical Information Systems (GIS) tools. At this stage LEAC includes Land cover data types, but with theoretically unlimited possibility to include other subjects as areas of different rates of primary productivity and areas with different degree of habitat richness among others.

Process

LEAC methodology is divided in two main parts:

- Transformation of spatial data into classic Entity-Relationship database (LEAC database) which allows the quick exploitation of such volume of information.
- Land Cover changes classification into hierarchical Land Cover Flows and its nomenclature.

¹⁹ <http://etc-lusi.eionet.europa.eu/LEAC>

From spatial domain to database

The aim of this step is to convert GIS data to a database, which is accessible for classic database management systems without the need of GIS processing facilities. The integration of spatial data is implemented through Reference Grids.

Input data: Land Cover Change products from CLC2000/CLC2006 project (polygon vector data, 5ha MMU) have been taken as main input for building LEAC database. Combining Land Cover Codes from initial year and final year layers creates a Change Code. For example, a change from coniferous forest (311) to continuous urban fabric (111) will be coded as 311111.

Territorial (statistical) units: Administrative (NUTS3, NUTS2, NUTS1, NUTS0) and physical boundaries (Watersheds, Sea Catchments, Biogeographic regions, ...) have been used as territorial units. These data are available mainly as polygon vector data with different precision.

Reference grid: A standard European 1km x 1km LAEA Reference Grid has been used as common reference, to integrate **input data** with **territorial units**. Each grid cell has a unique GRIDCODE and a unique LARU code (Land Analytical and Reporting Units, derived by rasterizing the territorial units to a 1 km x 1 km grid).

The reference grid is intersected with CLC change data, so one grid cell may be linked to different Land Cover change processes. Different change types referring to the same grid cell are stored in separate records and characterised by their Change Code and Change area (1 ha units).

Summary statistics for different territorial units ("zones") are calculated by establishing links between LARU codes and Change codes via the GRIDCODE.

Classification of changes: Land Cover Flows

Land Cover Accounts summarize and interpret the 44x43=1892 possible one-to-one changes between the 44 CORINE land cover classes. The changes are grouped to so called flows of land cover and are classified according to major land use processes:

- lcf1 Urban land management
- lcf2 Urban residential sprawl
- lcf3 Sprawl of economic sites and infrastructures
- lcf4 Agriculture internal conversions
- lcf5 Conversion from forested & natural land to agriculture
- lcf6 Withdrawal of farming
- lcf7 Forests creation and management
- lcf8 Water bodies creation and management
- lcf9 Changes of Land Cover due to natural and multiple causes

The nomenclature of flows is organized on 3 levels. Flows are described in details in the Reference Documents.

References

Environmental Accounting - Methodological guidebook. 2005. ETC-LUSI report.
<http://www.eea.europa.eu/themes/landuse/interactive/land-and-ecosystem-accounting-leac>

Land accounts for Europe 1990-2000 – Towards integrated land and ecosystem accounting. 2006. EEA Report No 11/2006.
http://www.eea.europa.eu/publications/eea_report_2006_11