CLC2006 technical guidelines

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1 Introduction

This technical report provides guidelines for the update of Corine land cover data for the reference year 2006. A Corine land cover map for the year 2006 (CLC2006) will be produced by integrating the data of land cover changes 2000–2006 with the land cover map from the year 2000 (CLC2000). The map of changes in land cover between the years 2000 and 2006 will be based on visual image comparison using satellite data from 2006 (+/– 1 year), so called IMAGE2006.

The production will be carried out or managed by the Eionet National Reference Centres (NRCs) for spatial analysis and land cover, where the best expertise as well as the ancillary data is available for mapping land cover changes. Data integration of all national contributions will be carried out by EEA supported by the European Topic Centre on Land Use and Spatial Information (ETC LUSI).

These guidelines should be read together with the Corine land cover nomenclature illustrated guide — Addendum 2006. This configures also an update of the technical report published by EEA in 2000 as addendum to the Corine land cover technical guide (see http://reports.eea.europa.eu/tech40add/en).

The first three chapters of this document describe the background, organisation and main technical parameters of CLC2006 Project within the GMES Fast Track Service Precursor (FTSP) Land Monitoring. Chapters 4–9 provide guidelines for producing CLC-Changes and CLC2006 databases and Chapter 10 provides guidelines for delivery of the products. The intended readers of this document are the members of CLC national teams and other organisations involved in the production, so the primary aim is to give guidance on practical issues of production, with a basic overview of the theoretical considerations.

1.1 From CLC1990 to CLC2000

From 1985 to 1990, the European Commission implemented the Corine Programme (Coordination of Information on the Environment). During this period, an information system on the state of the European environment was created and methodologies were developed and agreed at EU level. The Corine land cover (CLC) project has been implemented in most of the EU countries, as well as in Central and Eastern European countries.

Following the setting up of the European Environment Agency (EEA) and the establishment of the European Environment Information and Observation Network (Eionet), the coordination of the Corine databases — including the updates – is done by the EEA. Images acquired by earth observation satellites are used as the main source of data to derive land cover information.

As the first CLC inventory (CLC1990) was completed and came to use, several users at national and European level expressed their need for an updated CLC database. The update was implemented within the I&CLC2000 project. This project was based upon a number of key elements: lessons learnt from the earlier CLC project, an updated list of user needs, the available options for acquisition of satellite images and the processing and management requirements for a vast amount of data. The overall aim was to produce an updated, so called CLC2000, database and a database of land cover changes between the first inventory (1990) and 2000 (CLC-Changes).

The I&CLC2000 project consisted of two main components:

- IMAGE2000: covering all activities related to satellite image acquisition, ortho-rectification and production of the European and the national mosaics; and
- CLC2000: covering all activities related to the update of the first CLC inventory (CLC1990) by detection and interpretation of land cover changes (CLC-Changes) using CLC1990, IMAGE1990 and IMAGE2000.

Additionally, in order to prevent the propagation of errors into the new update, the geometric and thematic mistakes in CLC1990 were corrected. The

I&CLC2000 project was finished by the end of 2004 (Büttner *et al.*, 2004, Hazeu, 2003).

IMAGE2000 data is freely available at the JRC website (http://image2000.jrc.it/), while European CLC2000 data is freely available at the EEA website (http://dataservice.eea.europa.eu/). Also, some of the participating countries set up their own system for distributing the national CLC products.

1.2 Main technical parameters of Corine land cover

The choice of scale (1:100.000), minimum mapping unit (MMU) (25 hectares) and minimum width of linear elements (100 metres) for CLC mapping represents a trade-off between production costs and level of detail of land cover information (Heymann *et al.*, 1994). These two basic parameters are the same for CLC1990, CLC2000 and the subsequent CLC2006.

The standard CLC nomenclature includes 44 land cover classes. These are grouped in a three-level hierarchy. The five main (level-one) categories are: 1) artificial surfaces, 2) agricultural areas, 3) forests and semi-natural areas, 4) wetlands, and 5) water bodies (Heymann *et al.*, 1994). All national teams adopted this standard nomenclature. Although the 44 categories have not changed since the implementation of the first CLC inventory (1986–1998), the definitions of most of the nomenclature elements have been improved.

The approach of computer assisted visual interpretation of satellite images was chosen as the CLC mapping methodology. Raw satellite images have to be pre-processed and enhanced to yield a geometrically correct document in national projection. For CLC2000, ortho-corrected Landsat-7 ETM satellite images were provided by the IMAGE2000 component, with an RMS error below 25 metres. Detailed topographic maps and in some cases orthophotos were used to achieve this accuracy. Usually, in IMAGE90 only a polynomial correction was applied, and GCPs were mostly selected from 1:100.000 scale maps. The accuracy of IMAGE90 products was significantly poorer than that of IMAGE2000.

During the first CLC inventory the photointerpretation method was done on hardcopies: a transparent overlay was fixed on top of a satellite image and the photointerpreter drew polygons on it marking them with a CLC code. Later the overlay was digitised, topology was created and the CLC code entered. This procedure often resulted in several types of errors in geometry as well as in thematic content, which were mostly corrected later within the frame of the I&CLC2000 project.

In CLC2000 the method of drawing on transparencies was discarded and the use of computer-assisted image interpretation was applied (Büttner *et al.*, 2002).

Main characteristics of the CLC projects are summarised in Table 1.

1.3 Land cover changes

The most important novelty of CLC2000 was the creation of a database of Land Cover Changes (LCC). It was a policy requirement to map LCCs smaller than the 25 ha MMU size of CLC. The MMU of the LCC database was set to 5 ha. The 100 m minimum width is also valid for the LCC polygons for practical reasons (Büttner *et al.*, 2002 and Feranec *et al*., 2007). Changes should refer to real evolution processes and not to different interpretations of the same subject (Feranec *et al*., 2006).

1.4 Participating countries

38 countries with a total area of 5.8 Mkm^2 participate in GMES FTSP Land Monitoring: 32 EEA member countries and 6 collaborating countries (see Figure 1 and Table 2).

1.5 CLC2006 in the frame of GMES

In 2005–2006, strategic discussions amongst member countries, the European Parliament and the main EU institutions responsible for environmental policy, reporting and assessment (DG ENV, EEA, ESTAT and JRC) have underlined an increasing need for factual and quantitative information on the state of the environment to be based on timely, quality assured data, in particular in land cover and land use related issues.

Based on requirements of DG Environment, DG Agriculture and other users for the period 2006–2008, the EEA, in March 2006, put forward a proposal to collaborate with the European Space Agency (ESA) and the European Commission (EC) on the implementation of a fast track service precursor on land monitoring. This is in line with the Communication from the Commission

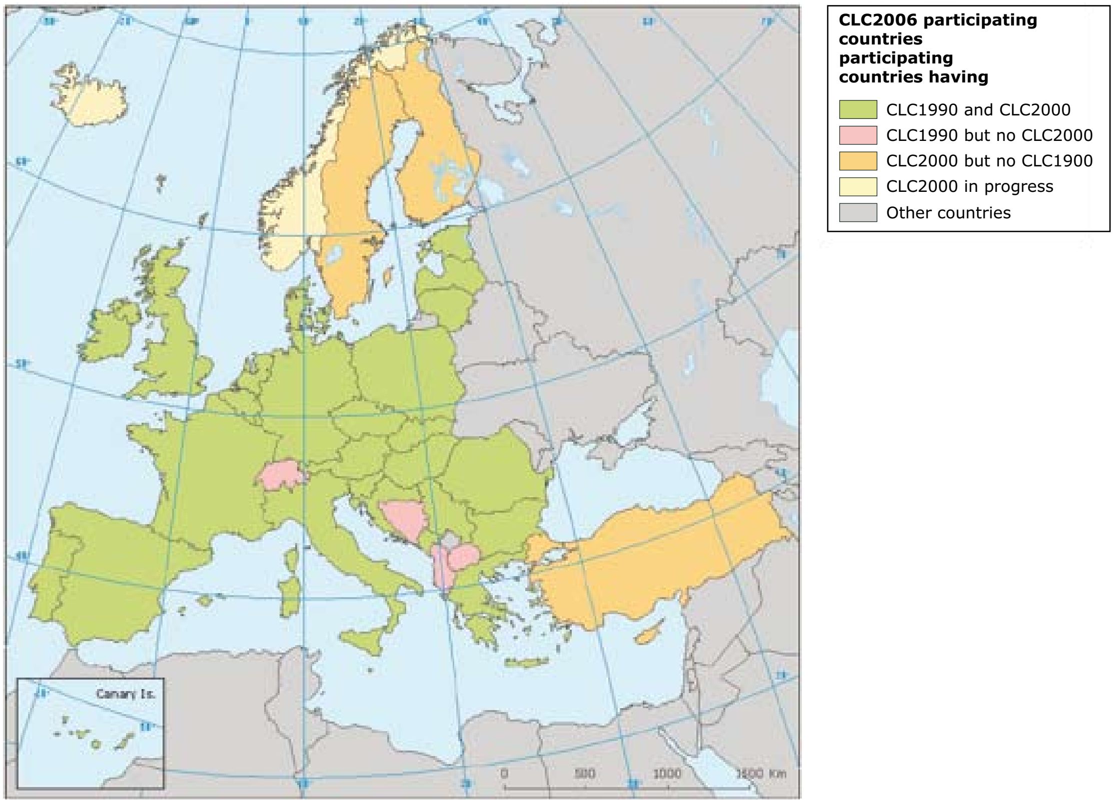
Table 1 Evolution of Corine land cover projects

	CLC1990 Specifications	**CLC2000 Specifications**	**CLC2006 Specifications**
Satellite data	Landsat-4/5 TM single date (in a few cases Landsat MSS, as well)	Landsat-7 ETM single date	SPOT-4 and/or IRS LISS III two dates
Time consistency	1986–1998	2000 +/– 1 year	2006+/– 1 year
Geometric accuracy satellite images	≤ 50 m	≤ 25 m	≤ 25 m
CLC minimum mapping unit	25 ha	25 ha	25 ha
Geometric accuracy of CLC data	100 m	better than 100 m	better than 100 m
Thematic accuracy	≥ 85 % (not validated)	≥ 85 % (validated, see Büttner, G., Maucha, G., 2006)	≥ 85 %
Change mapping	N.A.	boundary displacement min. 100 m; change area for existing polygons ≥ 5 ha; isolated changes ≥ 25 ha	boundary displacement min. 100 m; **all** changes > 5 ha have to be mapped
Production time	10 years	4 years	1.5 years
Documentation	incomplete metadata	standard metadata	standard metadata
Access to the data	unclear dissemination policy	free access	free access
Number of European countries involved	26	32	38

Table 2 Participants of the GMES FTSP Land Monitoring

Albania	Liechtenstein
Austria	Lithuania
Belgium	Luxemburg
Bosnia and Herzegovina	Macedonia, Former Yugoslavian Republic of
Bulgaria	Malta
Croatia	Montenegro
Cyprus	Netherlands
Czech Republic	Norway
Denmark	Poland
Estonia	Portugal
Finland	Romania
France	Serbia
Germany	Slovakia
Greece	Slovenia
Hungary	Spain
Iceland	Sweden
Ireland	Switzerland
Italy	Turkey
Latvia	United Kingdom

Figure 1 Participants of the GMES FTSP Land Monitoring



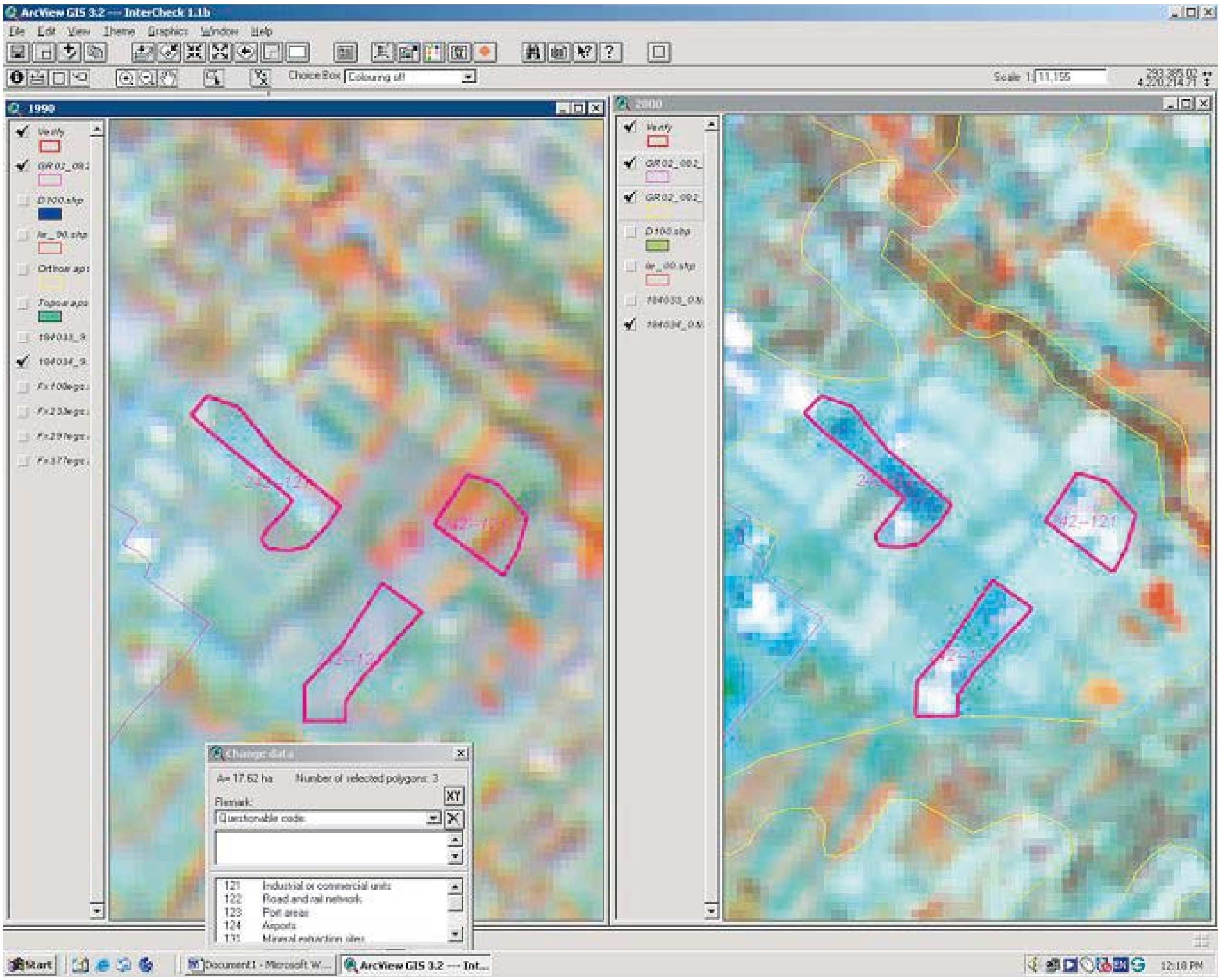
to the Council and the European Parliament (COM(2005)565 final. DG JRC expressed its availability to undertake together with ESA the definition and implementation of the necessary satellite data procurement and processing in view of supporting the proposal. This action will be undertaken in the context of the development of Community satellite-based core products that will serve a broad number of services to support environmental monitoring and assessment objectives. CLC2006 is just one of the components of GMES FTSP Land Monitoring. The other components are listed in Table 3 (EEA, 2006).

CLC2006 will be a direct continuation of previous Corine land cover mapping campaigns. There are, however, important differences compared to previous projects:

- In CLC2000 there was a strong requirement to improve CLC1990 (geometry and thematic content) which was accomplished. Due to its higher quality standard, there is no need for such a significant improvement of the CLC2000 data in the course of the CLC2006 project. However, if a mistake in CLC2000 is found, it should to be corrected. Revised CLC2000 is not to be released by EEA as a new product. It will only be used for the production of CLC-Changes and CLC2006.
- In CLC2006 the focus is on generating land cover change data (between 2000 and 2006). Such a focus has not been declared in previous CLC2000. Half of the countries of the CLC2000 project have produced the CLC-Changes database by intersecting CLC1990 and CLC2000, consequently, many 'false' or 'non-real' changes have been produced. Some countries flagged these 'non-real' changes as 'technical' changes. Production of these false changes should be avoided during current update.
- A novelty of CLC2006 project is that all changes > 5 ha have to be mapped, not only those that are associated to existing polygons (see Figures 2 and 3).
- The CLC2006 database will be generated in a, mostly, automatic way with some human interaction by combining CLC2000 and the photointerpreted CLC-Changes (see Chapter 6). In CLC2000 project half of the countries have interpreted CLC2000 directly, while the other half produced it by a GIS operation, using revised CLC1990 and CLC-Changes.

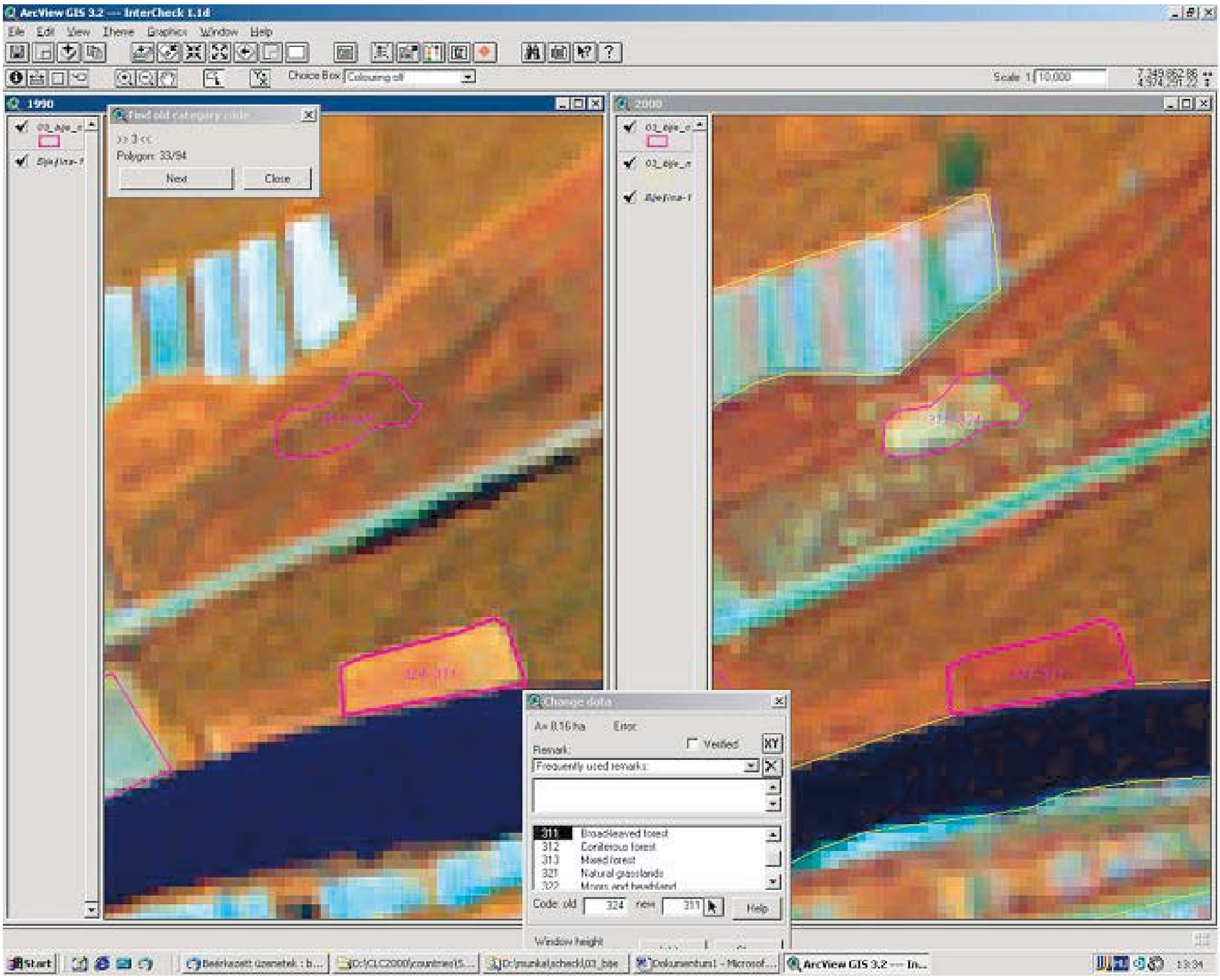
The description of CLC classes (Bossard *et al.*, 2000) has changed to a certain extent (Feranec *et al.*, 2006). However, these are minor changes having as first aim the improvement of some of the class definitions. Secondly, the Addendum 2006 (Büttner *et al.*, 2006) confirms the commonly accepted understanding and application of certain classes (e.g. class 324 for clear-cuts all over Europe).

Figure 2 Example: green-field industrial development in Greece. Left: old image, right: new image



Note: All outlined change polygons are < 25 ha. As a result of new approach isolated changes < 25 ha will also be mapped. These polygons would not have been mapped as change in CLC2000 project.

Figure 3 Example: forest changes in Serbia. Left: old image, right: new image



Note: Both outlined change polygons are < 25 ha. As a result of new approach isolated changes < 25 ha will also be mapped. These polygons would not have been mapped as change in CLC2000 project.

2 Components of the GMES fast track service precursor land monitoring

2.1 Work packages

Seven work packages have been defined to implement the GMES FTSP Land Monitoring. Table 3 provides an overview of the role of contributing partners involved in the execution of each work package (EEA, 2006).

This document describes only WP 3 in detail. Other WPs will be referred only if needed and in reference to WP 3.

2.2 Project organisation

Depending on the applied funding mechanisms, the administrative management of the different work packages is shared among EEA, ESA and the European Commission (Table 3, Figure 4).

The Eionet National Reference Centres (NRC) for spatial analysis and land cover are responsible for the organisation of work at national level. Each participating country submits to EEA a standardised plan for the implementation of activities carried out at national level.

A Steering Committee was set up with representatives from all contributing organisations, namely the Commission, ESA, EEA and participating countries.

The new GMES Land Monitoring Core Service (LMCS) Implementation Group, established by the GMES Bureau of DG Enterprise, plays an advisory role for interlinking with other GMES services.

The organisation of the work is summarised in Figure 4.

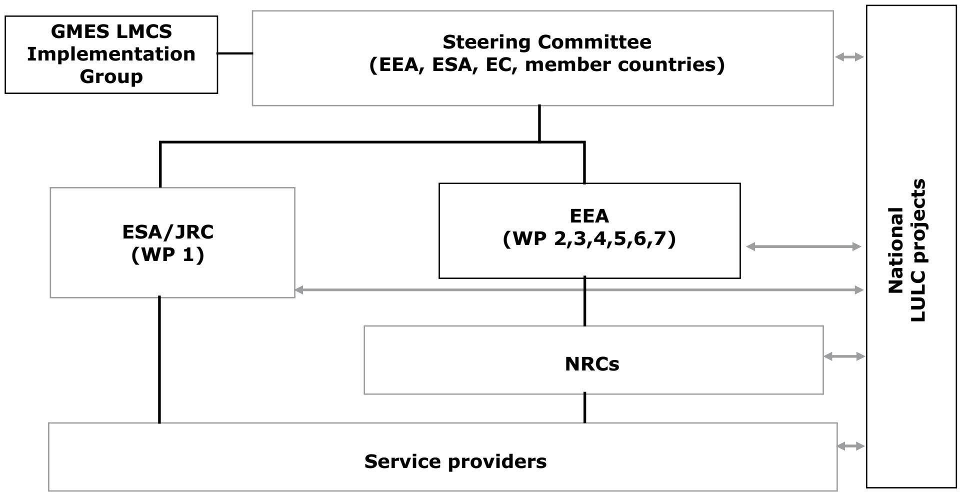
Table 3 Work packages and overview of partner's roles

Tasks	NRC	EEA	ESA	JRC	Data and service providers
WP 1.1 Satellite data acquisition	x		**x**	x	x
WP 1.2 Ortho-correction			**x**		x
WP 1.3 Satellite image mosaic				**x**	x
WP 2 In-situ and ancillary data collection	x	**x**			x
WP 3.1 Corine land cover change mapping 2000–2006	x	**x**			
WP 3.2 Corine land cover mapping 2006	x	**x**			
WP 4.1 Built-up areas including degree of soil sealing, 2006	x	**x**			x
WP 4.2 Forest areas, 2006	x			**x**	x
WP 5 Validation (to be defined)		**x**			
WP 6 Data dissemination	x	**x**	x	x	
WP 7 Project management	x	**x**	x	x	

Note: **x** = leading organisation
x = organisation involved
NRC = National Reference Centre

Source: EEA, 2006.

Figure 4 Organisational chart of GMES FTSP Land Monitoring (EEA, 2006)



3 IMAGE2006 basics

The purpose of the following chapter is not to provide methodological guidelines to produce IMAGE2006, but to give an overview of the satellite imagery basic characteristics for the CLC2006 project.

As the Landsat-7 satellite, used in CLC2000, was not available, new sources of suitable satellite imagery had to be found for the purposes of CLC2006 project. As a result of collaboration with ESA to implement GMES services, two satellites provide the necessary imagery for CLC2006 project (EEA, 2006):

- SPOT-4, and
- IRS P6.

IMAGE2006 project aims to provide a multi-temporal satellite data coverage (two dates) for the area to be mapped in order to achieve high quality photo-interpretation. The main characteristics of the imagery are shown in Table 4. Equivalent data for Landsat-7 (used in CLC2000 project) is provided for comparative purposes. As the priority lies in the full (and multi-temporal) coverage of all participating countries, panchromatic bands will not be available (like was the case in CLC2000).

Although the spectral coverage of the two sensors is very similar (two visible bands, one NIR band and one SWIR band) slight differences in the technical parameters might provide small colour differences in the images, which the photo-interpreters have to learn to tolerate. In order to gain similar colours on screen, as interpreters had got used to them with the Landsat TM sensor, the following band combinations shown in Table 5 are advised to be applied.

Table 4 Characteristics of SPOT-4 and IRS P6 imagery compared to Landsat-7

Satellite	Landsat-7	SPOT-4	IRS P6
Sensor	ETM	HRVIR	LISS III
Swath width (km)	180	60-80 (depending on looking angle)	141
Pixel size (m)	30 (multi-spectral) 15 (panchromatic)	20 (multi-spectral) 10 (panchromatic)	23
Image dynamics (bits)	8	8	7
Number of bands	7 + 1	4 + 1	4
Blue band	0.45 — 0.52 μm (TM1)	--	--
Green band	0.53 — 0.61 μm (TM2)	0.50 — 0.59 μm (XI1)	0.52 — 0.59 μm (MS1)
Red band	0.63 — 0.69 μm (TM3)	0.61 — 0.68 μm (XI2)	0.62 — 0.68 μm (MS2)
Near-infrared band	0.75 — 0.90 μm (TM4)	0.78 — 0.89 μm (XI3)	0.77 — 0.86 μm (MS3)
Middle-infrared band	1.55 — 1.75 μm (TM5)	1.58 — 1.75 μm (XI4)	1.55 — 1.70 μm (MS4)
Thermal infrared band	10.4 — 12.5 μm (TM6)	--	--
Middle-infrared band	2.09 — 2.35 μm (TM7)	--	--
Panchromatic band	0.52 — 0.90 μm (PAN)	0.61 — 0.68 μm (M)	--
Observation mode	Vertical only	Tiltable sensor (up to +– 31 degree)	Vertical only

Table 5 Recommended colour composites for photo interpretation

Sensor / Colour	Landsat TM/ETM	SPOT-4	IRS P6 LISS III	Spectral range
Red (R)	band 4	band 3	band 3	Near-infrared (NIR)
Green (G)	band 5	band 4	band 4	Middle-infrared (SWIR)
Blue (B)	band 3	band 2	band 2	Red (VIS)

Two images for each area will be acquired in the 2006 +/– 1-year period, in order to provide an opportunity for improved photo-interpretation. Multi-temporal imagery is considered especially useful in separating some land cover classes, e.g. irrigated/non-irrigated arable land and pasture land. Countries were asked to specify narrow and extended time windows for the basic image, and another time window for the second image. Automatic checking during image selection assures that the two images are not closer than 6 weeks in time.

In some cases land cover might change between the two images acquired for CLC2006. In such a case the most recent image has to be used as reference during interpretation.

When naming image files it is recommended to include image acquisition date in the name so that the interpreter is aware of the sequence and season of images. E.g. IRS image acquired on 23rd July 2006 can be named IRS_230706.

Example:

IMAGE2000: showing a forest
$IMAGE2006_1$: September 30, 2005 — showing a forest
$IMAGE2006_2$: August 30, 2006 — showing a clearcut

Decision: A change (31x-324) has to be interpreted, because the more recent image (August 30 2006) shows a change.

4 Production of CLC-Changes$_{2000–2006}$ database

4.1 Mapping land cover changes in CLC2006 project

CLC-Changes is the primary and most important product of the CLC2006 project. CLC-Changes is a separate product (i.e. not derived from CLC2000 and CLC2006) having a smaller MMU (5 ha) than CLC2000 and CLC2006 (25 ha).

The aim of producing CLC-changes is to have European coverage of real land cover changes that:

- are larger than 5 ha;
- are wider than 100 m;
- occurred between 2000 and 2006;
- are detectable on satellite images.

This should be regardless of their position (i.e. connected to existing CLC2000 polygon or being 'island'-like).

The method chosen (updating approach) to be used for derivation of the CLC-Changes database is to produce the change database directly, by means of computer-aided visual image interpretation.

4.1.1 The updating approach

In CLC2006 project, changes are interpreted directly, using comparison of IMAGE2000 and IMAGE2006 data in a dual-window environment. In practice, if a CLC2000 polygon has changed, it will be taken over into the database of CLC-Changes, where only the changed part will be kept as a polygon. Change polygons will be then combined with CLC2000 to obtain CLC2006 database:

CLC2006 = CLC2000 (+) CLC-Changes

Where (+) means the following operation: CLC2000 and CLC-Changes are intersected, first CLC-Changes polygons' code$_{2000}$ is replaced by code$_{2006}$ and finally neighbours with similar codes are unified. Main benefits of this approach are:

- changes are interpreted directly (the interpreter has to think about what the real process was) and not by intersecting databases;
- all changes larger than the MMU can be delineated regardless of their position.

The weakness of the method is that CLC2006 is derived with a not fully automatic process (see Chapter 3), and some small (< 5 ha) deficiencies in CLC2006 cannot be avoided (Maucha *et al.*, 2003).

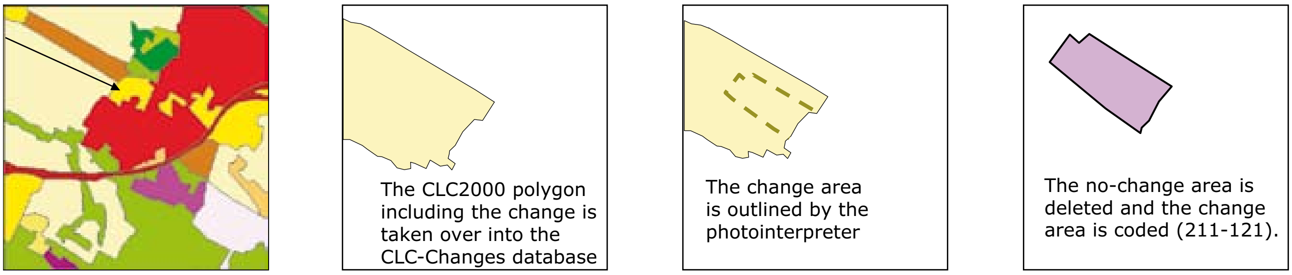
In CLC2000 project two different approaches were used for updating, according to countries' decision. Comparison of these two approaches and its consequences are described in detail in Annex 3.

Mapping is carried out by (visual) comparison of IMAGE2000 and CLC2000 vector data with IMAGE2006 satellite imagery and subsequent direct delineation of change polygons. Necessary thematic/geometric correction of CLC2000 data must precede the delineation of change polygons in order to avoid error propagation from CLC2000. It is for the country to decide how to document CLC2000 corrections (no centralised method is suggested), similarly to the correction of CLC1990 in I&CLC2000 project. The revision of CLC2000 serves only the purposes of CLC2006 project and should not be applied to earlier CLC products, i.e. CLC1990 and CLC-Changes$_{1990–2000}$.

The basis of identification of changes is the interpretation of detectable land cover differences on images from 2000 and 2006. Use of ancillary data, such as topographic maps and orthophotos (e.g. used for Land Parcel Identification System — LPIS) is highly recommended. In addition, land use and land cover codes and field photographs from LUCAS2001&2002 and LUCAS2006 projects will be made available for national teams and it is advisable to use them as ground truth data (Annexes 4 and 5).

Delineation of changes must be based on CLC2000 polygons in order to avoid creation of sliver polygons and false changes when producing the CLC2006 database by intersection. This means that during interpretation of changes, CLC2000 polygons must be visualised and used by the interpreter so that the outline of the change polygon exactly fits CLC2000 boundaries (see Figure 5).

Figure 5 A simple method of application of CLC2000 polygons as basis for change delineation, is taking over the changed CLC2000 polygon into the CLC-Changes database, outlining the changed part and then deleting the unchanged part



Note: This is the method that InterChange software (developed by FÖMI) also uses (Taracsák, 2003).

The interpreter must assign two CLC codes to each change polygon: $code_{2000}$ and $code_{2006}$. These codes must represent the land cover status of the given polygon in the two dates, respectively. The change code pair thus shows the process that occurred in reality which may be different from the codes occurring in the final CLC map (due to the generalisation applied in the production of CLC2006).

4.1.2 Source database (CLC2000) and working units

The database to be used as a basis for change interpretation is the edge-matched version of the national CLC2000 database. In CLC2000 project, border regions of national CLC2000 databases (produced by the countries) were matched by the CLC2000 Technical Team in order to provide a seamless European database. During this process the 2 km wide strip along the national borders was changed, to a minor extent, compared to the 'national version'. The difference is very small, between 1 % and 5 % of the total area of the strip (Table 6). Due to technical reasons, the sea (523) disappeared from the edge-matched version of the national CLC2000 database. Working with this version will make CLC2006 border matching easier, as changes rarely occur close to borders. There will be no need for separate edge-matching process for CLC2006 project.

Similarly to the CLC2000 project, photo-interpretation will progress in working units. Actual working units in the CLC2006 project might be different from the ones used in CLC2000 project. Working units usually correspond to either one or more topographic map sheets, geographic units (e.g. islands) or area covered by a single satellite image.

Table 6 Percentage of similarity of original and edge-matched versions of the CLC2000 photo-interpretation (% = identically coded areas/total area of 2 km border strip)

Country	Similarity (%)
AL	98.04 %
AT	97.93 %
BA	98.20 %
BE	98.54 %
BG	98.83 %
CZ	99.02 %
DE	97.88 %
DK	98.50 %
EE	99.37 %
ES	97.30 %
FI	97.89 %
FR	98.65 %
GR	98.69 %
HR	98.92 %
HU	98.24 %
IE	98.64 %
IT	98.11 %
LI	99.48 %
LT	98.16 %
LU	98.16 %
LV	98.86 %
MK	96.84 %
UK	99.07 %
NL	95.21 %
PL	95.10 %
PT	97.84 %
RO	95.12 %
SE	97.96 %
SI	96.99 %
SK	96.61 %

4.1.3 *Comparability of CLC-Changes$_{1990–2000}$ and CLC-Changes$_{2000–2006}$*

The different MMU for the CLC and CLC-Changes databases i.e. 25 ha and 5 ha, respectively, determine different levels of generalisation, different resolution, so ultimately different scale.

It is easy to admit that any simple automated operation, e.g. intersecting two smaller-resolution databases, will not result in a higher resolution database. In CLC2000 project some countries generated the change database by intersecting revised CLC1990 and CLC2000, thus, it was simply the difference of the two databases. Assuming that previously consequent interpretation and generalisation was carried out ([1]), the difference polygons would correspond to real changes in case of changes > 25 ha. Difference polygons < 25 ha would partly correspond to real changes, another part of them would correspond to 'technical' changes (e.g. 26 ha forest patch in CLC2000 decreases with 5 ha, the resulting 21 ha is generalized in CLC2006; the apparent change is 26 ha, the real change only 5 ha, while 21 ha is the 'technical change'), and significant part of real changes would be omitted this way (e.g. isolated changes < 25 ha).

The change mapping approach applied in CLC2006 project produces the higher resolution CLC-Changes database directly, by the delineation of all real changes > 5 ha.

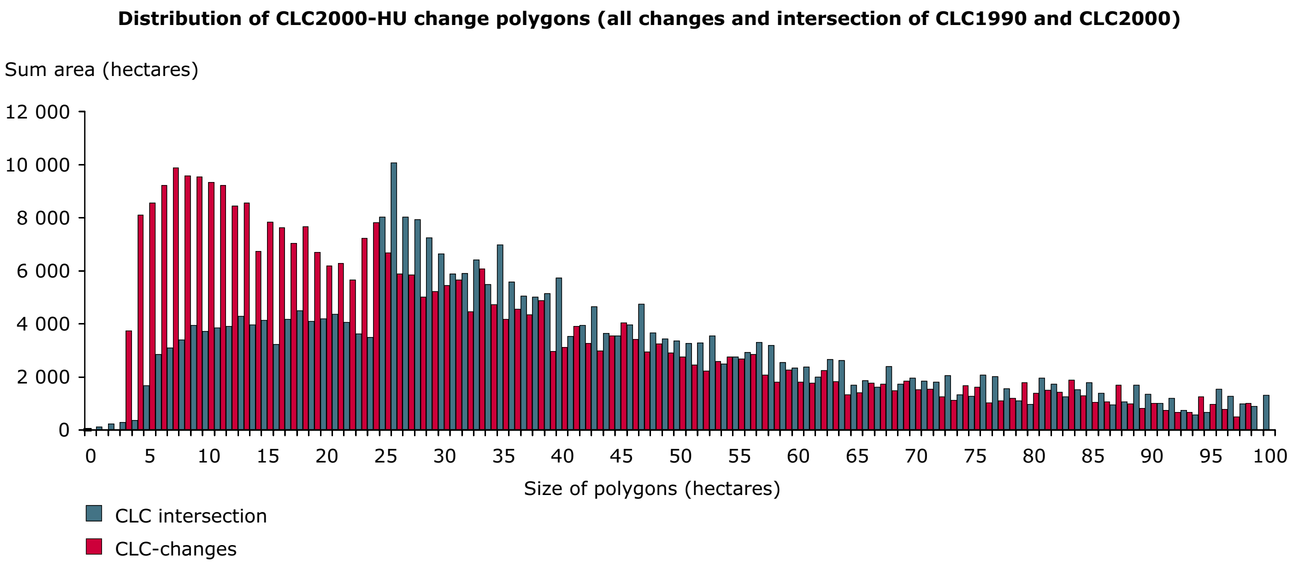
As a consequence, the two approaches will not generate the same change database.

The comparison of results achieved by earlier and recent approaches reveals that both the number of change polygons and the total area of changes < 25 ha is significant compared to all changes (see Figure 6). In this range of change polygons, recent approach gives more thorough results, as changes < 25 ha and > 5 ha are all mapped, regardless of their position, while these polygons are partly missing by the former approach.

The identified change type is also closer to reality with the recent method, as it maps real change processes, while changes provided by the intersection approach are the result of the comparison of two databases without individually examining what was the real process. All in all, the approach chosen for the 2006 exercise will provide a change database that better approximates reality.

As a result of the methodological differences described above, CLC-Changes$_{1990–2000}$ and CLC-Changes$_{2000–2006}$ cannot be directly compared as they arise from two different approaches. However, we can directly compare changes > 25 ha. Changes < 25 ha become comparable after exclusion of isolated change polygons.

Figure 6 Distribution of CLC-Changes polygons produced by intersection method (blue) and change mapping method (red)



Note: Data: CLC2000-HU.

([1]) If interpretation/generalisation errors or different interpretations of a single patch due to subjectivity are present in the source databases CLC2000 and CLC2006, this method introduces additional 'false' changes into the change database.

4.2 Photo-interpretation of changes

4.2.1 Figure legends and definitions

In the following chapter, schematic figures give guidance on how to interpret changes. On these illustrating figures (Figures 7–26) the same legend is applied. Colour polygons represent patches visible on the satellite image(s). Polygons with thick solid outlines represent land cover patches that form a CLC polygon. These are also marked with the corresponding CLC code. Polygons with dashed outlines show patches that changed land cover. Patches without an outline represent patches of land cover that do not form valid polygons.

Each explanatory figure consists of four boxes:

- first box shows the land cover status visible on IMAGE2000 and the polygon outlines in CLC2000 database;
- aecond box shows the land cover status visible on IMAGE2006 without polygon boundaries. Dashed outline marks patches that have changed;
- third box shows polygons to be drawn in the CLC-Changes database. Polygons marked with red T will be deleted from the final change database (see term 'technical change' below);
- fourth box shows the polygons as present in CLC2006 database.

Patch
Patch is a continuous area having a common Corine land cover type and being recognizable on the satellite image(s). A patch becomes a valid CLC polygon only if its size exceeds the MMU.

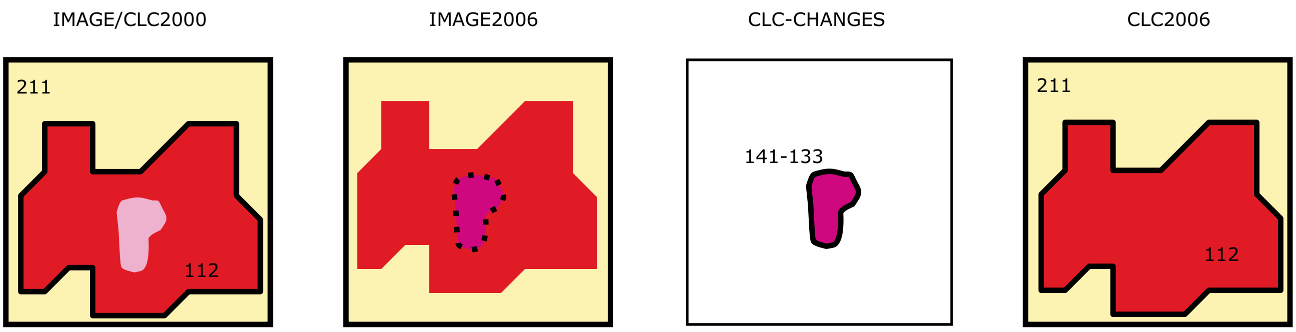
Direct delineation of changes
Change polygons are drawn directly over the corresponding image by means of CAPI and are not generated by a GIS operation (intersection of databases). Human expertise has control over the whole process avoiding the creation of false change polygons.

Real change
Unlike in CLC2000 project, change layer in CLC2006 project is interpreted directly, thus change polygons do not necessarily have to inherit their code$_{2000}$ and code$_{2006}$ from the corresponding CLC2000/ CLC2006 polygon, but can be modified. Interpreter is supposed to attribute to the change polygon the code$_{2000}$/code$_{2006}$ pair that best describes the process that the given land cover patch has undergone in reality. Code pairs thus reflect real processes instead of differences of two databases (see Figure 7).

In Figure 7 the real process is the building-up (133) of a small park (141) (being generalized into discontinuous urban fabric (112) in CLC2000), thus the code pair should be 141-133 instead of 112–133. In product CLC2006 this polygon will be generalised, too.

Technical change (T)
A Technical change polygon is an auxiliary change polygon used for avoiding some major (minimum 5 ha, maximum 25 ha) inaccuracies of the CLC2006 database. They are applied exclusively in the cases listed in the change typology (see Table 7, types E and F), which means that they should not be numerous. Technical change polygons do not represent a change of land cover in reality, but are consequences of the two different MMUs of CLC-Changes (5 ha) and CLC2006 (25 ha). They are

Figure 7 Interpreting a real change



Note: The loss of green urban area (141) < 25 ha by becoming a construction site (133) must be coded 141–133 in the CLC-Changes database, although the patch is generalised into discontinuous urban fabric (112) in both CLC2000 and CLC2006.

used only in order to allow for the creation of a new polygon in CLC2006 by a GIS operation, after which they are deleted from the CLC-Changes database.

Technical change polygons are drawn by the interpreter during change mapping over those patches < 25 ha and > 5 ha:

- whose land cover has NOT changed between 2000 and 2006 (although might include changed patches < 5 ha);
- that are not present as a polygon in CLC2000;
- but we still want them to exist as polygon/part of polygon in CLC2006.

Technical change polygons must be given **identical code$_{2000}$ and code$_{2006}$ AND an additional attribute** that makes them identifiable and makes possible to select them automatically. The attribute added to each change polygon should be named 'technical', having value 1 if the change polygon is technical, and value 0 if not.

The operation of identifying and delineating technical changes requires the interpreter to foresee the CLC2006 database.

In this document, the terms 'changes' and 'change polygons' without the tag 'technical' always mean real changes.

Elementary change
Although the MMU for change mapping is 5 ha, in some cases change polygons < 5 ha are also mapped. When a new polygon is formed by taking area from several other polygons (e.g. a road construction), the individually connected change parts can be mapped even if they are < 5 ha, given that they altogether make up a > 5 ha complex change polygon. Elementary changes have to have a common code either in 2000 or in 2006 and must make up, altogether, > 5 ha (see Figure 8).

Interpreters must be aware that not all changes visible on the images should be treated as changes, e.g.:

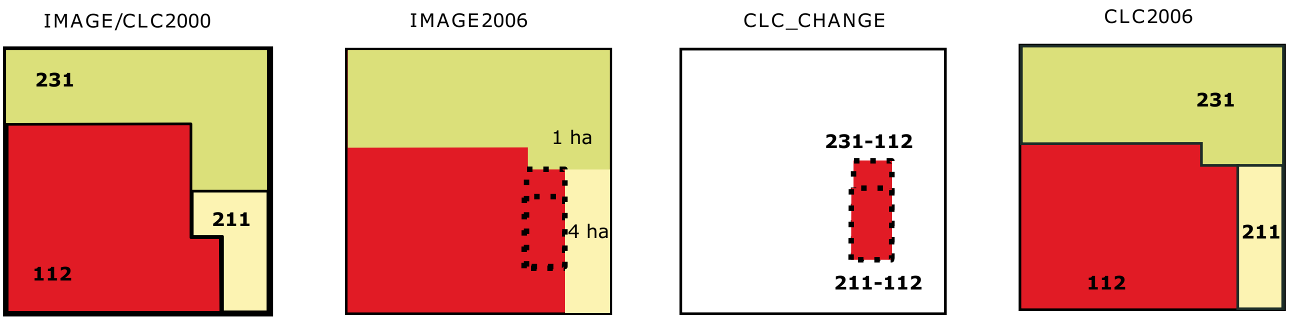
- transient phenomena such as floods and temporary water-logging;
- seasonal changes in natural vegetation, such as difference of biomass;
- seasonal changes in agriculture, such as effects of crop rotation on arable land;
- forest plantation growth, still not reaching the height and/or canopy closure of forest;
- changes of water level of Mediterranean/Alpine/karstic rivers;
- temporal changes in water cover of fishpond cassettes being part of their management;
- changes in distribution of patches of reed and floating vegetation in marshes;
- seasonal changes of snow spots in high mountains.

The introduction of false changes must also be avoided. Many of these can and should be excluded by pure logics. These vary from country to country (e.g. while normally sea water do not change into pasture, it might happen in the Netherlands), thus following examples are not exhaustive and not binding for all cases. However, in most cases they can be considered valid.

Highly non-probable changes are for example (not a complete list):

– 111 –> 131,132, …	Densely built-up areas seldom disappear
– 322 –> 323	Bushy vegetation of different climatic zones do not change to each other
– 411 –> 412	Peatland needs longer than 10 years time to develop
– etc.	

Figure 8 Elementary change



Note: Settlement (112) has taken 1 ha from pasture (231) and 4 ha from arable land (211). These two elementary changes make up a complex change of 5 ha.

4.2.2 *Change typology — guidelines for interpretation*

The rule of thumb for CLC2006 change mapping is that **ALL changes larger than 5 ha should be delineated regardless of their position** (whether being connected to existing CLC2000 polygon or being island-like). In order to help interpreters' work, a typology of changes was created dividing all change cases into one of the following 8 theoretical types (Table 7).

Three databases play a role during CLC update:

- revised CLC2000, which cannot contain polygons < 25 ha,
- CLC-Changes, which cannot contain polygons < 5 ha (except elementary changes, see Figure 5),
- CLC2006, which cannot contain polygons < 25 ha and is created using the previous two.

Based on existence/non-existence of a corresponding polygon in each of the three databases (CLC2000, CLC-Changes and CLC2006) we can create a typology of changes (Maucha *et al*. 2003).

Let us assign an 'L' logical variable to each patch, which has a value of 1 (true) if the patch in its database reaches the corresponding size limit and consequently emerges as a polygon. The value of L is 0 (false) if the patch is below the size limit and does not form a polygon in the database. 'A' refers to area in hectares.

$L_{2000} = 1$ if $A_{2000} \geq 25$ ha, $L_{2000} = 0$ if $A_{2000} < 25$ ha;
$L_{ch} = 1$ if $A_{ch} \geq 5$ ha, $L_{ch} = 0$ if $A_{ch} < 5$ ha;
$L_{2006} = 1$ if $A_{2006} \geq 25$ ha, $L_{2006} = 0$ if $A_{2006} < 25$ ha.

The decision table with three logical variables (corresponding to the three databases) includes altogether $2^3 = 8$ different types (see Table 7). Hereafter we give guidance on the way of handling each of the above types, illustrating them with examples.

Of course, no universal recipe can be given for any of the cases. Thus, the following examples are schematic (they show a simplified reality) and do not list all possible combinations of codes and sizes. However, any change case falls under one of these theoretical types. The examples do not deal thoroughly with questions of generalisation, as these are well described in other CLC documents.

For figure legend see beginning of this chapter.

A Simple change: a polygon > 25 ha grows or decreases with a change > 5 ha resulting in a polygon > 25 ha in CLC2006

Being the most frequently occurring change type, changes > 5 ha connected to an existing (> 25 ha) CLC2000 polygon are always mapped, similarly to project CLC2000 (see Figures 9 and 10).

Following their delineation, change polygons must be given a $code_{2000}$ and a $code_{2006}$ representing the processes having occurred to the given patch, in reality (see explanation at 'real change').

Table 7 Change types

Letter code	L_{2000} $A_{2000} \geq 25$	L_{ch} $A_{ch} \geq 5$	L_{2006} $A_{2006} \geq 25$	Short explanation	Remark
A	1	1	1	Simple change	*Occurs most frequently*
B	1	0	1	Small change in existing polygon	*Occurs frequently;* ***not interpreted*** *-> max. 5 ha error in CLC2006*
C	1	1	0	Disappearing polygon	*Occurs seldom*
D	1	0	0	Disappearing polygon with small change	*Occurs very seldom,* **not interpreted** *–> max. 5 ha error in CLC2006*
E	0	1	1	New polygon	***T*** *is used to avoid > 5 ha and < 25 ha error in CLC2006*
F	0	0	1	New polygon with small change	***T*** *is used to avoid > 20 ha and < 25 ha error in CLC2006*
G	0	1	0	Change only	*Occurs frequently*
H	0	0	0	Small change only	***Not interpreted***

Note: T refers to technical change.

B Small change in existing polygon: < 5 ha change in polygon > 25 ha

No change polygons < 5 ha should be mapped except if they are elementary changes of a complex change > 5 ha (see Section 1.2.1, Figure 8).

C Disappearing polygon: a polygon decreases to < 25 ha with a change > 5 ha

If due to a change > 5 ha the size of a polygon decreases below 25 ha, it will disappear in CLC2006 because of the generalisation, while the change polygon remains in CLC-Changes. Only the part that has really changed must be delineated during change mapping (see Figures 11 and 12).

D Disappearing polygon with small change: a polygon decreases to < 25 ha with a change < 5 ha

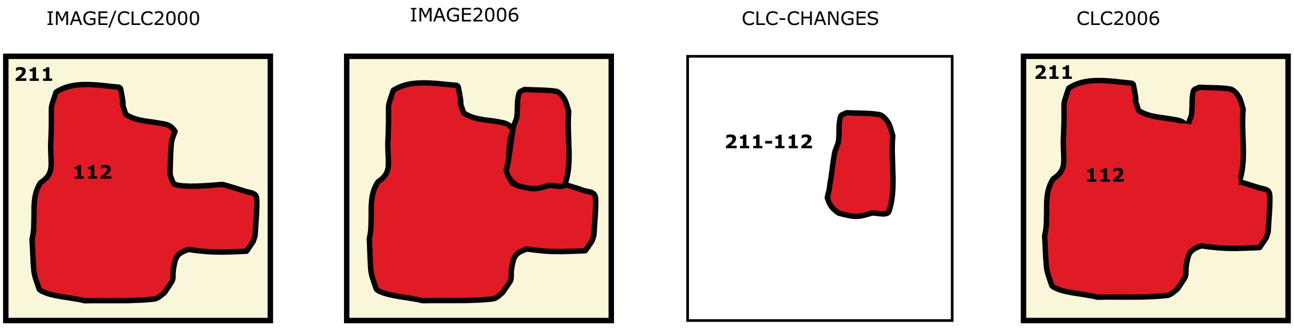
In a few cases existing polygons decrease to a size < 25 ha with a change < 5 ha. As the change is < 5 ha, the changed patch should not be delineated. This causes only a minor (< 5 ha) mistake in CLC2006, so these cases are not dealt with during this project.

E New polygon: a polygon grows > 25 ha with a change > 5 ha

The simplest case of this type is the emergence of a new patch > 25 ha (see Figure 13).

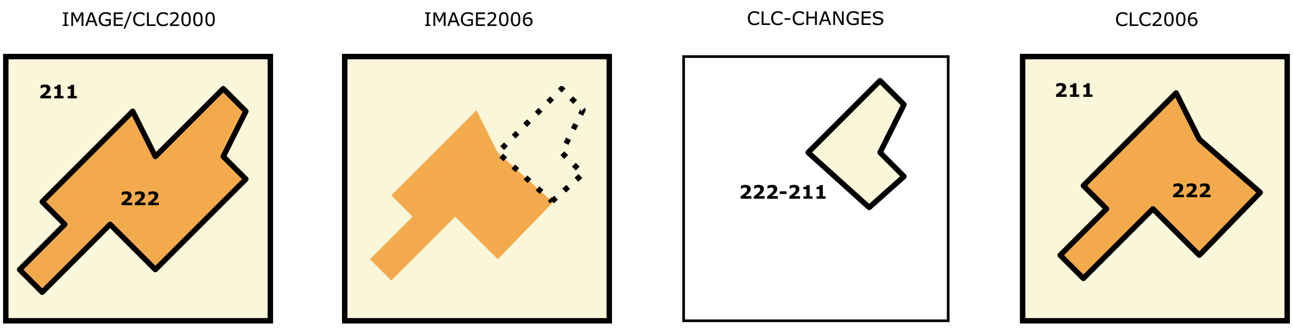
If a patch that existed in 2000, but used to be < 25 ha (thus not mapped in CLC2000) grows with a change > 5 ha so that it exceeds the 25 ha limit in 2006, a so-called 'technical change' polygon must also be applied. Besides delineating the real change (grown part of the polygon), the non-changed (originally existing) part must be delineated as well, with similar code$_{2000}$ and code$_{2006}$ and an additional attribute marking it as 'technical change'. By using the two types of change polygons, the patch will be included in CLC2006 automatically, whereas the 'technical change' polygon will be deleted later from the final CLC-Changes database (see Figure 14). For more information on technical changes, see also the definitions at the beginning of this chapter.

Figure 9 Simple change (I)



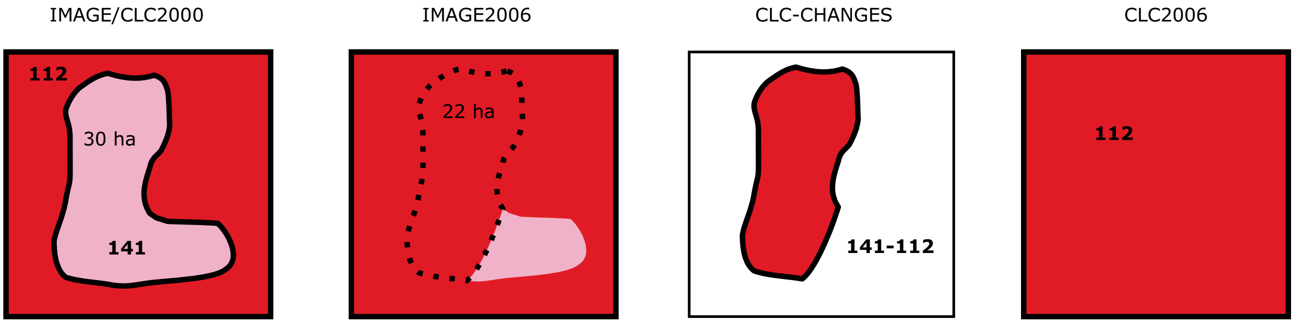
Note: A settlement (112) > 25 ha grows with > 5 ha, occupying arable land (211).

Figure 10 Simple change (II)



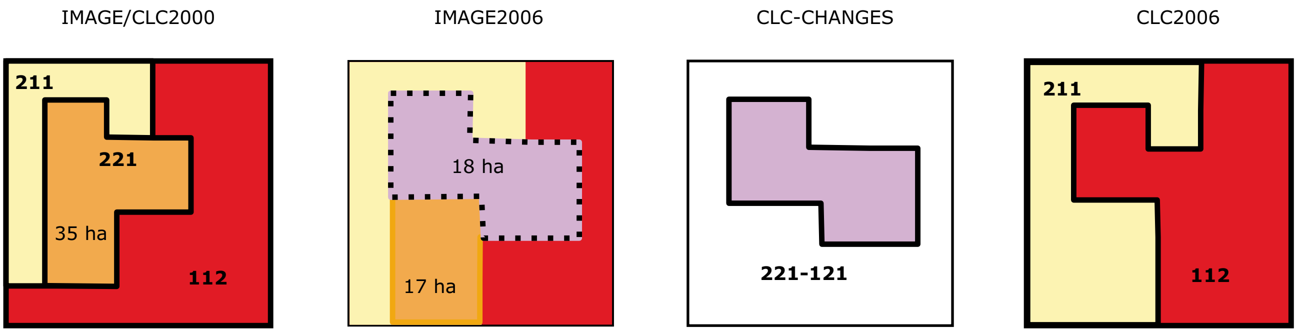
Note: A fruit orchard (222) > 25 ha decreases above > 5 ha, while an area of arable land (211) increases. The resulting 222 polygon in 2006 is still > 25 ha.

Figure 11 Disappearing polygon (I)



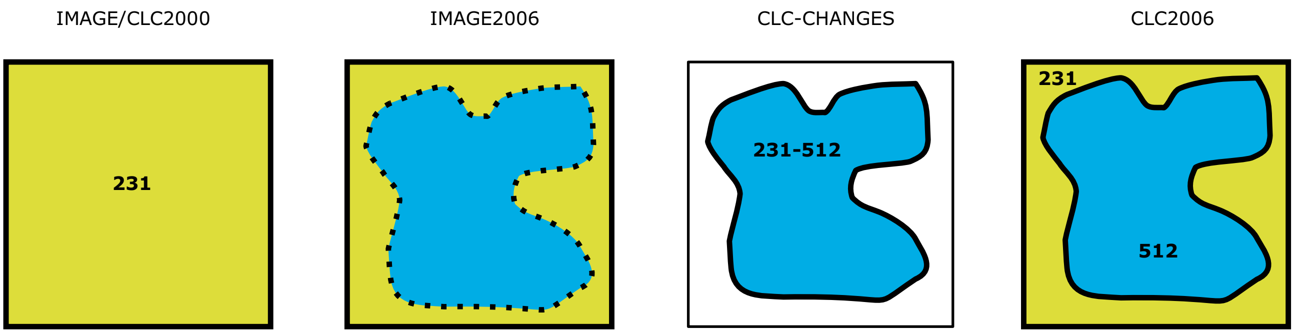
Note: Most of the area of a park (141) is built-up so that the park's size actually decreases below 25 ha. Consequently, what is left of it is generalized into the settlement (112) in CLC2006.

Figure 12 Disappearing polygon (II)



Note: Significant (> 5 ha, but < 25 ha) part of a vineyard (221) is occupied by new industry (121). A change polygon coded 221–121 is delineated in CLC-Changes database. The area left from the vineyard is < 25 ha. Consequently in CLC2006 the remaining vineyard and the new industry is generalized into arable land (211) and urban fabric (112), respectively.

Figure 13 New polygon (I)



Note: A > 25 ha new fishpond (512) is established on former pasture (231).

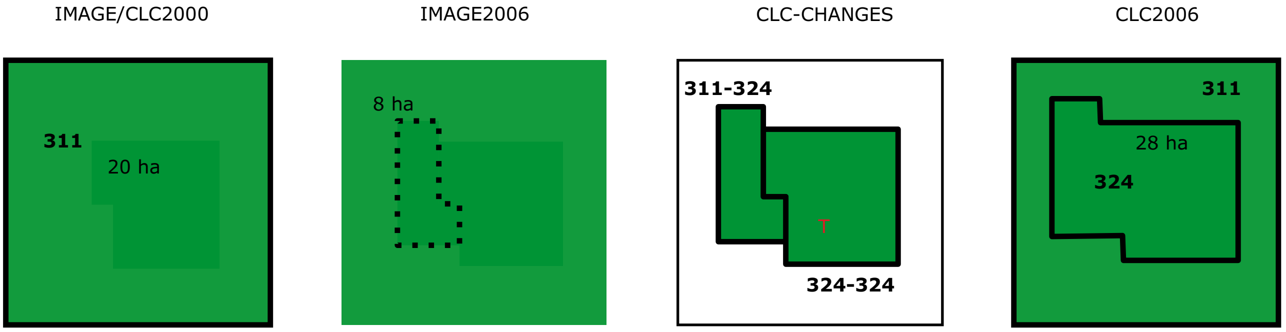
In order to avoid inaccuracies being introduced into CLC2006, the same method is applied also in cases when the real change is > 25 ha so that it would make up a new polygon itself in CLC2006. In this case too, a real change polygon must be drawn over the changed ('new') part and a 'technical change' polygon must be drawn above the non-changed ('already existing') part if > 5 ha (see Figure 15).

A special case of this type (combined with type C) is the code change of a polygon (see Figure 16).

F New polygon with small change: a polygon grows > 25 ha with a change < 5 ha

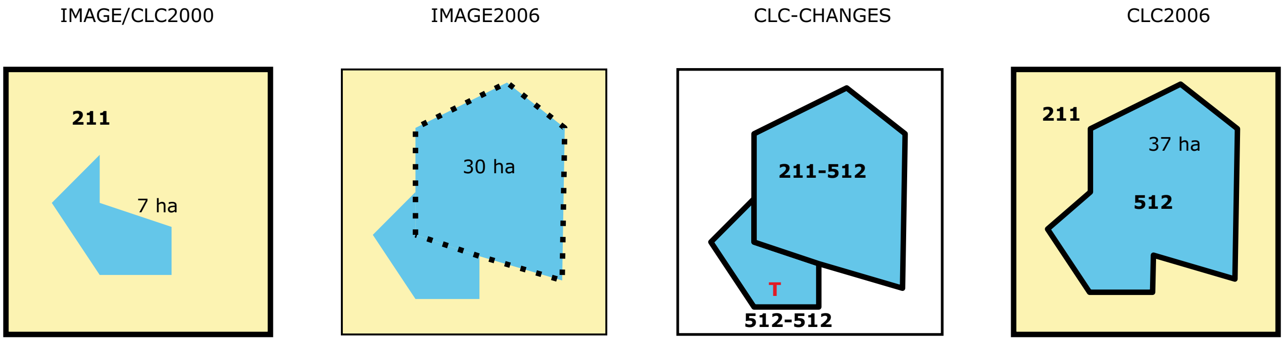
In the few cases when polygon grows over 25 ha with a real change < 5 ha, the real change should

Figure 14 New polygon (II)



Note: A 20 ha forest clearcut (324) grows by 8 ha. As a result, the clearcut's area is > 25 ha. Two change polygons must be delineated: an 8 ha real change (311–324) and a 20 ha 'technical change' (324–324). The 'technical change' will be deleted from the final version of CLC-Changes, while the corresponding polygons will make up a 324 polygon in CLC2006.

Figure 15 New polygon (III)



Note: A 7 ha fishpond (512) grows by 30 ha. Although the change is > 25 ha, so the polygon would be enough to form new polygon in CLC2006, in order not to miss the 7 ha part, a 'technical change' polygon (512–512) must also be delineated. This will be deleted from the final version of CLC-Changes, while CLC2006 will contain a correct 37 ha water body (512) polygon.

be added to the 'technical change' polygon as well. Without using 'technical change' we would introduce a major (20–25 ha) mistake into CLC2006. Using 'technical change' the new polygon will be included in CLC2006 while the change database will not contain any polygon (no real change > 5 ha) (see Figure 17).

G Change only: changes in a non-existing polygon ('island change')

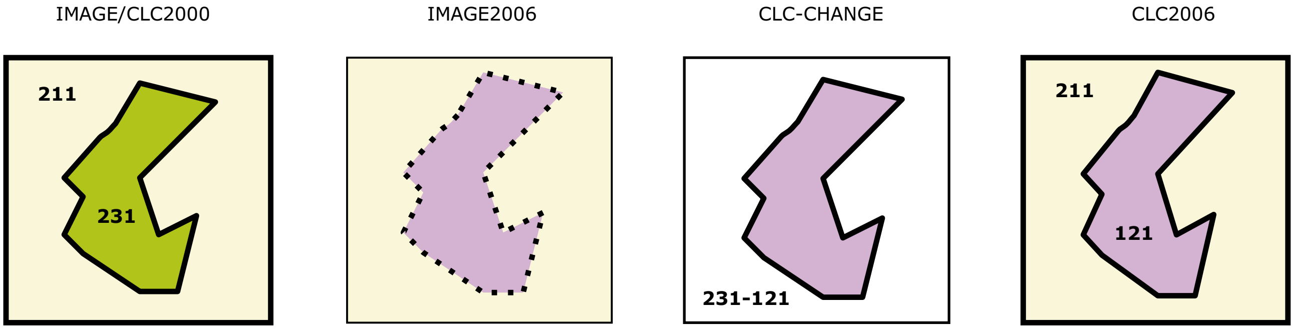
This type includes the cases when the change polygon is not connected to a valid polygon in CLC2000 or in CLC2006, while a valid (> 5 ha) change occurred. The change might be the emerging of a new patch/complete disappearance of an existing patch (Figure 15), or the growth/decrease of an existing small (< 25 ha) patch (Figure 16), none of them resulting on a polygon > 25 ha. Thus, no valid polygon emerges in CLC2006, as the polygons are generalised.

This type of changes must be coded according to their real change process. Change polygons < 25 ha will be generalised in CLC2006 based on their code2006 (see Figures 18–21).

H Small change only: change < 5 ha in not existing polygon (< 25 ha)

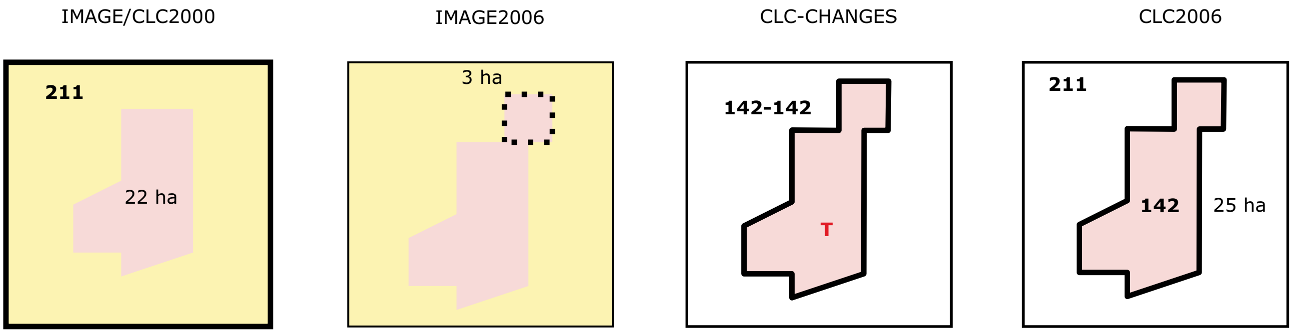
As polygons in all three databases are smaller than their respective area limits, this case should not be dealt with during CLC2006 project.

Figure 16 New polygon (IV)



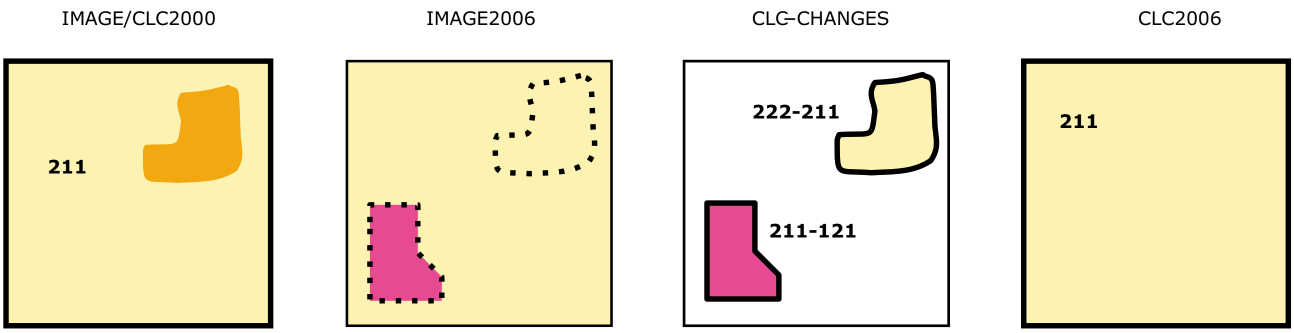
Note: A new industrial unit (121) is built on a > 25 ha pasture (231), totally occupying the area. With a change 231–121 the pasture disappears, while a new industry emerges.

Figure 17 New polygon with small change



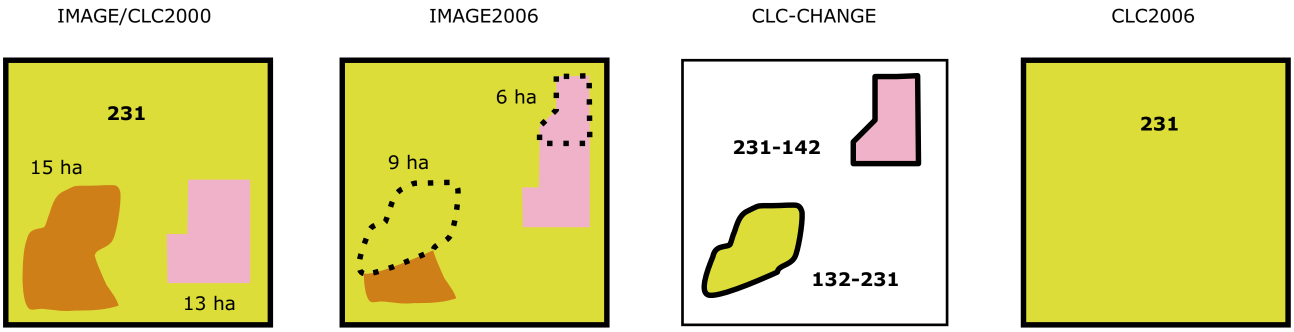
Note: A 22 ha sports facility (142) grows by 3 ha, thus just reaching the 25 ha MMU. As the changed part is < 5 ha, no real change polygon must be delineated. The polygon should however appear in CLC2006, so a 25 ha technical change (142–142) polygon must be drawn.

Figure 18 Change only (I)



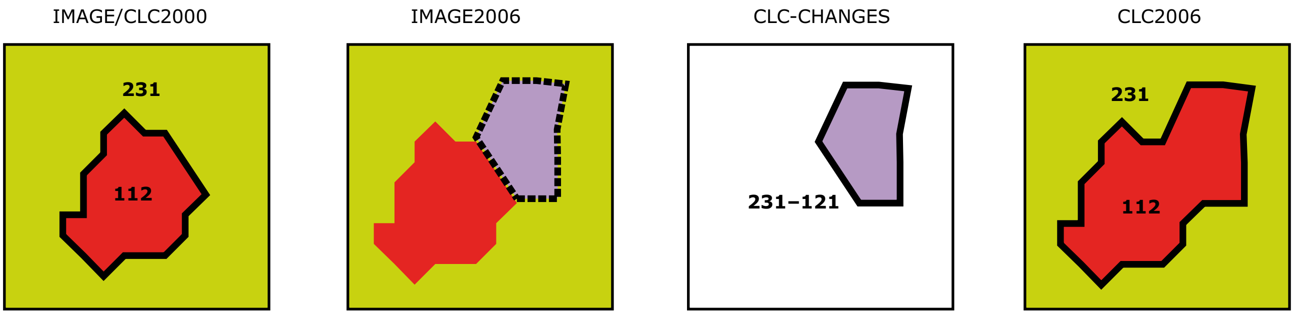
Note: A new small industrial unit (121) > 5 ha is built on former arable land (211), while a small patch of fruit orchard (222) > 5 ha disappears because of being turned into arable land (211). Both patches must be delineated as changes (211–121 and 222–211), as being > 5 ha. No new polygons emerge in CLC2006, as corresponding polygons are generalised.

Figure 19 Change only (II)



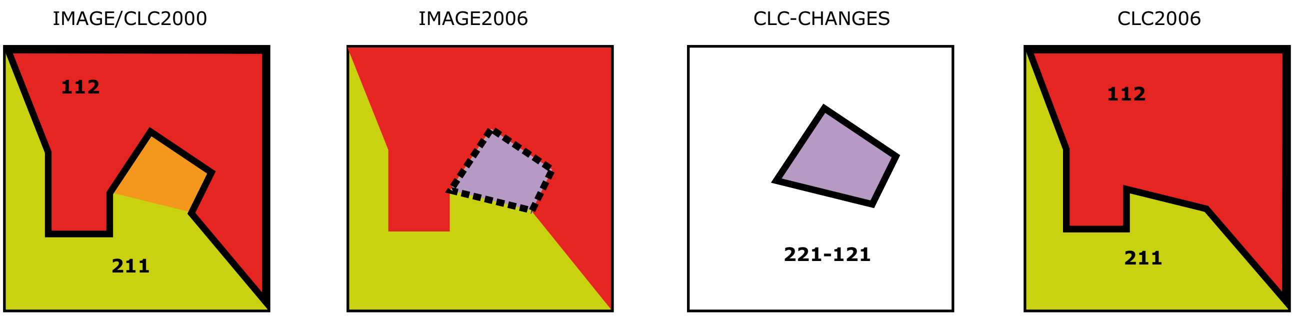
Note: A 13 ha sports facility (142) expands with 6 ha, while in the neighbourhood 9 ha of a 15 ha dump site (132) are re-cultivated by being turned into grassland (231). Both changed areas are > 5 ha thus resulting in a valid polygon in CLC-Changes database. However, none of them results in a > 25 ha polygon in 2006, so no valid polygons appear in CLC2006.

Figure 20 Change only (III)



Note: New industry (121) > 5 ha and < 25 ha has been built beside a village (112). In CLC2006 the 121 polygon is generalized into 112.

Figure 21 Change only (IV)



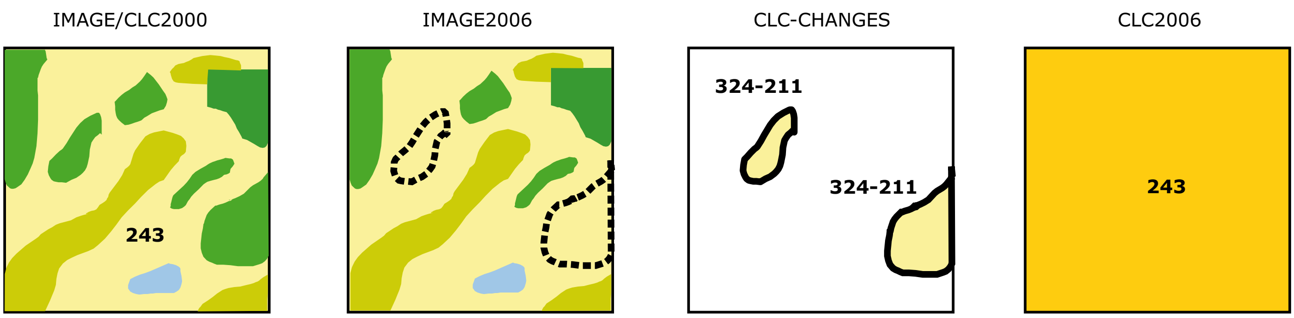
Note: A patch of vineyard (221) > 5 ha (but < 25 ha, thus generalized into arable land (211) in CLC2000) is occupied by industry (121). The 221–121 change polygon is included in CLC-Changes, while the resulting industry polygon (121) is generalized into a settlement (112) in CLC2006.

4.2.3 *Handling changes in, by-definition, heterogeneous classes — changes at landscape level*

CLC nomenclature includes some land cover classes that, by definition, represent heterogeneous landscapes, thus certain polygons are made up of a mosaic of smaller homogenous patches, most of them < 25 ha. This means a shift from a dominantly feature-level mapping generally applied by CLC to a landscape-level approach for classes, especially: 242, 243 and 313 ([2]). If individual land cover changes occur within polygons of these classes in a way that they altogether change the characteristics of the area at landscape level, then change polygons should be delineated at landscape level, too. Let us take, for example, a 243 polygon, being mostly agricultural landscape with mosaic of small (< 25 ha) patches of semi natural features: forest, bushes, wetlands and/or natural grassland. If a few of the bushes are cut and turned into arable land, the main character of the polygon does not change, being still an agricultural landscape with significant amount of natural features. This changes case must be mapped individually as 324–211, for they will represent real changes in the CLC-Changes database, whereas in CLC2006 the 243 polygon will be left unchanged as new 211 patches will be generalized into 243 (see Figure 22).

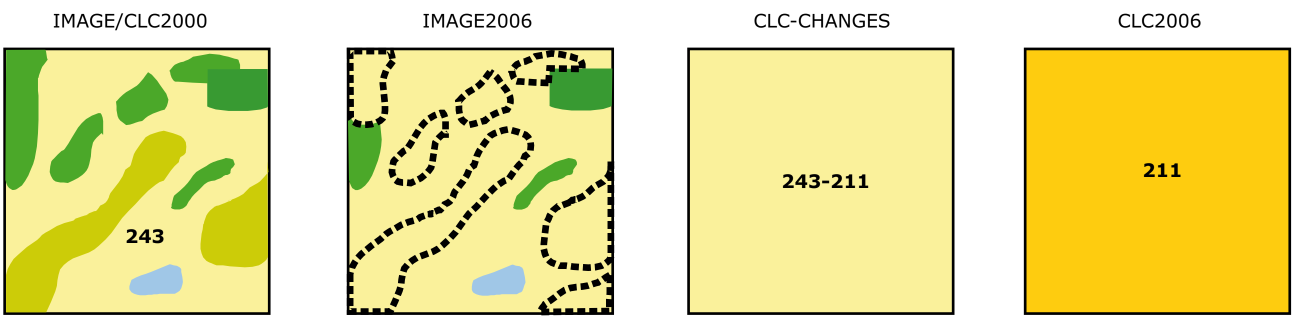
It might happen, however, that due to an economic/social impact (say change in EU subsidisation system) or for some natural phenomena all or most of the natural patches are turned into arable land, turning the whole landscape's character into agricultural. The area is not a mosaic of natural patches and agricultural land anymore, but mostly arable land. This case the change happened at the landscape level, so the change polygon will include the whole area, its code pair being 243–211. It is only in these cases that the delineation of individual changes can be replaced by landscape-level change mapping (see Figures 23 and 24).

Figure 22 Small change only (I)



Note: In a heterogeneous landscape (243) a few patches of semi-natural vegetation (324) are turned into arable land (211). As still significant area of natural vegetation is left, the character of the polygon does not change, it is still best characterised with code 243. Change polygons delineated must represent the real process (324–211). Due to generalisation the 243 polygon will be left unchanged in CLC2006.

Figure 23 Small change only (II)



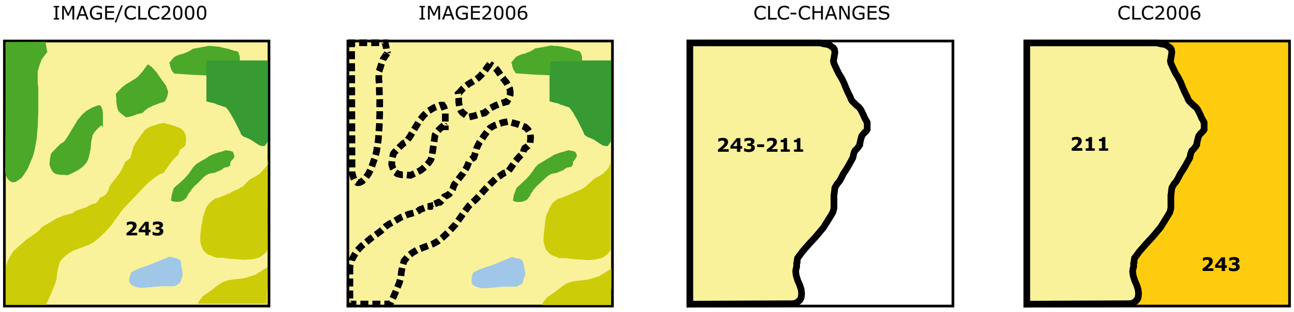
Note: In a heterogeneous landscape (243) most of patches of semi-natural vegetation (324, 321) are turned into arable land (211). As the area of natural vegetation left is not significant, the character of the whole area has changed. A 243–211 change polygon must be delineated.

([2]) Heterogeneous classes should not to be confused with general rule of CLC mapping i.e. all classes might have some portion with different land cover. E.g. discontinuous urban fabric (112) might include < 25 ha parks, water bodies, industry etc.

Processes showing the opposite direction (from homogeneous to heterogeneous landscape) should be treated similarly (see Figures 25 and 26).

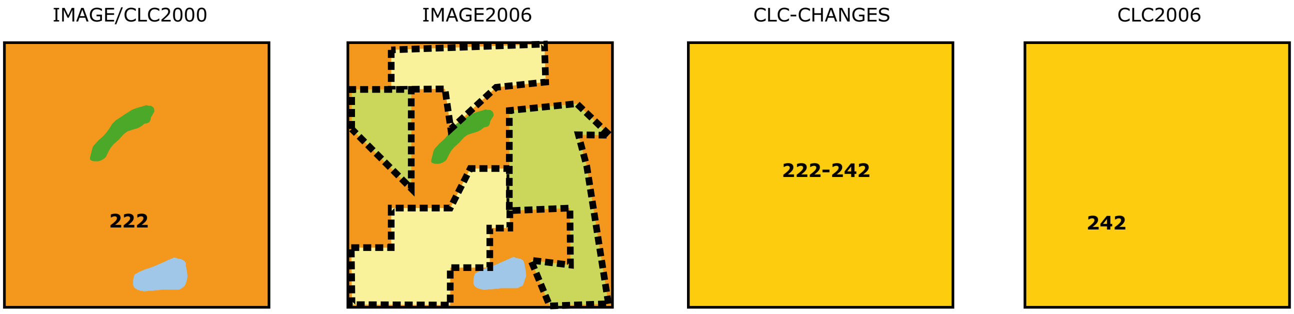
Similar approach should be applied for all three, by-definition, heterogeneous classes: 313, 242 and 243.

Figure 24 Small change only (III)



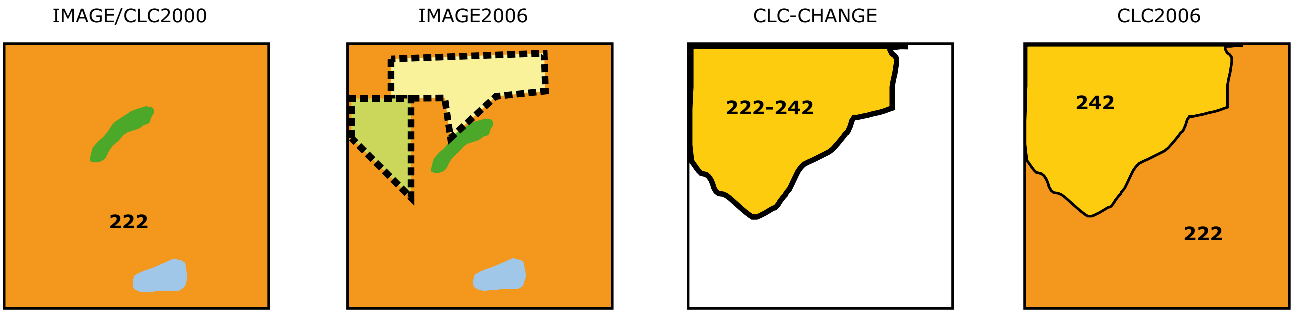
Note: In a part of a heterogeneous landscape (243) most of the patches of natural vegetation (324, 321) are turned into arable land (211). The delineated change polygon (243–211) must cover only the changed part of the landscape.

Figure 25 Small change only (IV)



Note: In an area dominantly occupied by orchards (222), a significant part of the plantations is cut and turned into arable land and pasture. The landscape becomes heterogeneous agricultural landscape (242); orchards do not dominate it any more.

Figure 26 Small change only (V)



Note: If fruit tree plantations (222) are kept in a part of the same area, only the altered part should be delineated as change (222–242).

5 Ancillary data

5.1 Proposed ancillary data

Similarly to CLC2000 project, the following types of basic ancillary data are proposed to be used in support of interpretation of land cover changes:

- Topographic maps, minimum scale 1:50.000; in digital format (if available);
- Orthophotos taken recently (as topographic maps are usually out of date);
- Additional, medium or high resolution, satellite imagery (different than IMAGE2000 and IMAGE2006) is highly recommended. These might help the interpreter to understand the evolution processes and to identify certain CLC categories.

5.2 LUCAS data to support photo-interpretation

LUCAS land use and land cover codes and field photographs from LUCAS2001&2002 and LUCAS2006 projects are available to national teams. The use of LUCAS data is a novelty and a great advantage for photo-interpreters. LUCAS data exists for countries listed in Table 8.

Table 8 Availability of LUCAS data in support of photo-interpretation

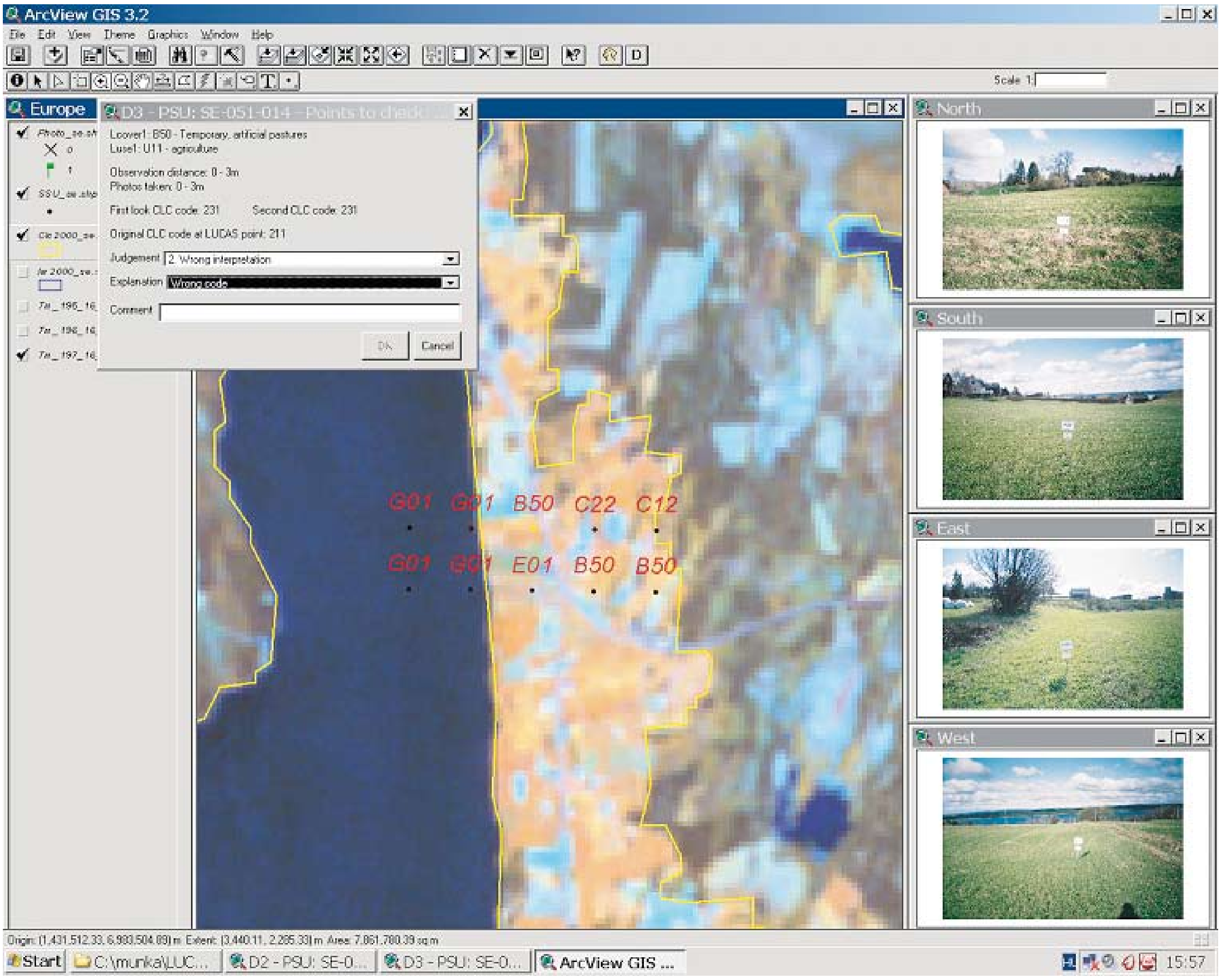
Country	LUCAS 2001/2002	LUCAS 2006
Austria	x	
Belgium	x	x
Czech Republic		x
Denmark	x	
Estonia	x	
Finland	x	
France	x	x
Germany	x	x
Greece	x	
Hungary	x	x
Ireland	x	
Italy	x	x
Luxemburg	x	x
Netherlands	x	x
Poland		x
Portugal	x	
Slovakia		x
Slovenia	x	
Spain	x	x
Sweden		
United Kingdom	x	

LUCAS is a ground-based agri-environmental survey organised by Eurostat. Two surveys have been organised so far, which differ in the sampling design. In each sampling point the surveyor registers the land use and the land cover code valid in the small (usually 3 meter) vicinity of the point. The LUCAS LU and LC nomenclature are included in Annexes 4 and 5. The nomenclatures used in 2001 and 2006 are slightly different. In addition to land use and land cover information, field photographs are also taken in four directions (N, W, E and S). In LUCAS 2001&2002 there are field photos for the central sampling point of each cluster (made up of 10 sampling points, altogether). In LUCAS2006 field photos were taken in all sampling points.

LUCAS data, by giving ground truth data for the photointerpreter, provides valuable information either in improving CLC2000 (with LUCAS 2001&2002) or in delineating land cover changes (with LUCAS 2006). Two examples (Figures 27 and 28) illustrate the use of LUCAS in improving CLC data (Büttner *et al.*, 2006).

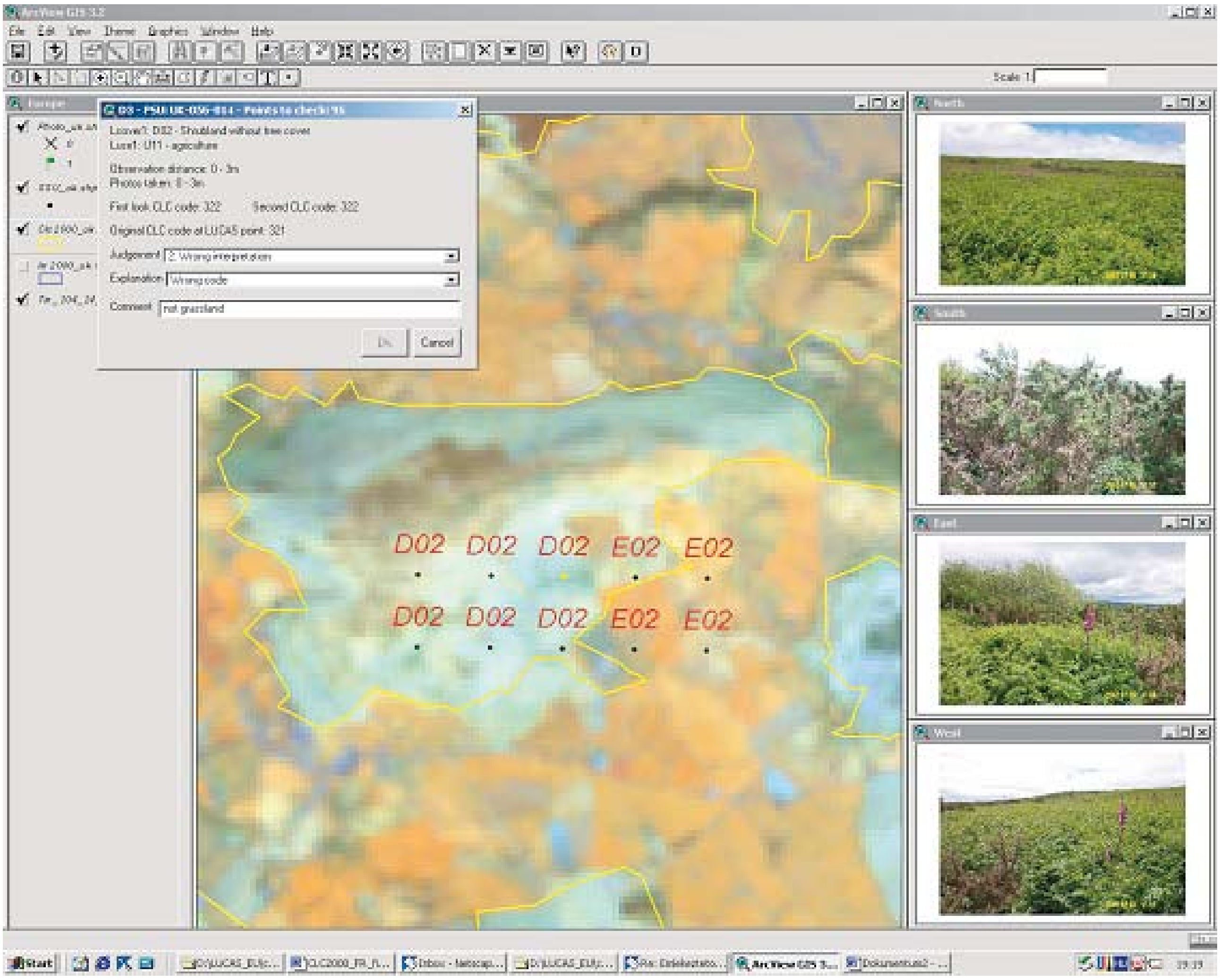
More detailed description of LUCAS can be found at: http://circa.europa.eu/irc/dsis/landstat/info/data/survey_documentation.htm

Figure 27 Example of using LUCAS in improving CLC2000 (I)



Note: LUCAS LC: temporary artificial pasture (B50);
LUCAS field photographs: confirm pasture (231);
CLC2000: arable land (211) is interpreted, which is a mistake.

Figure 28 Example of using LUCAS in improving CLC2000 (II)



Note: LUCAS LC: shrubland without tree cover (D02);
LUCAS field photographs: confirm shrubs (322);
CLC2000: natural grassland (321) is interpreted, which is a mistake.

6 Production of CLC2006 database

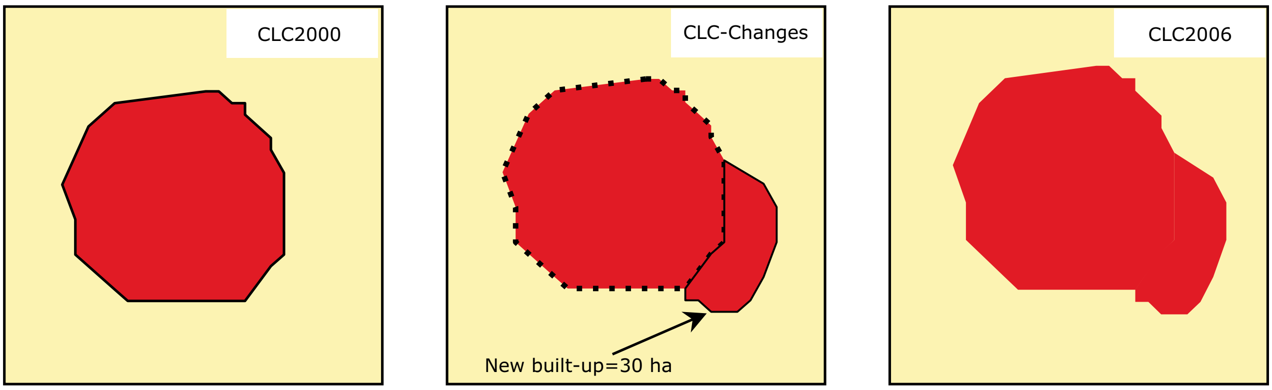
In the CLC2006 project the Corine land cover database is updated by the 'change mapping first' approach (see Annex 3). This means that national teams will interpret all LCCs which are larger than 5 ha. The given change codes should approximate, as much as possible, the real evolution process. During change mapping, found errors (thematic as well as geometric) of CLC2000 have to be corrected, providing a $CLC2000_{rev}$ dataset.

Integrating $CLC2000_{rev}$ and CLC-Changes in order to produce CLC2006 should rely on the equation:

$$CLC2006 = CLC2000_{rev} + CLC\text{-}Changes$$

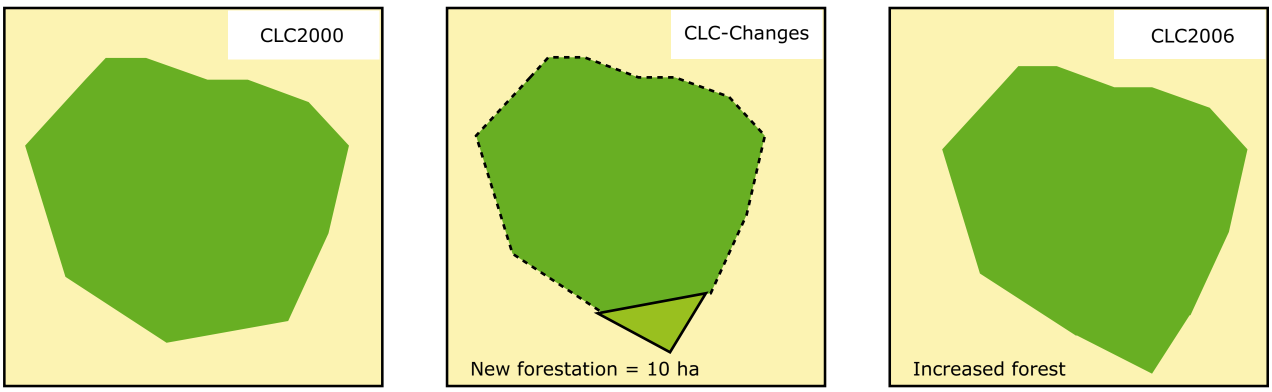
However, due to the different MMU in CLC and CLC-Changes, the above equation will be valid only for changes > 25 ha (Figure 29), and will not be valid for changes < 25 ha (Figure 30).

Figure 29 Integration of CLC2000 and CLC-Changes > 25 ha



Note: Increase of a settlement/decrease of arable land by 30 ha. As the change is > 25 ha, the integration of CLC2000 and CLC-Changes is straightforward and can be done automatically. The exact mathematical relation between the three databases (CLC2000, CLC-Changes and CLC2006) is fulfilled.

Figure 30 Integration of CLC2000 and CLC-Changes < 25 ha



Note: 10 ha of new forest plantation on former arable land. As the change is < 25 ha, the integration of CLC2000 and CLC-Changes is not straightforward and generalisation is needed. Using the priority table, this case can be solved automatically. The forest plantation area will be added to the area of the former forest. The exact mathematical relation between the three databases (CLC2000, CLC-Changes and CLC2006) is not fulfilled.

Producing CLC2006 according to the above constraints is a semi-automatic process, and includes two main parts:

1. Computerised processing:
- Integration of changes > 25 ha (see Figure 29);
- Generalisation of small (< e.g. 23 ha) changes (amalgamation). The threshold of amalgamation could be slightly lower than 25 ha to allow for 'intelligent' exaggeration (see Figure 31);
- Generalisation of small changes to one of the neighbours (if generalisation situation is clear).

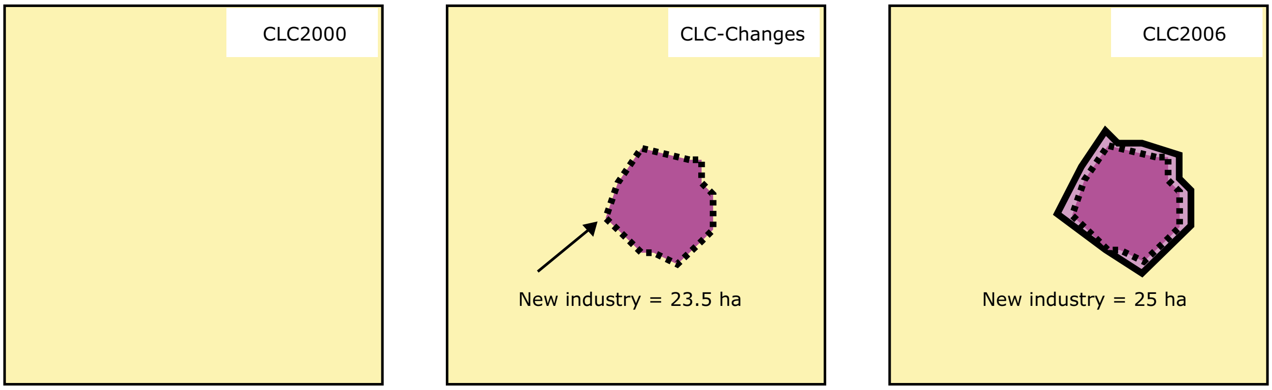
2. Non-automated processing (requires a photointerpreter decision):
- Handling polygons just under the 25 ha limit (e.g. between 23 and 25 ha) (see Figure 31);
- Generalisation of small changes to one of the neighbours (if generalisation situation is not clear, see Figure 32).

The previously established generalisation table has to be applied to guide the generalisation (see Annex 6). Other CLC2006 integration examples are included in Figures 7–26.

As a consequence of the above, no exact mathematical relation could be established between the three databases, due to two different MMUs. Therefore CLC2000, CLC2006 and CLC-Changes have to be considered in applications of land cover data (e.g. indicator development) as three (nearly) independent databases.

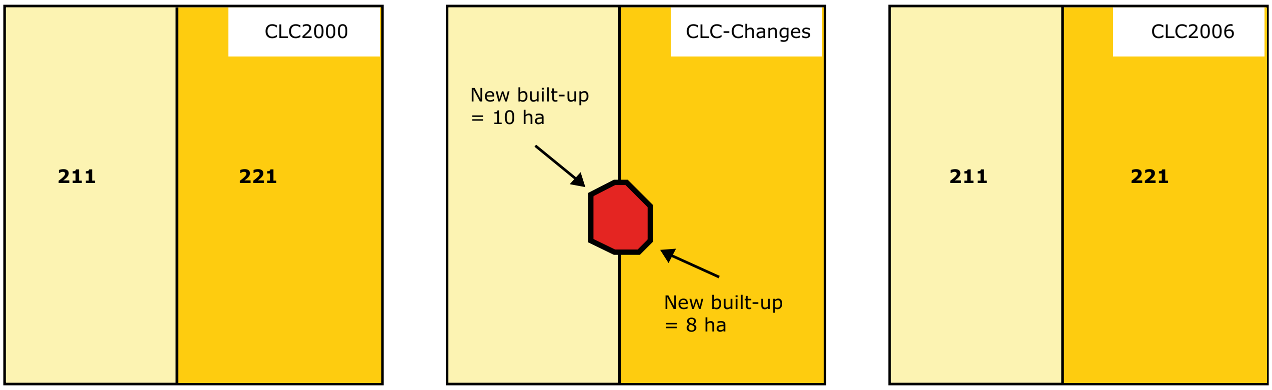
It is for each country to decide whether the CLC2006 integration is done by the national team or by ETC-LUSI. ETC-LUSI will assist the interested countries by providing an ArcInfo script written for this data integration (outcome of CLC2006 Expert Meeting, EEA, October 2006).

Figure 31 Generalisation of small changes (amalgamation)



Note: New industry (23.5 ha) on arable land. With an automatic process, this would have not appeared in CLC2006. However, with a slight exaggeration to reach the 25 ha limit, this object will be part of CLC2006. The exact mathematical relation between the three databases (CLC2000, CLC-Changes and CLC2006) is not fulfilled.

Figure 32 Generalisation of small changes (to one of the neighbours)



Note: New built-up area (18 ha) established partly on arable land and partly on vineyard. This situation is called 'unclear generalisation', as the priority of generalising 112 into 211 is the same as that of into 221. In this case, the photointerpreter has to solve the generalisation. The exact mathematical relation between the three databases (CLC2000, CLC-Changes and CLC2006) is not fulfilled.

7 Metadata

Similarly to CLC2000 project, two levels of metadata are produced in CLC2006 project.

7.1 Working unit level metadata

The purpose of the working unit level metadata is to document all the steps regarding the production of the CLC-Changes database. These, mostly, serve data producers.

Working unit level metadata (see Annex 1) is produced only for CLC-Changes data. National teams are responsible for preparing working unit level metadata for their CLC-Changes database.

7.2 Country level metadata

Country level metadata mostly serves the users by informing them about the main parameters of the product.

Country level metadata are produced for CLC-Changes, CLC2006 and, if applicable, for the revised CLC2000 databases:

- Country level metadata for CLC-Changes is to be prepared by the national teams;
- Country level metadata for CLC2006 is to be prepared by the organisation that is going to produce it (either the national team or ETC-LUSI);
- Country level metadata for revised CLC2000 should be prepared only by those countries for which ETC-LUSI is preparing CLC2006.

7.2.1 Country level metadata format

Country level metadata for CLC2006 products should, preferably, be delivered according to EEA-MSGI, which is the metadata standard developed by EEA for geodata. The standard – termed 'European Environment Agency Metadata Standard for Geographic Information' (EEA-MSGI) – is a profile of the ISO19115 standard for geographical metadata, in accordance with INSPIRE recommendations.

EEA has developed a metadata editor working under ArcGIS9.x providing easy editing and validation of EEA-MSGI metadata. Organizations having access to ESRI ArcCatalog should preferably use the EEA Metadata Editor.

System information for EEA Metadata Editor:

- Compatible Windows systems: *NT 4.5*, *Win 2000 and Win XP*;
- Compatible ArcGIS (ArcView, ArcInfo, ArcEditor) versions: 9.x

Organizations having no access to ESRI ArcCatalog might use the 'EEA metadata form for spatial datasets', which is an MS Word document. An example of a filled-in EEA metadata form is included in Annex 2.

Both the EEA metadata editor (including Installation Guide and Users Manual) and the 'EEA metadata form for spatial datasets' can be downloaded from the Eionet website at: http://www.eionet.europa.eu/gis/geographicinformationstandards.html.

8 Verification

Similarly to CLC2000 project, the CLC Technical Team of ETC-LUSI will verify the photo-interpretation of national teams. Technical Team verifies CLC2000 and CLC-Changes databases. The aim of the verification is two-fold:

- to inform the EEA and the national authority of the member country about the work progress;
- to assist the country in producing a high-quality CLC update, which is harmonised across Europe.

The reasons to re-check CLC2000 are:

- Only 8 % of the country area has been checked in CLC2000;
- CLC2006 is based on CLC2000, so producing a good quality CLC2006 requires a good quality CLC2000.

Two verification missions in each country are foreseen: the first one in the 2nd quarter of the production phase (25–50 % of the area processed), while the 2nd one in the 4th quarter of the production phase (75–100 % of the area processed).

Like in CLC2000, InterCheck software (provided by FÖMI) will be used for verification. A GIS-file that includes the remarks and recommendations of the CLC Technical Team will also be provided to the national team in order to help integrate corrections more easily. Details of the checking process are shown in Table 9.

Table 9 CLC2006 Verification/Quality assurance implemented by the CLC Technical Team

	CLC2000 database	Remarks	CLC-Changes database	Remarks
Technical issues (for automatic control)	Topological consistency	No dangles, all polygons are closed, only a single code per polygon, no neighbour polygons with the same code	Topological consistency	No dangles, all polygons are closed, two different codes per polygon (2000, 2006), no neighbour polygons with the same code
	Area limit = 25 ha	No polygons with area < 25 ha are permitted (except along working unit boundary)	Area limit = 5 ha	No change polygons with area < 5 ha are permitted (except complex changes)
	Valid CLC codes, no '0' code	Only valid CLC codes are permitted	Valid CLC codes, no '0' code	Only valid CLC codes are permitted
Thematic issues (expert control)	Geometrical accuracy	No geometric errors > 100 m	Accuracy of delineation of changes	Delineation of changes should have an accuracy within a pixel size of the input satellite image
	Width of linear elements (> = 100 m)	Linear elements are at least 100 m wide	Boundary displacement of changes > = 100 m	No change is recorded if the boundary displacement is less than 100 m
	Consistent application of CLC nomenclature	The CLC nomenclature with extended definitions (see Addendum 2006) is applied in a consistent manner (right codes, enough details, right application of refined definitions and generalisation rules)	Consistent delineation of changes	All changes larger than the limits (5 ha, 100 m) are mapped regardless of their position. Only real changes which have taken place between 2000 and 2006 are included
Metadata sheets	Metadata sheets for each working unit (CLC-Changes) will be checked (obligatory, see Annex 1 of this document — format could be changed, if relevant)			

Source: Büttner *et al.*, 2002.

9 Deliverables

The following deliverables [delivery file name] are expected from the countries:

- **CLC-Changes (2000-2006) [CHA06_xx]** according to guidelines for delivery (see Chapter 10);
- **revised CLC2000 [CLC00_xx]** according to guidelines for delivery (see Chapter 10) — only for those countries that will NOT prepare CLC2006 themselves; it will exclusively be used to generate CLC2006 by ETC-LUSI;
- **CLC2006 [CLC06_xx]** according to guidelines for delivery (see Chapter 10) — only for those countries, which will prepare CLC2006 themselves (by using support of the CLC Technical Team);
- **working unit level metadata for CLC-Changes [MWU_xx_nn]** (see Annex 1);
- **country level metadata for CLC-Change [MCOCH_xx**] (see Annex 2);
- **country level metadata for CLC2006 [MCO06_xx]** — only for those countries, which will prepare CLC2006 themselves (with support from CLC Technical Team).

Deliveries have to be submitted to CDR (Central Data Repository) of EEA. See details in Chapter 10.

Note: In case other data are delivered to EEA in the scope of CLC2006 update (e.g. CLC1990, CLC-Change (1990–2000) etc.), the same delivery procedure and data specification (with adapted naming) shall be applied.

10 Delivery guidelines

10.1 Introduction

This chapter is dedicated to the process of delivery of finalised CLC national products from National Technical Team (NT) to the European Environment Agency (EEA) including both technical and organisational aspects of this interaction.

Based on the experience from the I&CLC2000 exercise, the original document (Buttner *et al.*, 2002) has been updated to cover all key elements of the delivery process and provide clear guidance to all partners involved. Also, changes in organisational setup and responsibilities within CLC2006 update are reflected, including technical development taking place in countries as well as in the European Environment Agency (EEA).

Nevertheless, the objectives of the delivery guidelines remain the same:

- to streamline the delivery process;
- to assure technical consistency of each individual national CLC database from countries;
- to enable smooth and fast integration of data into the seamless European CLC database 2006.

10.2 Delivery procedure

10.2.1 Delivery schedule

Delivery of national CLC2006 products from National Technical Team (NT) to the EEA is part of the CLC2006 planning in countries and follows the agreed CLC2006 projects schedule (the national project proposals can be found at http://eea.eionet.europa.eu/Members/irc/eionet-circle/spatial/library?l=/clc2005_update/national_documents&vm=detailed&sb=Title). Any foreseen alteration of the delivery schedule shall be indicated to the ETC LUSI Technical Team (TT) in advance, so these can be accommodated appropriately in the project planning.

National data are considered as 'ready for delivery' after the following steps are fulfilled:

1. last verification mission of Technical Team (TT) took place and Verification Mission Report has been issued;
2. recommendations specified in the Verification Mission Reports from such verification missions have been integrated into the data;
3. technical quality of deliverables has been checked internally by NT and conforms to all specifications as defined in previous chapters and summarised here.

10.2.2 Where to deliver

National CLC2006 coordinators should liaise with national focal points on the delivery process to the EEA. All deliveries shall be provided via the EEA Central Data Repository (CDR). Nevertheless, the CDR is not intended as a tool for data dissemination to third parties. The national project leader or the person designated to deliver the data (as indicated in the national proposals) has been given upload rights to the CLC folder for each country.

In order to deliver data you have to log in with your Eionet account and password in the relevant folder for your country in the Reportnet Central Data Repository (see links in Table 10).

You should then carry out the following steps:

- Create the delivery envelope
- Activate the task
- Upload your files from your system to CDR
- Verify that the delivery complies with the national quality requirements
- Release the envelope (Files which should not be available to the public can be locked)
- Finish

If you need any assistance during the delivery process, do not hesitate to contact Eionet helpdesk at helpdesk@eionet.europa.eu or by telephone on +37 2 508 4992 from Monday through Friday 9:00 to 17:00 CET.

Uploading data to CDR starts the process of final data acceptance by the TT and it is also a requirement in the formal procedure of data delivery to the EEA.

Each delivery should to be placed into one envelope. Each of the delivery components has to be placed as separate compressed (ZIP) file within this envelope (see Section 1.2 for file names to be used).

10.2.3 Delivery flow

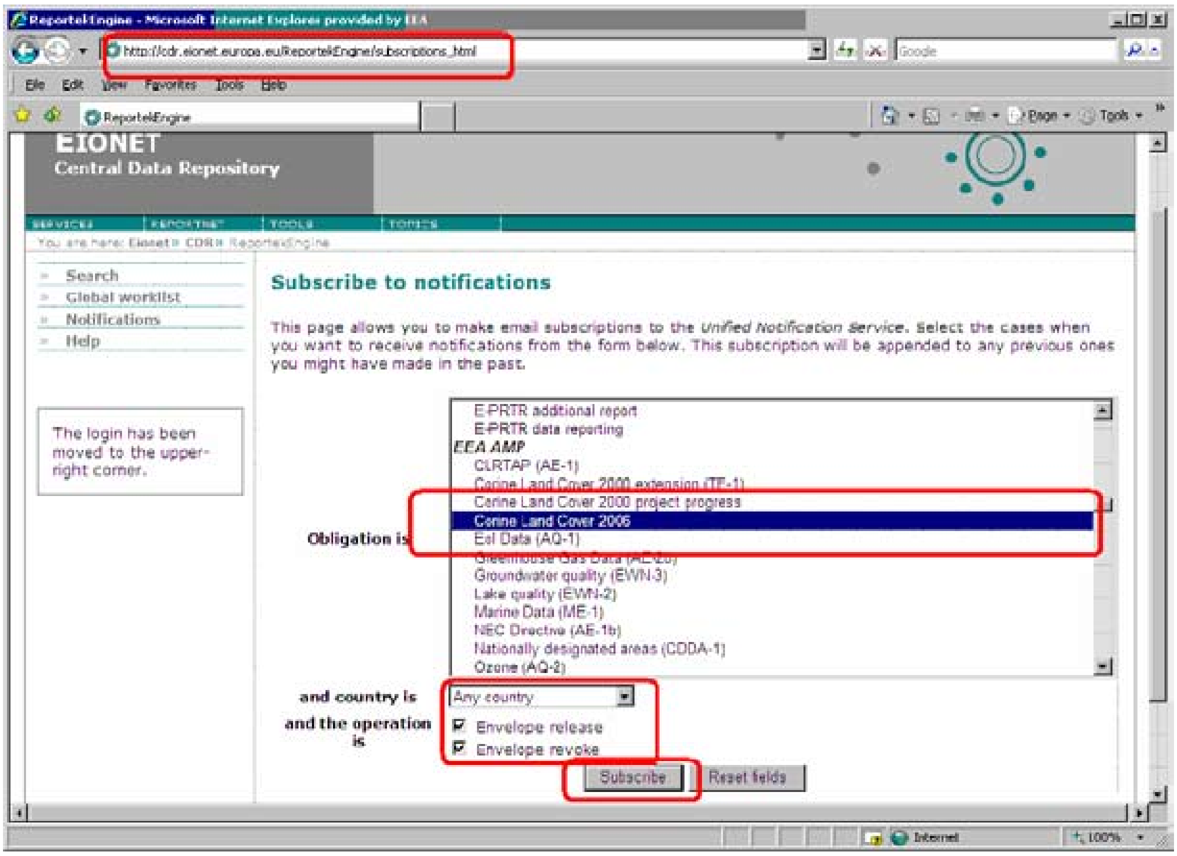
When the envelope is released, automatic CDR notification is sent to CLC2006 coordinator, CLC2006 TT coordinator, and technical acceptance coordinator (GISAT, ETC-LUSI TT member) with information that data are accessible.

To receive notifications you must register to the Unified Notification Service. This service is open to any Eionet user from http://cdr.eionet.europa.eu/ReportekEngine/subscriptions_html (see Figure 33).

Table 10 Country list — Corine land cover links in CDR

Country	Url to Corine land cover folder
Albania	http://cdr.eionet.europa.eu/al/eea/clc
Austria	http://cdr.eionet.europa.eu/at/eea/clc
Belgium	http://cdr.eionet.europa.eu/be/eea/clc
Bosnia-Herzegovina	http://cdr.eionet.europa.eu/ba/eea/clc
Bulgaria	http://cdr.eionet.europa.eu/bg/eea/clc
Croatia	http://cdr.eionet.europa.eu/hr/eea/clc
Cyprus	http://cdr.eionet.europa.eu/cy/eea/clc
Czech Republic	http://cdr.eionet.europa.eu/cz/eea/clc
Denmark	http://cdr.eionet.europa.eu/dk/eea/clc
Estonia	http://cdr.eionet.europa.eu/ee/eea/clc
Finland	http://cdr.eionet.europa.eu/fi/eea/clc
France	http://cdr.eionet.europa.eu/fr/eea/clc
Germany	http://cdr.eionet.europa.eu/de/eea/clc
Greece	http://cdr.eionet.europa.eu/gr/eea/clc
Hungary	http://cdr.eionet.europa.eu/hu/eea/clc
Iceland	http://cdr.eionet.europa.eu/is/eea/clc
Ireland	http://cdr.eionet.europa.eu/ie/eea/clc
Italy	http://cdr.eionet.europa.eu/it/eea/clc
Latvia	http://cdr.eionet.europa.eu/lv/eea/clc
Liechtenstein	http://cdr.eionet.europa.eu/li/eea/clc
Lithuania	http://cdr.eionet.europa.eu/lt/eea/clc
Luxembourg	http://cdr.eionet.europa.eu/lu/eea/clc
Macedonia, former Yugoslav Republic of	http://cdr.eionet.europa.eu/mk/eea/clc
Malta	http://cdr.eionet.europa.eu/mt/eea/clc
Montenegro	http://cdr.eionet.europa.eu/me/eea/clc
Netherlands	http://cdr.eionet.europa.eu/nl/eea/clc
Norway	http://cdr.eionet.europa.eu/no/eea/clc
Poland	http://cdr.eionet.europa.eu/pl/eea/clc
Portugal	http://cdr.eionet.europa.eu/pt/eea/clc
Romania	http://cdr.eionet.europa.eu/ro/eea/clc
Serbia	http://cdr.eionet.europa.eu/rs/eea/clc
Slovenia	http://cdr.eionet.europa.eu/si/eea/clc
Slovakia	http://cdr.eionet.europa.eu/sk/eea/clc
Spain	http://cdr.eionet.europa.eu/es/eea/clc
Sweden	http://cdr.eionet.europa.eu/se/eea/clc
Switzerland	http://cdr.eionet.europa.eu/ch/eea/clc
Turkey	http://cdr.eionet.europa.eu/tr/eea/clc
United Kingdom	http://cdr.eionet.europa.eu/gb/eea/clc

Figure 33 Unified Notification Service



After delivery the technical quality check of data is performed by TT. The next steps depend on the result of this check, as specified below:

A] if no problems (or minor inconsistencies only) are found in the data, the data are accepted as they are (or minor inconsistencies are corrected by TT). Then the national team is notified by 'a final acceptance note' — an email containing the final version of 'CLC2006 Database Technical Acceptance Report' document and download link to the accepted data. Then, final data together with final DBTA document shall be uploaded by NT back to the CDR folder, in a new envelope named 'CLC 2006 update/version_final'. Release and finish this envelope and then the National CLC2006 coordinator, CLC2006 coordinator and CLC2006 TT coordinator (as well as other subscribed users) will be informed by automatic CDR notification system that the data has been accepted and are ready for European integration.

B1] if severe inconsistencies are found in the data during acceptance procedure, then the national team is notified by a request for improvement note — an email containing the draft version of 'CLC2006 Database Technical Acceptance Report' document stating the problems found, accompanied with check protocols and a download link to supporting data pointing to problematic cases.

B2] new corrected data delivery, required as a response to request for improvement, is then (when ready) uploaded by NT to Central Data Repository {CDR) under a new envelope named 'CLC 2006 update/version_02. When the envelope is released, the automatic CDR notification system sends a message to the technical acceptance coordinator (and other subscribers) informing that a new version of the data is accessible and ready for new acceptance check.

All severe problems and inconsistencies found by TT in the delivered data are solved with National Teams in this iterative way until the data are accepted (and whole process can proceed with step A). Nevertheless, the aim is to avoid or at least minimize the number of iterations needed. Therefore TT team is ready to support pre-delivery QC, by providing QC guidance for national teams working in ESRI environments.

Technical specifications required as well as quality criteria checked are described in the following section.

10.3 Delivery — technical specifications

All deliverables have to conform to the CLC2006 technical specifications as defined in previous chapters and summarised here.

Technical specifications for data delivery include:

- formal specifications — format, naming and structure conventions at file and attribute level;
- mapping specifications — standards based on CLC methodology (e.g. MMU, CLC codes);
- topology specifications — standards assuring topological integrity and correctness of data;
- metadata specifications — standards allowing integration of accompanying metadata documentation;

10.3.1 Formal specifications

File format

Data should be delivered in a standard data format. As default, the supported file format for delivery is the same as during CLC2000 update:

- **ESRI Arc/INFO Export Interchange File [E00]** with no compression (export of ESRI Arc/INFO (A/I) coverage in double precision with 'build polygon' topology.

A/I coverage is a file-based vector data storage format using a robust arc-node data structure supporting three major topological concepts — connectivity (arcs connect to each other at nodes), area definition (connected arcs that surround an area define a polygon) and contiguity (arcs have a direction and left and right sides). A/I coverage data can be fully exploited in an ESRI environment only.

Optional (MDB delivery)

In addition to the A/I E00 file format, accepted as default, there is a new option supported for the CLC2006 update, which can be used for data delivery:

- **ESRI Personal Geodatabase [MDB]**

A geodatabase is an object-oriented geographic database that provides services for managing geographic data. A geodatabase contains feature datasets as well as feature classes that can be stored inside a feature dataset or maintained independantly. These datasets are stored, analyzed, and queried as layers similar to the coverage and shapefile models. The geodatabase extends these models with support for complex networks, topologies, relationships among feature classes, and other object-oriented elements. A Personal geodatabase is stored inside a relational database management system (Microsoft Access). A Personal geodatabase is managed by ArcCatalog and can be used in ArcGIS environment.

Both formats support topology, preventing and highlighting major inconsistencies in the data. Nevertheless, while A/I E00 (based in A/I coverage structure) is a robust topological file format of the past, ESRI geodatabase represents a modern database based solution, supporting a flexible data model with predefined rules. On the other hand, both formats are proprietary formats of the ESRI family of products and are dependend on vendor specific software environment. See summary below in Table 11.

Figure 34 Export command and options to be used for E00 files generation from coverage within ESRI Arc/INFO environment

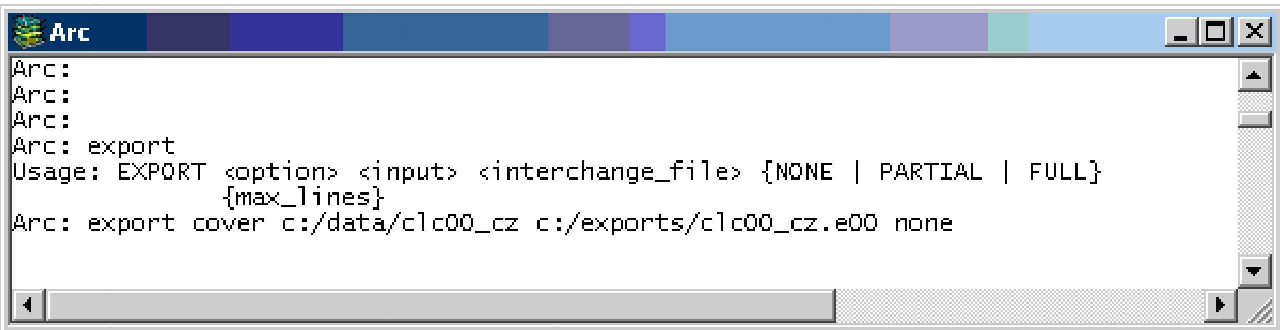


Table 11 Supported file formats (default and optional) for CLC2006 update delivery

Format name	Short name	Use	Comments	Advantages	Disadvantages
ArcInfo export interchange file (default)	E00	For export between old ESRI ArcInfo systems	Export of file based format	Supports topology and feature relations	Non-generic format; designed for data exchange between old ESRI systems
ESRI Personal Geodatabase (optional)	MDB	New ESRI system format	Database-based format	Supports topology and feature relations	Proprietary ESRI format

File name conventions

[1] File name of delivered national products should be 8 characters long.

[2] The file name should include a standard prefix and two characters for ISO standard country code (xx) as listed in Table 12 below:

CHA06_xx.e00 CLC change layer for 2000–2006

CLC06_xx.e00 CLC status layer for year 2006

CLC00_xx.e00 CLC status layer for year 2000 (revised)

Example: for Austria the names are: CHA06_AT, CLC06_AT, CLC00_AT.

In case of additional (second, third…) data delivery, as a result of a request for improvement, delivered data of national products should be 10 characters long with 2 additional positions clearly indicating the version number.

Example: For a second (improved) delivery from Malta: CHA06_MT02, CLC06_MT02,: CLC00_MT02.

An example is illustrated in Figure 35.

Table 12 Standard ISO codes [ISO 3166-1-alpha-2 code elements] for CLC2006 participating countries

Country	ISO code
Albania	AL
Austria	AT
Belgium	BE
Bosnia and Herzegovina	BA
Bulgaria	BG
Croatia	HR
Cyprus	CY
Czech Republic	CZ
Denmark	DK
Estonia	EE
Finland	FI
France	FR
Germany	DE
Greece	GR
Hungary	HU
Iceland	IS
Ireland	IE
Italy	IT
Latvia	LV

Country	ISO code
Liechtenstein	LI
Lithuania	LT
Luxembourg	LU
Macedonia, the FYR	MK
Malta	MT
Monte Negro	ME
Netherlands	NL
Norway	NO
Poland	PL
Portugal	PT
Romania	RO
Serbia	RS
Slovakia	SK
Slovenia	SI
Spain	ES
Sweden	SE
Switzerland	CH
Turkey	TR
United Kingdom	GB

Source: http://www.iso.org/iso/en/prods-services/iso3166ma/02iso-3166-code-lists/list-en1.html

Optional (MDB delivery)

For delivery in ESRI Personal Geodatabase [MDB] the file name conventions are as follows:

CLC2006_xx.mdb	CLC2006 project country geodatabase
xx	country code of feature dataset
CHA06_xx	CLC change layer for 2000–2006 feature class
CLC06_xx	CLC status layer for year 2006 feature class
CLC00_xx	CLC status layer for year 2000 feature class (revised)
+ ccccc_xx_lin	temporal linear feature class for checking purposes
+ ccccc_xx_lin_topo	topology specification for linear feature class
+ ccccc_xx_topo	topology specification for polygon feature class

In case of additional (second, third…) data delivery, as a result of a request for improvement, delivered data of national products should be 10 characters long with 2 additional positions clearly indicating the version number.

Example: For a second (improved) delivery from Austria: clc2006_AT02.mdb.

Attribute definition and name conventions

[1] FeatureID for each datafile must be unique (it should not contain the CLC code!)

[2] ID to be used for error reference in each datafile must be unique, in format 'xx'-<FeatureID> (Example: AT-21253)

[3] Each polygon of the CLC change database must have two character attributes: the 3-digit CLC codes for both 2000 and 2006.

[4] Each polygon of CLC2006 must have a character attribute: the 3-digit CLC code.

[5] Each polygon of CLC2000 must have a character attribute: the 3-digit CLC code.

[6] Area_ha shall be computed for all datasets based on Area attribute figures.

For complete attribute tables definition see detailed specifications in Table 13.

Figure 35 Example of name conventions in ArcCatalog environment

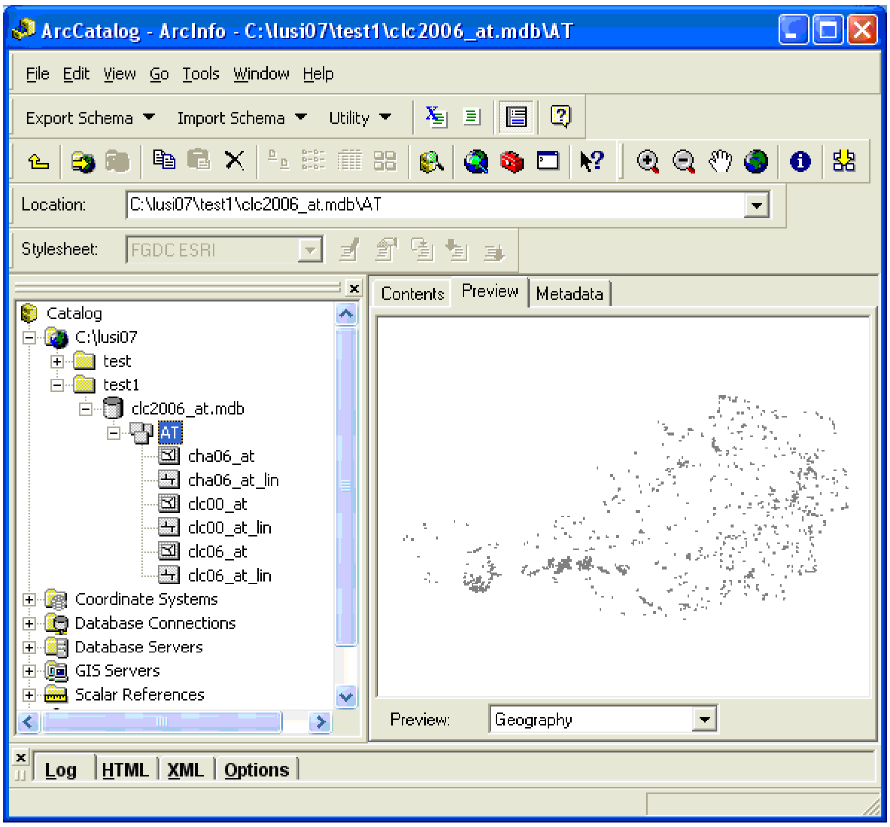


Table 13 Attribute tables definition

CHA06			
Attribute name	**Attribute type**	**Attribute length**	**Comment**
Area	Floating		internal, no need to define
Perimeter	Floating		internal, no need to define
<name>#	Binary		internal, no need to define
<name>-ID	Binary		internal, no need to define
ID	Character	18	'xx'-'<name>-ID'
Code_00	Character	3	
Code_06	Character	3	
Change	Character	7	<code_00>-<code_06>
Chtype	Character	1	See note below
Area_ha	Floating	18,11	'Area'/1000
Remark	Character	20	

CLC06			
Attribute name	**Attribute type**	**Attribute length**	**Comment**
Area	Floating		internal, no need to define
Perimeter	Floating		internal, no need to define
<name>#	Binary		internal, no need to define
<name>-ID	Binary		internal, no need to define
ID	Character	18	'xx'-'<name>-ID'
Code_00	Character	3	
Area_ha	Floating	18,11	'Area'/1000
Remark	Character	20	

CLC00			
Attribute name	**Attribute type**	**Attribute length**	**Comment**
Area	Floating		internal, no need to define
Perimeter	Floating		internal, no need to define
<name>#	Binary		internal, no need to define
<name>-ID	Binary		internal, no need to define
ID	Character	18	'xx'-'<name>-ID'
Code_00	Character	3	
Area_ha	Floating	18,11	'Area'/1000
Remark	Character	20	

Note: Change type (Chtype) — this attribute refers to a characteristic of the change (technical change (T) or real change (R). This information is very important and will be used during CLC2006 creation.

Optional (MDB delivery)

For delivery in ESRI Personal Geodatabase [MDB] attribute definition and name conventions are as stated in Table 14.

Coordinate Reference System (CRS)

Data should be delivered in national projection, the same used in the production of IMAGE2006. Detailed specifications of national CRS used for IMAGE2000 are summarised in the document 'I&CLC2000 CRS Database'3. Any updates or replacements of country CRS parameters used for CLC2006 should be indicated to TT and described in country metadata.

Note: National CRS specification parameters (including datum shifts) should be provided to TT to ensure accurate data integration into the European database. In case of countries where the national projection parameters are confidential, national delivery will be required in European CRS.

10.3.2 Mapping specifications

Deliveries should conform to several mapping specifications as defined for Corine land cover mapping methodology:

[1] Minimal Mapping Unit (MMU) threshold — deliveries have to conform to the minimum mapping unit criteria stated in Table 15.

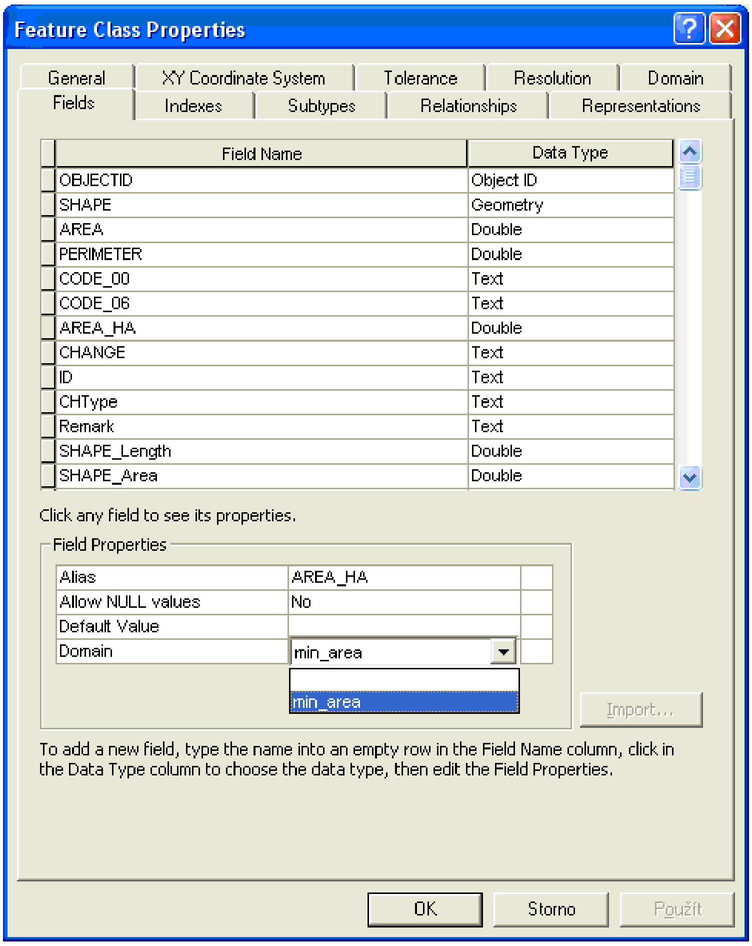
Table 14 Attribute definition and name conventions (MDB delivery)

CHA06			
Attribute name	**Attribute type**	**Attribute length**	**Comment**
ObjectID	Double	18,0	
ID	Text	18	'xx'-<FeatureID>
Area	Double	18,11	
Perimeter	Double	18,11	
Code_00	Text	3	
Code_06	Text	3	
Change	Text	7	<code_00>-<code_06>
Chtype	Text	1	See note above
Area_ha	Double	18,11	'Area'/1000
Remark	Text	20	

CLC06			
Attribute name	**Attribute type**	**Attribute length**	**Comment**
ObjectID	Double	18,0	
ID	Text	18	
Area	Double	18,11	
Perimeter	Double	18,11	
Code_06	Text	3	
Area_ha	Double	18,11	'Area'/1000
Remark	Text	20	

CLC00			
Attribute name	**Attribute type**	**Attribute length**	**Comment**
ObjectID	Double	18,0	
ID	Text	18	
Area	Double	18,11	
Perimeter	Double	18,11	
Code_00	Text	3	
Area_ha	Double	18,11	'Area'/1000
Remark	Text	20	

Figure 36 Example of attribute definitions in ArcCatalog environment



[2] Width threshold for linear elements — linear elements mapped in the database have to be, at least, 100 m wide.

[3] Valid codes — only valid CLC codes from CLC nomenclature are permitted (e.g. no '0' or 'Null' code).

Note 1: Areas in change database (CHA06) with no change, but surrounded with changed polygons (ring type, or 'donut shape' change polygons) should have labels, and should be coded as '999–999' (i.e. code 999 for both CLC dates). By default, these polygons are coded as '0' or 'Null', when the topology building process is run e.g. in Arc/INFO.

[4] Mapping area buffer — to ensure a perfect overlay with neighboring CLC data sets, national teams shall interpret CLC layer(s) in a buffer zone of 1 km into the neighboring country, across national boundaries. To have consistency in sea (523) interpretation in coastal areas, final dataset should be delivered with minmum 1 km of sea (523) buffer zone along coastline. This will avoid the creation of gaps in the European CLC2006 database.

Table 15 Mapping specifications

Database	Minimal Mapping Unit (MMU) threshold
Change 2000-2006 (CHA06)	5ha *
CLC 2006 (CLC06)	25ha
CLC 2000 (CLC00)	25ha

Note: * in case of complex CLC changes, elementary changes can be smaller than 5ha, but total area of change either in CLC00 or in CLC06 must exceed 5 ha (see Chapter 4 for more details).

10.3.3 Topology specifications

Deliveries have to conform also to a number of topological specifications in order to create consistent and correct national and European CLC databases.

[1] Topological consistency — all deliverables have to be topologically consistent

- no duplicated lines
- no dangles
- no self-crossing polygons boundary
- no self-overlapping polygons boundary
- no overlapping polygons
- all polygons are closed, with only one label per polygon
- no neighboring polygons with the same code.

[2] No artificial boundaries — there should be no visible map sheet or administrative boundaries in the data sets, i.e. working units should be edge-matched.

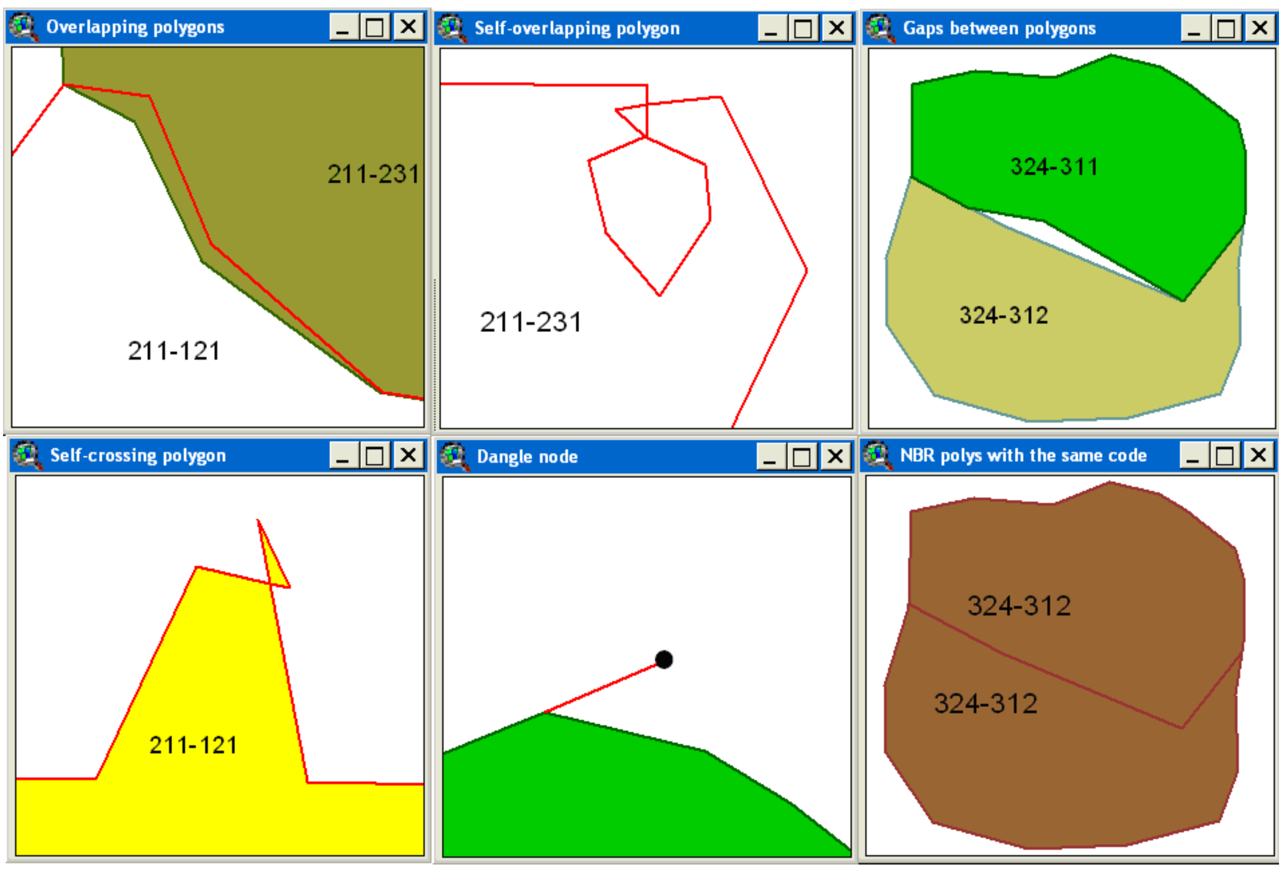
[3] No gaps — deliveries should be in the form of seamless databases. There should be no gaps within data sets (not applicable for CHA06)

[4] Datasets have to be also cross-layer consistent — consistent delineation of related polygons in status (CLC00 and CLC06) and change (CHA06) layers is required. Double delineation is not acceptable.

10.3.4 Metadata specifications

Each data delivery shall be accompanied by metadata description of dataset origin. Both types of metadata (working unit level and country level) should be delivered. Metadata shall conform to the specifications in Annexes 1 and 2. Metadata will be checked concerning their existence and completeness.

Figure 37 Example of topology errors to be checked



Working unit level metadata [MWU_xx_nn] should include one record for each working unit. Standard contents can be implemented in MS Word, Excel or Access formats. Working unit level metadata should be accompanied by a reference data file (Arc/Info E00 format, ESRI GDB or ArcView Shape) with the same working unit identifier as used in the metadata file. See detailed WU metadata structure in template provided in Annex 1.

Country level metadata [MCOCH_xx, MCO06_xx] should include separate files for each delivered dataset of CLC-changes and revised CLC2000. See detailed country metadata structure in template provided in Annex 2 in the form of a MS Word document, which follows the European Environment Agency Metadata Standard for Geographic Information (EEA-MSGI). In case of access to ESRI ArcCatalog software, the EEA Metadata Editor can be used as alternative and metadata provided in XML format. EEA metadata editor v4 for ESRI ArcCatalog 9.x (January 2007) provides easy editing and validation of metadata. Installation and user manual can be found at http://www.eionet.europa.eu/gis/geographicinformationstandards.html.

10.4 Technical quality check report

For each deliverable a technical quality check report is prepared named 'Database Technical Acceptance (DBTA)' report. This report is used either

- as final data acceptance confirmation — to confirm that all delivery parts have been accepted without problems;

or

- to document inconsistencies found as part of 'the request for improvement' and guide the NT in data improvement.

The DBTA report contains summary of data and metadata check lists as presented in the examples below.

10.4.1 Summary check list

This check list summarises the results of the technical acceptance procedure for all data and metadata provided in the delivery. See example of summary check list contents in Table 16.

Table 16 Example of summary check list

Country: <country>				
Delivery contents	**Checked**	**Corrected**	**Status**	**Notes**
CHA06	•		x	
CLC06	•		✔	
CLC00	•		✔	
Metadata — Working unit level	•	•	x	
Metadata — Country level	•		✔	

- • Check/correction performed
- ✔ Data/metadata accepted for integration
- x Data/metadata not accepted — request for improvement has been issued to NT

10.4.2 Data check list

This check list provides an insight into the results of the technical acceptance procedure for all datasets provided in the delivery. See example of data check list contents in Table 17.

10.4.3 Metadata check list

This check list provides an insight into results of the technical acceptance procedure for all metadata provided in the delivery. See example of metadata check list contents in Table 18.

For questions regarding CLC2006 technical specifications and data delivery or technical checking process, please see contacts in Annex 7.

Table 17 Example of data check list

Country: <country>				
Dataset: CHA06				
Checked item	**Checked**	**Corrected**	**Status**	**Notes**
A — Formal specification check criteria (see Section 10.3.1)				
1 — File format	•		✔	
2 — File name convention	•		✔	
3 — Attributes definition	•		✔	
4 — Attributes name convention	•	•	✔	
5 — Coordinate reference system (CRS)	•	•	✔	
B — Mapping specification check criteria (see Section 10.3.2)				
1 — Minimal mapping unit (MMU)	•		x	B1
2 — Unique identifier	•	•	✔	
3 — Valid codes	•		x	B3
4 — Mapping area buffer	•		✔	
C — Topology specifications check criteria (see Section 10.3.3)				
1 — All polygons are closed, with one label only	•		✔	
2 — No duplicated lines	•		✔	
3 — No dangles	•		✔	
4 — No self-crossing polygons boundary	•		✔	
5 — No self-overlapping polygons boundary	•		✔	
6 — No overlapping polygons	•		✔	
7 — No neighboring polygons with the same code	•		✔	
8 — No artificial boundaries in data	•		✔	
9 — No gaps in data			✔	

- • Check/correction performed
- ✔ Conform with criteria
- x Not conform with criteria

Note: B1 — See CHA06_B1.shp for locations.
B3 — See CHA06_B3.shp for locations.

Table 18 Example of metadata check list

Checked item	Checked	Corrected	Status	Notes
M — Metadata specifications check criteria (see Section 10.3.4)				
1 — Working unit level — Format	•		✔	
2 — Working unit level — Contents	•		✔	
3 — Working unit level — Completeness	•		✔	
4 — Working unit level — Reference file	•		x	M4
5 — Country level — Format	•		✔	
6 — Country level — Contents	•		✔	
7 — Country level — Completeness	•		✔	

- • Check/correction performed
- ✔ Conform to criteria
- x Not conform to criteria

Note: M4 — Reference file IDs do not match with Metadata IDs.

11 References

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12 List of abbreviations

CAPI	Computer assisted photo interpretation
CLC	Corine land cover
CLC90	CLC inventory for the 1990s
CLC2000	Corine land cover update 2000
CLC2006	Corine land cover update 2006
Corine	Coordination of information on the environment
DEM	digital elevation model
DG AGRI	Directorate General for Agriculture and Rural Development
DG ENTR	Directorate General for Enterprise and Industry
DG ENV	Directorate General for Environment
DG REGIO	Directorate General for Regional Policy
EC	European Commission
EEA	European Environment Agency
Eionet	European Environment Information and Observation Network
ESA	European Space Agency
ESTAT	EUROSTAT
ETC-TE	European Topic Centre on Terrestrial Environment
ETC-LUSI	European Topic Centre on Land Use and Spatial Information (successor of ETC-TE)
ETRS	European terrestrial reference system
ETM	enhanced thematic mapper (Landsat sensor)
EU	European Union
FTSP	fast track service precursor
GCP	ground control points
GIS	geographic information system
GMES	global monitoring for environment and security
HRVIR	high resolution visible and infrared (SPOT sensor)
I&CLC2000	IMAGE2000 & Corine land cover 2000 project
IMAGE90	satellite image coverage for the reference year 1990
IMAGE2000	satellite image coverage for the reference year 2000
IMAGE2006	satellite image coverage for the reference year 2006
INSPIRE	infrastructure for spatial information in Europe
IRS	Indian remote sensing (satellite)
JRC	joint research centre
LANDSAT ETM	U.S. Landsat satellite with Enhanced Thematic Mapper sensor
LC	land cover
LCC	land cover change
LISS	linear self scanning (sensor on-board of IRS satellites)
LMCS	land monitoring core service
LUCAS	land use/cover area frame statistical survey
LULC	land use & land cover
MMU	minimum mapping unit
MS	Member States
NIR	near infrared
NRC	national reference centre
QA/QC	quality assurance/quality control
SPOT	Système Probatoire d'Observation de la Terre
SWIR	short wave infrared
TG	technical guidelines
TM	thematic mapper (Landsat sensor)
VIS	visible and infrared (band)
WP	work package

Annex 1 Working unit level metadata

CLC2006 METADATA

Working unit level

- Please provide a single summary file for each interpretation sheet -

Title of working unit:	

A: GENERAL INFORMATION

Sponsor:	
Address:	
Phone:	
Fax:	
Responsible:	
E-mail:	

Contractor:	
Address:	
Phone:	
Fax:	
Project leader:	
E-mail:	

1. IMAGE2006 data used

SPOT-4 XI and / or IRS P/ LISS III scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**

2. IMAGE2000 data used

Landsat-7 ETM and / or other scene(s)				
Satellite & Sensor	**Path-**	**Row**	**Date (m/d/y)**	**Remark (e.g. clouds)**

3. Topographic maps used *(indicate in remark if digital)*

Scale	Sheet id	Title/Name	Year of production	Year of last revision	Remark

4. Other ancillary data used (thematic data, satellite images, aerial photos, city maps, vegetation maps, LUCAS data)

Id.	Data source/type	Title (if relevant)	Date of production (m/d/y)	Scale (spatial detail)	Remark

5. Photointerpreter(s)

Name	Affiliation	Phone	E-mail	interpretation		
				start (m/d/y)	end (m/d/y)	no. of days

B: INTERPRETATION OF CHANGES

1. Photo-interpretation of changes and internal quality control

Date of submission (m/d/y)	Control made by	Date of control (m/d/y)	Remark (errors, corrections, etc.)

2. Field checking (*if carried out*)

Date (m/d/y)	Itinerary (main settlements crossed on the working unit)	Problems checked and main conclusions

3. Border matching of CLC-changes with neighbour working units

working unit	Controlled and corrected by	Date (m/d/y)	Remark

C: FINAL TECHNICAL QUALITY CONTROL

1. Control of topology, unnecessary boundaries, 25 ha limit, invalid codes and invalid changes (internal control)

	Date (m/d/y)	Controlled by	Remark
CLC2006*			
CLC Changes			
Revised CLC2000			

*If produced by the country

2. Verification and acceptance (CLC-changes and revised CLC2000)

	Date (m/d/y)	Name	Signature	Remark
National level				
CLC technical team				

D: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Interpretation of changes		
Technical quality control		

Annex 2 Country level metadata

Example of a filled-in EEA metadata form (yellow column)

EEA Field name			ISO Number	EEA Description	Please fill in	Max
Level 1	Level 2	Level 3				
Metadata on metadata				Defines the metadata on the dataset		1
	Point of contact			Responsible organisation and individual for the metadata		1
		Organisation name	8.376	Responsible organisation name	Institute of Geodesy, Cartography and Remote Sensing (FOMI)	1
		Individual name	8.375	Responsible individual name	Mr. George Buttner	1
		Position name	8.377	The responsible individual role or position in the organisation	Project manager	1
		Role	8.379	Function performed by the responsible organisation		1
		Address: Delivery point	8.378.381	Address line for the location	Bosnyák tér 5.	1
		Address: City	8.378.382	City of the location	Budapest	1
		Address: State, Province	8.378.383	State, province of the location		1
		Address: Postal code	8.378.384	Postal code of the location	H-1149	1
		Address: Country	8.378.385	Country of the location	Hungary	1
		Address: E-mail	8.378.386	The electronic mail address of the responsible organisation or individual	buttner.gyorgy@fomi.hu	1
	Last modified		9	Date of the last modification of the metadata (YYYYMMDD)	20040827	1
	Name of standard		10	Name of metadata standard	EEA-MSGI/ISO19115 (First Edition)	1
	Version of standard		11	Version of the metadata standard	EEA-MSGI 1.1	1
Dataset identi-fication				Basic information required to identify the dataset		1
	Title		15.24.360	Title of the dataset	CHANG_HU	1
	Alternative title		15.24.361	Alternative titles of the dataset	Corine land cover change (1990–2000) database of Hungary; CLC change (1990-2000) — Hungary	N
	Brief Abstract		15.EEA Brief Abstract	Brief abstract explaining in short the content of the dataset	Corine land cover change (1990–2000) database of Hungary;	1

Dataset identi-fication	Abstract		15.25	An abstract explaining the content of the dataset	The European Environment Agency (EEA) and the Joint Research Centre (JRC) launched the IMAGE&CLC2000 project with 26 participating countries in Europe in order to provide timely and relevant information on land cover to policy makers. Presently the number of participating countries is 30. In Hungary the project is co-financed by: • The Ministry of Environment and Water (MoEW). Contract number: KvVM-4937/2002. • The European Environment Agency (EEA). Contract numbers: 3213/B2002. EEA.51338.; 3213/B2003. EEA.51517.	1
	Keywords		15.33.53	Keywords helping to classify the dataset	CLC change, CLC2000, Corine, geographic, landcover change, environment, vector data, Hungary	N
	Topic category		15.41	A predefined ISO category, see **code list 2** underneath	010 (imageryBaseMapsEarthCover)	1
	Dataset version		15.24.363	Version of the dataset	Version 1	1
	Reference date		15.24.362.394	Date of last modification to the dataset (YYYYMMDD)	20040827	1
Reference system				Definition of the reference system used for the dataset		1
	Name		13.196.207	Name of reference system	HD_1972_Egyseges_ Orszagos_Vetuleti	1
	Datum			Identity of the datum		1
		Name	13.192.207	Name of datum	D_Hungarian_1972	1
	Ellipsoid			Identity of the ellipsoid		1
		Name	13.191.207	Name of ellipsoid	GRS_1967	1
		Semi-major axis	13.193.202	Radius of the equatorial axis of the ellipsoid	6378160	1
		Axis units	13.193.203	Units of the semi-major axis	Meter	1
		Flattening ratio	13.193.204	Ratio of the difference between the equatorial and polar radii of the ellipsoid to the equatorial radius when the numerator is set to 1	3,35292371299641E-03	1

Reference system	Projection			Identity of the projection		
		Name	13.190.207	Name of projection	Hotine_Oblique_Mercator_ Azimuth_Center	1
		Zone	13.194.216	Unique identifier for grid zone		1
		Standard parallel	13.194.217	Line of constant latitude at which the surface of Earth and the plane or developable surface intersect		1
		Longitude Of Central Meridian	13.194.218	Line of longitude at the centre of a map projection generally used as the basis for constructing the projection		1
		Latitude of projection origin	13.194.219	Latitude chosen as the origin of rectangular coordinates for a map projection		1
		False easting	13.194.220	Value added to all 'x' values in the rectangular coordinates for a map projection. This value frequently is assigned to eliminate negative numbers. Expressed in the unit of measure identified in planar coordinate units	650000	1
		False northing	13.194.221	Value added to all 'y' values in the rectangular coordinates for a map projection. This value frequently is assigned to eliminate negative numbers. Expressed in the unit of measure identified in planar coordinate units	200000	1
		False easting northing units	13.194.222	Units of false northing and false easting	Meter	1
		Scale factor at equator	13.194.223	Ratio between physical distance and corresponding map distance, along the equator	0,99993	1
		Longitude of projection centre	13.194.224	Longitude of the point of projection for azimuthal projections	19,04871778	1
		Latitude of projection centre	13.194.225	Latitude of the point of projection for azimuthal projections	47,14439372222	1

Distribution information				Information about the distributors of the dataset		1
	Owner 1			Information about the owner organisation		N
		Organisation name	15.29.376	Name of the owner organisation	European Environment Agency	1
		Individual name	15.29.375	Name contact person in the owner organisation	**See contract with EEA!**	1
		Position name	15.29.377	Position of the contact person in the owner organisation	**See contract with EEA!**	1
		Role	15.29.379	Always 'Owner' role	Owner	1
		Address: Delivery point	15.29.378.389.381	Address line for the location	Kongens Nytorv 6	1
		Address: City	15.29.378.389.382	City of the location	Copenhagen	1
		Address: State, Province	15.29.378.389.383	State, province of the location	K	1
		Address: Postal code	15.29.378.389.384	Postal code of the location	1050	1
		Address: Country	15.29.378.389.385	Country of the location	Denmark	1
		Address: E-mail	15.29.378.389.386	The electronic mail address of the owner organisation or individual	eea@eea.europa.eu	1
				Information about the distributors of the dataset		
	Owner 2			Information about the owner organisation		
		Organisation name	15.29.376	Name of the owner organisation	Ministry of Environment and Water (Hungary)	
		Individual name	15.29.375	Name contact person in the owner organisation	Dr. Erzsébet SCHMUCK	
		Position name	15.29.377	Position of the contact person in the owner organisation	Deputy State Secretary	
		Role	15.29.379	Always 'Owner' role	Owner	
		Address: Delivery point	15.29.378.389.381	Address line for the location	Fö utca 44-50	
		Address: City	15.29.378.389.382	City of the location	Budapest	
		Address: State, Province	15.29.378.389.383	State, province of the location	-	
		Address: Postal code	15.29.378.389.384	Postal code of the location	1011	
		Address: Country	15.29.378.389.385	Country of the location	Hungary	
		Address: E-mail	15.29.378.389.386	The electronic mail address of the owner organisation or individual		

	Originator			Information about intellectual creator (person and/or organisation with intellectual rights) of the dataset		N
		Organisation name	15.29.376	Name of the creating organisation	Institute of Geodesy, Cartography and Remote Sensing (FOMI)	1
		Individual name	15.29.375	Name contact person in the creating organisation	Mr. George Buttner	1
		Position name	15.29.377	Position of the contact person in the creating organisation	Project manager	1
		Role	15.29.379	Always 'Originator' role	Originator	1
		Address: Delivery point	15.29.378.389.381	Address line for the location	Bosnyák tér 5.	1
		Address: City	15.29.378.389.382	City of the location	Budapest	1
		Address: State, Province	15.29.378.389.383	State, province of the location	-	1
		Address: Postal code	15.29.378.389.384	Postal code of the location	H-1149	1
		Address: Country	15.29.378.389.385	Country of the location	Hungary	1
		Address: E-mail	15.29.378.389.386	The electronic mail address of the originator/creator organisation or individual	buttner.gyorgy@fomi.hu	1
	Processor			The technical producer or processor of the data		N
		Organisation name	15.29.376	Name of the processor organisation	Institute of Geodesy, Cartography and Remote Sensing (FOMI)	1
		Individual name	15.29.375	Name contact person in the processor organisation	Mr. George Buttner	1
		Position name	15.29.377	Position of the contact person in the processor organisation	Project manager	1
		Role	15.29.379	Always 'Processor' role	Processor	1
		Address: Delivery point	15.29.378.389.381	Address line for the location	Bosnyák tér 5.	1
		Address: City	15.29.378.389.382	City of the location	Budapest	1
		Address: State, Province	15.29.378.389.383	State, province of the location	-	1
		Address: Postal code	15.29.378.389.384	Postal code of the location	H-1149	1
		Address: Country	15.29.378.385	Country of the location	Hungary	1
		Address: E-mail	15.29.378.389.386	The electronic mail address of the processor organisation or individual	buttner.gyorgy@fomi.hu	1

	Distributor			The organisation distributing the data		N
		Organisation name	15.29.376	Name of the distributor organisation	European Environment Agency	1
		Individual name	15.29.375	Name contact person in the distribution organisation		1
		Position name	15.29.377	Position of the contact person in the distributor organisation		1
		Role	15.29.379	Always 'Distributor' role		1
		Address: Delivery point	15.29.378.389.382	Address line for the location	http://dataservice.eea.europa.eu/dataservice	1
		Address: City	15.29.378.389.383	City of the location		1
		Address: State, Province	15.29.378.389.384	State, province of the location		1
		Address: Postal code	15.29.378.385	Postal code of the location		1
		Address: Country	15.29.378.389.386	Country of the location		1
		Address: E-mail	15.29.378.389.382	The electronic mail address of the distributor organisation or individual	eea@eea.europa.eu	1
	Access rights			Defines access rights for the dataset		N
		Type of constraint	20.70	The type of access right applied to assure the protection of privacy or intellectual property, and any special restriction or limitations on obtaining the resource. See **code list 1**.	005 (licence)	1
		Restriction	20.72	Description of the restriction of the access right.		1
Other dataset information				Other aspects explaining the dataset		1
	Language		15.39	Language used within the dataset	EN	1
	Format name		15.32.285	Name of the used exchange format for the dataset	ArcInfo coverage	1
	Format version		15.32.286	Version of the used exchange format for the dataset	-	1

	Methodology description		18.81.83	General explanation of the data producer's knowledge about how the geometry was constructed/derived and how the attribute information being part of the dataset was generated.	CLC2000 for Hungary has been produced by a variant of the standard methodology. A detailed national Corine land cover databases (CLC-50) related to 1998/99 has been generalised to yield CLC1998. Using IMAGE2000 satellite images CLC1998 has been updated to provide CLC2000 (CLC00_HU). CLC-Changes (CHANG_HU) database has been derived from CLC2000 by visually comparing IMAGE2000 and IMAGE90. All changes fulfilling the mapping criteria (> 5 ha, > 100 m boundary displacement) have been delineated, not only those that form a valid (>25 ha) polygon in CLC90. Büttner, G., Feranec, G., Jaffrain, G., 2002. Corine land cover update, Technical Guidelines, http://terrestrial.eionet.europa.eu, EEA Technical Report No. 89.	1
	Changes		18.EEA Changes	Description of the changes since last version of the dataset	-	1
	Process steps			Information about the event in the creation process of the dataset		N
		Description	18.81.84.87	Description of the process step including related parameters or tolerance	Step1: Visual comparison of IMAGE1990 and CLC2000 database displayed on IMAGE2000, direct delineation of changes. Software used: InterChange sw package under ArcView 3.2	1
		Source data reference title	18.81.84.91.360	Name of the resource used in process step	IMAGE2000 data: Ortho-corrected Landsat ETM imagery, pan sharpened. Pixelsize: 12,5 m; Date range: 06/10 — 08/20 2000.	N
		Source data reference date	18.81.84.91.362	Date of the resource used in process step		N
		Source data reference title	18.81.84.91.360	Name of the resource used in process step	IMAGE1990 data: Landsat TM imagery, pixelsize: 25 m. Date range: 1990–1992 (summer and autumn data)	
		Source data reference date	18.81.84.91.362	Date of the resource used in process step		
		Source data reference title	18.81.84.91.360	Name of the resource used in process step	Topographic paper maps, scale 1:50.000 Last updates: 1980–1991.	
		Source data reference date	18.81.84.91.362	Date of the resource used in process step		
		Description	18.81.84.87	Description of the process step including related parameters or tolerance	Step2: Internal verification (Technical&thematic)	
		Description	18.81.84.87	Description of the process step including related parameters or tolerance	Step3: External verification by the CLC2000 Technical Team	
		Description	18.81.84.87	Description of the process step including related parameters or tolerance	Step4: Merging of adjacent mapsheets	

	Scale		15.38.60.57	Gives a rough value of accuracy of the dataset; e.g. 2500000 means dataset has an accuracy suitable for use at scale 1:2.5 million at best	100.000	1
	Geographic accuracy		15.38.61	Geographic accuracy of location, ground distance as an value in meters	100	1
	Geographic box		Geographic position bounding box of the dataset		1	
		West bound longitude	15.42.336.344	Western-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	16,0187307140508	1
		East bound longitude	15.42.336.345	Eastern-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	22,9416191788024	1
		South bound latitude	15.42.336.346	Southern-most coordinate of the limit of the dataset extent, expressed in latitude in decimal degrees (positive north)	48,6097876729138	
		North bound latitude	15.42.336.347	Northern-most coordinate of the limit of the dataset extent, expressed in latitude in decimal degrees (positive north)	45,6779668546424	

Code list 1: MD_RestrictionCode

Name	**Domain code**	**Definition**
MD_RestrictionCode	RestrictCd	limitation(s) placed upon the access or use of the data
Copyright	001	exclusive right to the publication, production, or publication
Licence	005	formal regulation of user rights
intellectualPropertyRights	006	rights to financial benefits from and control of distribution of a non-tangible property that is the result of creativity
Restricted	007	withheld from general circulation or disclosure
otherRestrictions	008	limitation not listed

Code list 2: MD_TopicCategoryCode

Name	Domain code	Definition
MD_TopicCategoryCode	TopicCatCd	High-level geographic data thematic classification to assist in the grouping and search of available geographic data sets. Listed examples are not exhaustive. NOTE It is understood there are overlaps between general categories and the user is encouraged to select the one most appropriate.
Farming	001	Rearing of animals and/or cultivation of plants. Examples: agriculture, irrigation, aquaculture, plantations, herding, pests and diseases affecting crops and livestock.
Biota	002	Flora and/or fauna in natural environment. Examples: wildlife, vegetation, biological sciences, ecology, wilderness, sealife, wetlands, habitat.
Boundaries	003	Legal land descriptions. Examples: political and administrative boundaries.
ClimatologyMeteorologyAt mosphere	004	Processes and phenomena of the atmosphere. Examples: cloud cover, weather, climate, atmospheric conditions, climate change, precipitation.
Economy	005	Economic activities, conditions and employment. Examples: production, labour, revenue, commerce, industry, tourism and ecotourism, forestry, fisheries, commercial or subsistence hunting, exploration and exploitation of resources such as minerals, oil and gas.
Elevation	006	Height above or below sea level. Examples: altitude, bathymetry, digital elevation models, slope, derived products, monitoring environmental risk, nature reserves, landscape.
Environment	007	Environmental resources, protection and conservation. Examples: environmental pollution, waste storage and treatment, environmental impact assessment.
GeoscientificInformation	008	Information pertaining to earth sciences. Examples: geophysical features and processes, geology, minerals, sciences dealing with the composition, structure and origin of the earth's rocks, risks of earthquakes, volcanic activity, landslides, gravity information, soils, permafrost, hydrogeology, erosion.
Health	009	Health, health services, human ecology, and safety. Examples: disease and illness, factors affecting health, hygiene, substance abuse, mental and physical health, health services.
ImageryBaseMapsEarthCover	010	Base maps. Examples: land cover, topographic maps, imagery, unclassified images, annotations.
IntelligenceMilitary	011	Military bases, structures, activities. Examples: barracks, training grounds, military transportation, information collection.
InlandWaters	012	Inland water features, drainage systems and their characteristics. Examples: rivers and glaciers, salt lakes, water utilization plans, dams, currents, floods, water quality, hydrographic charts.
Location	013	Positional information and services. Examples: addresses, geodetic networks, control points, postal zones and services, place names.
Oceans	014	Features and characteristics of salt water bodies (excluding inland waters). Examples: tides, tidal waves, coastal information, reefs.
PlanningCadastre	015	Information used for appropriate actions for future use of the land. Examples: land use maps, zoning maps, cadastral surveys, land ownership.
Society	016	Characteristics of society and cultures. Examples: settlements, anthropology, archaeology, education, traditional beliefs, manners and customs, demographic data, recreational areas and activities, social impact assessments, crime and justice, census information.
Structure	017	Man-made construction. Examples: buildings, museums, churches, factories, housing, monuments, shops, towers.
Transportation	018	Means andw aids for conveying persons and/or goods. Examples: roads, airports/airstrips, shipping routes, tunnels, nautical charts, vehicle or vessel location, aeronautical charts, railways.

Annex 3 Approaches for updating CLC data

There are two basic approaches that could be applied for updating CLC data and derive CLC-Changes (Maucha *et al*., 2003). According to approach a) in Figure 1 ('*update first*') CLC2000 is revised first and corrected (if needed) using IMAGE2000 data. Then secondly the photo-interpreter modifies the database according to the status seen on IMAGE2006 imagery, which yields the CLC2006 database. CLC-Change will be computed accordingly:

- CLC-Change = CLC2006 (–) CLC2000 (1)

Where (–) means the following operation: CLC2000 and CLC2006 is intersected in GIS, all polygons having two CLC codes: code$_{2000}$ and code$_{2006}$ as a result, referring to land cover code in 2000 and in 2006, respectively. Then polygons with identical code$_{2000}$ and code$_{2006}$ are deleted. Experience shows that revision and updating cannot be fully sequentially organised. If during the updating process a new mistake is discovered in CLC2000 (e.g. a missing polygon), it has to be drawn into the CLC2006 database as well. Drawbacks of this method are:

- if CLC2000 is not correct, false changes are generated;
- 'island'-like changes are not mapped;
- after the intersect operation further editing is needed to eliminate non-real changes, otherwise false changes appear in the change database.

According to approach b) in Figure 1 ('*change mapping first*'), after some revision of CLC2000 (if needed), first CLC-Changes are interpreted using comparison of IMAGE2000 and IMAGE2006 data in a dual-window environment. In practice, if a CLC2000 polygon has changed, it will be taken over into the database of CLC-Changes, where only the changed part will be kept as polygon. This means that revision and correction of CLC2000 can be accomplished in parallel, not necessarily in a sequential order. The CLC2006 database will be computed accordingly:

- CLC2006 = CLC2000 (+) CLC-Change (2)

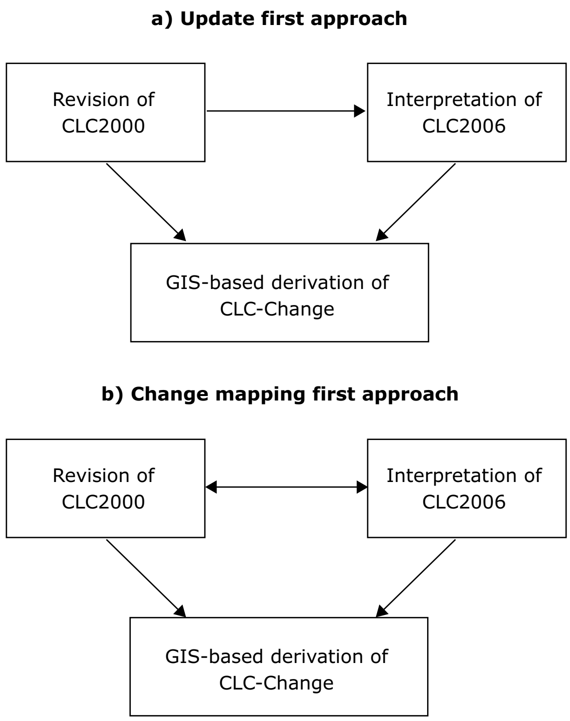
Where (+) means the following operation: CLC2000 and CLC-Changes are intersected, for CLC-Changes polygons code$_{2000}$ is replaced by code$_{2006}$, and finally neighbours with similar code are unified. Main benefits of this approach are:

- changes are interpreted directly (the interpreter has to think about what the real process was);
- all changes larger than the MMU can be delineated regardless of their position.

The weakness of the method is that CLC2006 is derived by a not fully automatic process (see Chapter 3), and some small (< 5 ha) deficiencies in CLC2006 cannot be avoided.

The chosen method to be used in CLC2006 project is the '*change mapping first*' approach, as it gives a better and more complete result from the change mapping point of view. See also Chapter 4.1.3.

Figure A.1 Approaches for updating and derivation of CLC-Changes



Source: Maucha *et al.*, 2003.

Annex 4 LUCAS land cover nomenclature

Black colour refers to nomenclature used in 2001–2002.

Red colour means differences introduced in 2006.

CODE	Meaning	CODE	Meaning
		B53	Other Legumes and mixtures for Fodder
A	**ARTIFICIAL LAND**	~~B60~~	~~Fallow land~~
A11	Buildings with one to three floors	B71	Apple fruit
A12	Buildings with more than three floors	B72	Pear fruit
A13	Greenhouses	B73	Cherry fruit
A21	Non built-up area features	B74	Nuts trees
A22	Non built-up linear features	B75	Other fruit trees and berries
B	**CROPLAND**	B76	Oranges
B11	Common wheat	B77	Other citrus fruit
B12	Durum wheat	B81	Olive groves
B13	Barley	B82	Vineyards
B14	Rye	B83	Nurseries
B15	Oats	B84	Permanent industrial crops
B16	Maize	**C**	**WOODLAND**
B17	Rice	C11	Broadleaved forest
B18	Triticale	C12	Coniferous forest
B19	Other cereals	C13	Mixed forest
B21	Potatoes	C21	Other broadleaved tree land ~~wooded area~~
B22	Sugar beet	C22	Other coniferous tree land ~~wooded area~~
B23	Other root crops	C23	Other mixed tree land ~~wooded area~~
B31	Sunflower	~~C30~~	~~Poplars, eucalyptus~~
B32	Rape and turning rape	**D**	**SHRUBLAND**
B33	Soya	D01	Shrubland with sparse tree cover
B34	Cotton	D02	Shrubland without tree cover
B35	Other fibre and oleaginous crops	**E**	**GRASSLAND**
B36	Tobacco	E01	Grassland with sparse tree/shrub cover
B37	Other non-permanent industrial crops	E02	Grassland without tree/shrub cover
B41	Dry pulses	**F**	**BARE LAND**
B42	Tomatoes	F00	Bare land
B43	Other fresh vegetables	**G**	**WATER AREAS**
B44	Floriculture and ornamental plants	G01	Inland water bodies
B45	Strawberries	G02	Inland running water
~~B50~~	~~Temporary, artificial pastures~~	G03	Coastal water bodies
B51	Clovers	G04	Wetland
B52	Lucerne	G05	Glaciers, permanent snow

Annex 5 LUCAS land use nomenclature

Black colour refers to nomenclature used in 2001–2002.

Red colour means differences introduced in 2006.

CODE	Meaning	CODE	Meaning
U11	AGRICULTURE	U32	WATER AND WASTE TREATMENT
U111	Agriculture (excluding fallow land and kitchen gardens)	U321	Water supply and treatment
U112	Fallow land	U322	Waste treatment
U113	Kitchen garden	U33	CONSTRUCTION
U12	FORESTRY	U34	COMMERCE, FINANCE, BUSINESS
U13	FISHING	U35	COMMUNITY SERVICES
U14	MINING AND QUARRYING		
U21	ENERGY PRODUCTION	U36	RECREATION LEISURE, SPORT
U22	INDUSTRY AND MANUFACTURING	U361	Amenities, museums,leisure
U221	Manufacturing of food, beverages and tobacco products	U362	Sport
U222	Manufacturing of textile products	U363	Holiday camps
U223	Coal, oil and metal processing	U37	RESIDENTIAL
U224	Production of Non-metal mineral goods	U40	UNUSED
U225	Chemical and alied industries and manufacturing	U50	WETLAND
U226	Machinery and equipment		
U227	Wood based products		
U31	TRANSPORT, COMMUNICATION NETWORKS, STORAGE, PROTECTIVE WORKS		
U311	Railways		
U312	Roads		
U313	Water transport		
U314	Air transport		
U315	Transport via Pipelines		
U316	TELECOMMUNICATION		
U317	STORAGE		
U318	PROTECTION WORKS		

Annex 6 Priority table for generalising CLC classes

		codes of neighbouring polygon 25 > ha																																											
		111	112	121	122	123	124	131	132	133	141	142	211	212	213	221	222	223	231	241	242	243	244	311	312	313	321	322	323	324	331	332	333	334	335	411	412	421	422	423	511	512	521	522	523
unit < 25 ha	111		1	1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
	112	1		1	1	1	1	1	1	1	1	1	3	3	3	3	3	3	3	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
	121	3	3		1	1	1	2	2	2	4	4	6	6	6	6	6	6	6	5	5	6	7	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	8	8	8
	122	2	2	1		1	1	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5
	123	3	3	1	1		1	2	2	2	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6
	124	3	3	1	1	1		4	4	4	2	2	6	6	6	6	6	6	5	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7
	131	3	3	2	2	3	3		1	1	4	4	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6	8	8	8	8	5	8	8	8
	132	3	3	2	2	3	3	3		1	4	4	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6	8	8	8	8	5	8	8	8
	133	1	1	1	1	1	1	2	2		2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
	141	3	2	3	3	3	3	3	3	3		1	7	7	7	7	7	7	7	7	7	5	5	4	4	4	4	4	4	4	7	7	7	7	7	7	7	7	7	7	7	6	6	7	7
	142	3	2	3	3	3	3	3	3	3	1		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5
	211	5	5	5	5	5	5	5	5	5	5	5		1	1	4	4	4	3	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
	212	5	5	5	5	5	5	5	5	5	5	5	1		1	4	4	4	3	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
	213	5	5	5	5	5	5	5	5	5	5	5	1	1		4	4	4	3	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	7
	221	4	4	5	5	5	5	5	5	5	5	5	3	3	3		1	1	3	2	2	2	2	5	5	5	4	4	4	4	4	4	4	4	6	6	6	6	6	6	7	7	7	7	7
	222	5	5	6	6	6	6	6	6	6	6	6	3	3	3	1		1	3	2	2	2	2	4	4	4	6	5	5	5	6	6	6	6	7	7	7	7	7	7	8	8	8	8	8
	223	5	5	6	6	6	6	6	6	6	6	6	3	3	3	1	1		3	2	2	2	2	4	4	4	6	5	5	5	6	6	6	6	7	7	7	7	7	7	8	8	8	8	8
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	242	3	2	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1		1	1	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5
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	313	7	7	7	7	7	7	7	7	7	3	3	7	7	7	7	6	6	7	6	6	2	3	1	1		5	4	4	4	5	5	5	5	8	6	6	6	8	8	8	8	8	8	8
	321	8	8	8	8	8	8	8	8	8	3	3	7	7	7	7	7	7	5	6	6	2	6	4	4	4		1	1	1	3	3	3	3	8	4	4	4	9	4	8	8	8	8	8
	322	6	6	6	6	6	6	6	6	6	3	3	5	5	5	4	4	4	5	5	5	2	4	3	3	3	2		1	1	3	3	3	3	8	2	2	4	7	4	8	8	8	8	8
	323	6	6	6	6	6	6	6	6	6	3	3	5	5	5	4	4	4	5	5	5	2	4	3	3	3	2	1		1	3	3	3	3	8	2	2	4	7	4	8	8	8	8	8
	324	6	6	6	6	6	6	6	6	6	3	3	5	5	5	4	4	4	5	5	5	2	4	1	1	1	1	1	1		2	2	2	2	8	3	3	4	7	4	8	8	8	8	8
	331	6	6	6	6	6	6	6	6	6	3	3	5	5	5	5	5	5	5	5	5	2	5	4	4	4	2	2	3	3		1	1	1	1	4	4	2	4	2	2	2	3	3	3
	332	5	5	5	5	5	5	3	3	3	4	4	4	4	4	3	4	4	4	4	4	2	4	3	3	3	2	2	2	2	1		1	1	1	4	4	4	4	4	6	6	6	6	6
	333	6	6	6	6	6	6	6	6	6	3	3	5	5	5	5	5	5	4	5	5	2	5	3	3	3	2	2	2	2	1	1		1	1	4	4	4	4	4	7	7	7	7	7
	334	7	7	7	7	7	7	7	7	7	4	4	5	6	6	5	4	4	5	5	5	3	3	2	2	2	2	2	2	2	1	1	1		8	6	2	6	6	6	8	8	8	8	8
	335	8	8	8	8	8	8	8	8	8	8	5	8	8	8	8	8	8	8	8	8	8	8	6	6	6	4	5	7	6	1	1	1	7		4	4	5	5	5	3	2	5	5	5
	411	7	7	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	5	6	6	2	6	4	4	4	4	4	4	4	4	4	4	5	3		1	2	2	2	3	3	3	3	3
	412	7	7	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	5	6	6	2	6	4	4	4	4	4	4	4	4	4	4	5	3	1		2	2	2	3	3	3	3	3
	421	8	8	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	4	7	7	4	7	7	7	7	4	6	6	6	5	5	5	8	8	3	3		1	1	2	2	1	1	1
	422	6	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	2	3	1		1	4	4	3	3	3
	423	6	6	6	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	4	4	1	1		3	3	2	2	2
	511	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	2	5	5	6	6	4	4	3	3	3		1	2	2	2

Note: 1 is the highest priority. Larger numbers indicate lower priority.

Source: Bossard *et al.*, 2000.

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