Final Report

CORINE Land Cover 2012

Switzerland

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Summary

The CORINE programme, which was initiated in the mid to late 1980s by the European Commission, strives to coordinate base information on the state of the European environment with the goal of creating and maintaining a community-wide environmental information system. A first inventory of CORINE Land Cover (CLC) was done 1990, followed by CLC2000, 2006 and 2012. The next update is foreseen for 2018.

The CORINE Land Cover comprises a hierarchical nomenclature of 3 levels, where level 3 comprises 44 classes. Out of these 44 classes, 29 are present in Switzerland. CLC maps artificial surfaces, agricultural areas, forests, semi-natural areas, wetlands and water bodies. The minimum mapping unit is 25 ha, the minimum mapping width 100 m.

Switzerland created a comparable dataset for CLC 1990, which was finished 1998 (Bundesamt für Statistik 1998). It was derived directly from the Swiss Land Use Statistics, but due to differences in nomenclatures, only CLC levels 1 and 2 were included. Fully compatible CLC datasets for Switzerland were produced for 2000, 2006 and 2012 due to be a member of the EEA.

The CORINE programme also maps the changes between the mapping intervals since CLC 2000. The minimum mapping unit for changes is 5 ha. These changes are kept as extra data sets (CLCC2000-2006 CLCC2006-2012).

Attention

The Swiss CORINE data should not be used to assess the land cover of a particular location in Switzerland. Neither should it be used to compile statistics for Switzerland or parts of the country.

CORINE is a generalized and simplified land cover dataset. Its purpose is to complete the EEA CORINE Land Cover database of Europe in order to serve the EEA, European institutions and research activities with a homogeneous European land cover dataset as input.

Swiss official statistics about land use / land cover are published by Swiss Federal Statistical Office (http://www.bfs.admin.ch/bfs/portal/de/index/themen/02/03.html).
1  The Swiss CORINE 2012 project ................................................................. 4
   1.1  Organisation .......................................................................................... 4
2  Data ........................................................................................................... 5
   2.1  Image data .............................................................................................. 5
   2.2  Ancillary data ......................................................................................... 10
   2.3  Data Preparation .................................................................................... 11
3  Method ....................................................................................................... 12
   3.1  Revision CLC 2006 ............................................................................... 12
   3.2  Mapping Changes 2006 – 2012 ............................................................... 15
   3.3  Validation ................................................................................................. 16
       CLC2012 .................................................................................................. 16
   3.4  Delivery .................................................................................................. 16
1 THE SWISS CORINE 2012 PROJECT

1.1 ORGANISATION
The Federal Office for the Environment (FOEN) is the Swiss National Focal-point (NFP) for the EEA and thereby responsible for the national part of CORINE Land Cover. The responsibility for the project is the Environmental Monitoring Section and the IT and Services Section. Technical support for the complete project was done by the Swiss Federal Research Institute WSL\(^1\) and the production itself was carried out by MFB Geoconsulting\(^2\).

The financing was completely covered by FOEN.

1.1.1 PROJECT TEAM

FOEN
Nicolas Perritaz, Europe, Trade and Cooperation on Development Section / EEA, Environmental Reporting (NFP Switzerland)
Tom Klingl, IT & Services Section
Markus Wüest, Environmental monitoring Section

WSL
Charlotte Steinmeier, Landscape Dynamics, Remote Sensing Group

1.1.2 CLC PRODUCTION TEAM
The change mapping CLC\textsubscript{2006-2012} as well as the revision of CLC\textsubscript{2006} was done by the private company MFB Geoconsulting on behalf of FOEN. Working for the production were Martin Sauerbier and Gabriela Apfl.

1.1.3 WORKFLOW
March 2013 Start of CLC-CH 2012 project
September 2013 Start of mapping changes
February 2014 First (remote) verification report (ETC SIA / FÖMI)
June 2014 Second (remote) verification report (ETC SIA / FÖMI)
September 2014 Final acceptance report of EEA

\(^{1}\) http://www.wsl.ch/fe/landschaftsdynamik/projekte/corine_landcover_update/index_DE
\(^{2}\) http://www.mfb-geo.com
2 DATA

2.1 IMAGE DATA

In order to map the CORINE Changes, two time steps of high resolution satellite images were provided by EEA (via ESA facilities). All datasets were delivered georeferenced in the national projection CH1903_LV03. An additional data set was available from FOEN, with DMC data of 2012.

Coverage 1: IRS data from 2011 / 2012
Coverage 2: Rapid Eye data 2011 / 2012, resampled to 20m
Coverage 3: DMC data 2012

2.1.1 COVERAGE 1 – IRS

Geometrical resolution: 20 m

Spectral resolution: green (520 – 590nm)
red (620 – 680nm)
NIR (770 – 860nm)
MIR (1550 – 1700nm)

Dates:
- 5 scenes between 02.08.2011 and 31.08.2011
- 3 scenes between 24.09.2011 and 29.09.2011
- 1 scene from 08.07.2012
- 1 scene from 15.08.2012

Fig. 1: footprints IRS data
Although there were large parts of overlapping scenes (up to 4 times) not all of Switzerland was cloud free or in “summerly snow/ice conditions”.

In order to support easy mapping the data was mosaicked to a single image with the best available data.

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Fig. 2: overlapping scenes & examples of clouds / snow

Fig. 3: IRS mosaic, coverage 1
2.1.2 COVERAGE 2 – RAPID EYE

Geometrical resolution: 20 m (resampled from originally 6.5m, by ESA)

Spectral resolution:
- blue (440 – 510nm)
- green (520 – 590nm)
- red (630 – 685nm)
- Red Edge (690 – 730nm)
- NIR (760 – 850nm)

Dates:
- 1 scene from 21.03.2011
- 19 scenes between 02.04.2011 and 19.04.2011
- 58 scenes between 01.10.2011 and 21.10.2011
- 9 scenes between 14.03.2012 and 20.03.2012
- 1 scene from 02.04.2012
- 10 scenes between 02.10.2012 and 05.10.2012

Fig. 4: footprints Rapid Eye data

The coverage 2 data showed only a little bit of cloud cover, but the restrictions here were mainly the early or late acquisition dates and the lack of the MIR channel. Also for coverage 2 a mosaic was produced to enable fast mapping without handling the different images.
Fig. 5: Overlapping scenes coverage 2

Fig. 6: Rapid Eye mosaic, coverage 2
2.1.3 COVERAGE 3 – DMC

Geometrical resolution: 22 m
Spectral resolution: green (520 – 600nm)
red (630 – 690nm)
NIR (770 – 900nm)

Dates:
- 1 scene from 29.06.2012
- 1 scene from 18.07.2012
- 1 scene from 19.08.2012

Fig. 7: DMC footprints coverage 3

Fig. 8: DMC mosaic coverage 3
2.1.4 MOSAIC 2006
In order to map changes, it is necessary to look simultaneously at the images of 2006. Both coverages of the 2006 data were made available as single mosaics, including the necessary metadata of acquisition date and sensor type. Both mosaics contain Spot data as well as IRS data. The details are listed in the CLC2000/2006 report of Switzerland3.

2.1.5 MOSAIC 2000
Also the mosaic of 2000 (Landsat-TM) was made available in order to check the status of 2000 when working for the CLC 2006 revision.

2.1.6 AERIAL IMAGES
For all of Switzerland aerial false colour images (G/ R/ IR) were available. For better handling the data was resampled to 2.5 m geometric resolution and 8 bit depth. All the images are taken between 2010 - 2012 (© Swisstopo).
Besides the direct data access the true colour aerial images with 25 cm resolution are available via internet access and also between 2010-2012.

2.1.7 SPOT MOSAIC 2004/2005
For the revision of CLC2006 also the national SPOT mosaic at 5 m geometric resolution was available (© Swisstopo).

2.2 ANCILLARY DATA

2.2.1 TOPOGRAPHIC MAPS
Digital topographic maps at scale 1:25'000 and 1:50'000 were available (© Swisstopo).

2.2.2 VEGETATION HEIGHT
The vegetation height data set was resampled to the geometric resolution of 10 m x 10 m. For areas with vegetation (depending on ndvi), it lists the nominal height of vegetated areas. This allows e.g. the differentiation of trees and shrubs, especially in alpine areas (© WSL).

2.2.3 DEM
The Swiss digital elevation model with 25 m resolution was available (DHM25 © Swisstopo).

2.2.4 **Probability map of changes**

This map was specially developed by WSL for CORINE 2012. The basic idea is to derive possible CLC changes based on already known changes of different data sets. The mapped changes shall serve as hints for the interpreter to pay special attention in these areas. The borders of the mapped changes however have to be proven on base of the satellite images.

**TLM Changes**

The topographic landscape model (TLM) consists of the basic geographical data which describes in three dimensions the shape of the earth’s surface, the nature of the land cover and the names of features and places. The data is updated in a 6 year cycle. Two time stamps were available (TLM 1.0 / TLM 1.1) in the western part of Switzerland.

For the probability map only 3 classes were considered: gravel pits, forest and glaciers. Only areas with changes bigger than 4 ha were regarded as relevant and taken into the probability map. By this five different types of changes were obtained: gravel pit enlargement / gravel pit decrease / forest enlargement / forest decrease / glacier decrease.

**Vegetation height**

The vegetation height allows to derive areas in which changes may occur. Two different change types were calculated: forest increase and forest decrease. The first one shows all those areas where the vegetation height data shows values of 5 meters and more and which are mapped in CLC 2006 as one of the following CLC classes: 231, 242, 243, 321, 322, 324, 333. The forest decrease on the other hand is mapped when the vegetation height is below 5 meters and in CLC 2006 a forest class (311, 312, 313). For both types only areas bigger 4 ha were taken into the probability mapped.

**CLC2006 Gravel Pit buffer**

Since it is known that the Swiss gravel pits change rapidly an additional layer for the probability map was created. All mineral extraction sites from CLC 2006 (131) were buffered with 300 meters and added as potential change area.

2.3 **Data Preparation**

All data sets were split seamless into map sheets 1:25'000. The tiling into map sheets (259) allowed to have all ancillary data easily available and nevertheless to enable efficient working.

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3 Method

In the CORINE 2012 project three new data sets are produced. CLC 2006 revision, CLC Changes 2006-2012, CLC 2012. The base for these data is CLC 2006, which is delivered to each country before the start by EEA in national projection. It is extracted from the seamless CLC 2006 data of EEA. The general processes are the same as the production of CLC 2006.

- Revision of CLC 2006 (correction of obvious errors)
- Mapping changes between 2006 / 2012 bigger than 5 ha
- Calculating CLC 2012 by GIS software based on the CLC2006rev / changes.

New in 2012 is the process of the final delivery to EEA. A new quality control tool (CLC QC Tool) was developed for that by ETC SIA (partner: GISAT).

The work was mostly done with the CLC 2012 Support Package (V3134), put at the disposal by EEA. Additionally ArcGIS 10.0 and Erdas Imagine 2013 was used.

3.1 Revision CLC 2006

In the CLC2012 Addendum to CLC2006 Technical Guidelines it is mentioned under 4.1.2.1 “Occurrence of interpretation mistakes is an inherent characteristic of visual interpretation of remote sensing data, coming not necessarily from negligence, but insufficient information. During updating, by examining newly available satellite images or ancillary data usually a
number of thematic mistakes are discovered in the database to be updated. In order to avoid error propagation into CLC2012, mistakes discovered in CLC2006 are much recommended - in locations of changes absolutely necessary - to be corrected.

For the Swiss CLC 2006 it was known that some major discrepancies are present in the data due to the semi automatic mapping of CLC 2000. It was therefore foreseen from the very beginning to improve the data set as far as possible within the given time and financial constraints.

Main corrections were done for the following four cases:

- Megapolygons
- Sliverpolygons
- Spikes / complex polygon outlines
- Thematic content

### 3.1.1 Megapolygons

In the CLC2006 data some polygons were extremely huge (Fig. 10). This was corrected in a separate step before any other revision. All polygons with areas > 10’000 ha were split up by a Delauney triangulation and afterwards a thinning and partly manual correction of the remaining polygons (Fig. 11).

![Fig. 10: Example of Megapolygon in CLC2006 in the Jura](image1)

![Fig. 11: Delauney triangulation/ thinning / correction](image2)
With this procedure most of the mega polygons could be corrected.

### 3.1.2 Sliverpolygons

As usual for sliverpolygons, they are difficult to see directly. Most probably they were introduced during the generation of CLC2006 by combining the status layer CLC2000 and the change layer CLC2000-2006. The sliverpolygons were classified into size classes. Except the very small polygons (< 0.1 ha) all were corrected manually. The remaining ones were corrected either directly when found by mapping changes or in the end at the topology control.

<table>
<thead>
<tr>
<th>Größe</th>
<th>Anzahl</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>von 0.01 ha - 1 ha</td>
<td>480</td>
<td>80%</td>
</tr>
<tr>
<td>von 1.01 ha - 2ha</td>
<td>48</td>
<td>8%</td>
</tr>
<tr>
<td>von 2.01 ha - 5 ha</td>
<td>60</td>
<td>10%</td>
</tr>
<tr>
<td>&gt; 5ha</td>
<td>12</td>
<td>2%</td>
</tr>
</tbody>
</table>

### 3.1.3 Spikes / Complex Polygon Outlines

This problem is also due to the semi automatic generation of CLC2000. A typical example is shown in Fig. 13 and Fig. 14.
3.1.4 THEMATIC CONTENT

The revision of the thematic content was done in an extra working step. Different regions were treated differently in respect to “problem” classes. Special attention was given to in

- Jura: forest classes 31x / grassy (231 / 321) / transition zone forest-bush (324).
- Mid plains: agriculture (211)
- Pre Alpine: grassy (231 / 321) and complex (242)
- High Alpine: glacier (335)

3.2 MAPPING CHANGES 2006 – 2012

The change mapping was done manually as recommended in the guidelines. The most important difference was the availability of the probability map, which indicated possible changes based on the mapped changes for the Swiss Topographic Landscape Model (TLM). Mainly the classes “mineral extraction site”, “forest” and “glaciers and perpetual snow” could be easily detected by
this data. The difference to the work without it was obvious since for larger parts in eastern Switzerland it was not available.

The mapping was carried out for all the 259 tiles. First the probable changes from the support layer were inspected and then finished with the visual inspection for further changes.

### 3.3 Validation

Besides the internal quality control during the whole mapping process two “remote verifications” were carried out by the EEA Technical Team. The first one was done after about 50% of the tiles, the second one after 75% of the country area. The comments from the verification team were taken into account for the remaining work.

### CLC2012

The update of the CLC2006 was done by GIS tools. The changes $^{\text{2006-2012}}$ were combined with the CLC2006 data after extracting purely technical changes. This procedure was done with a software tool developed from the EEA Technical Team.

At the very end of the mapping the Swiss CLC Team verified the two data sets CLC Changes $^{\text{2006-2012}}$ and CLC2012. The main errors resp. error types were corrected. Due to time limits not all of the problems could be resolved. These are foreseen to be corrected before the next CLC Update.

### 3.4 Delivery

A final quality check was done with the “Online Quality Control” tool developed by the EEA SIA team. The tool integrates all formal, technical and topological checks as defined in CLC2006 Technical Guidelines, which can be done in fully automatic way. That way it was ensured that no checks are skipped or omitted and the assurance of technical consistency and semantic correctness of each individual national CLC database is given. The process was run several times and finally the data was delivered August 20$^{\text{th}}$, 2014.

The final acceptance from EEA was given September 2$^{\text{nd}}$, 2014 with the report “CLC2012 – Database Technical Acceptance”.