

CORINE Land Cover products for Germany, created by DLR-DFD on behalf of the Federal Environment Agency (UBA) – an Overview

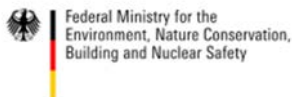
Manfred Keil, DLR-DFD, January 2017

1 CORINE Land Cover in Germany – an Introduction

The objective of the pan-European project CORINE Land Cover (CLC) is the provision of a unique and comparable data set of land cover for Europe. It is part of the European Union program CORINE (Co-ordination of Information on the Environment). The mapping of the land cover and land use was performed on the basis of satellite remote sensing images on a scale of 1:100,000. The first CLC data base CLC1990, finalized for Germany in the 1990s by the Federal Statistical Office (Destatis), consistently provided land use information comprising 44 classes, out of which 37 classes are relevant in Germany.

In the project CORINE Land Cover 2000 (CLC2000), an update of the database and a mapping of changes have been accomplished using the year 2000 as reference. The project CLC2000 in Germany was led by the German Remote Sensing Data Center (DFD) of the German Aerospace Center (DLR) on behalf of the Federal Environmental Agency (UBA). With CLC2000, a reliable, objective and comparable data base for the description of the current situation (at 2000) was available, due to the nomenclature and guidelines of EEA (2000), supplemented by the analysis of changes during the decade between 1990 and 2000 (Keil et al 2006a, Keil et al 2006b).

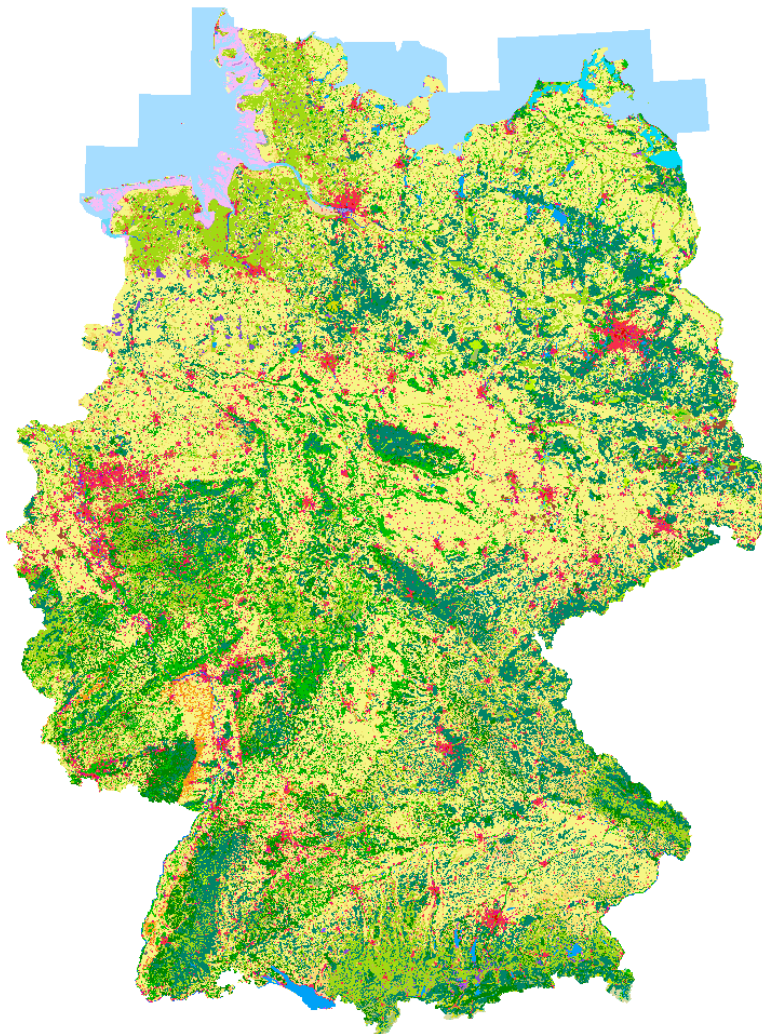
Integrated in the European GMES activities, an update of CORINE Land Cover was done in 37 European countries with the reference year 2006, completed in most of the countries in 2010. The project CLC2006 in Germany was again performed by the German Remote Sensing Data Center, on behalf of the Federal Environment Agency (UBA). The updated CORINE Land Cover 2006 for Germany was available since February 2010 (Keil et al 2010).



For the update 2012 of land cover according to CORINE Land Cover classes, a specific national approach has been chosen in Germany. This approach uses the more accurate geometry of the Official Topographical Cartographic Information System ATKIS of the land survey authorities. The “Digital Landscape Model for Germany”, DLM-DE, derived from ATKIS, was applied as base for the deduction of CLC classes, filled with thematic information for updating by satellite image information. In the responsibility of the German Federal Agency for Cartography and Geodesy (BKG), a first DLM-DE 2009 database was built-up for the reference year 2009 with a minimum mapping unit (MMU) of 1 ha. Up to now, an updated DLM-DE 2012 database was produced by BKG, published under the name LBM-DE 2012. Using methods of generalization, this database was afterwards transferred into the CLC2012 database (CORINE Land Cover 2012, having 25 ha MMU due to the EU specifications) as part of the European database, with an intermediate step of generalization to a 10 ha MMU. On the European level, CORINE Land Cover 2012 is now part of the Copernicus Land Monitoring services, coordinated by the European Environment Agency (EEA).

The German Remote Sensing Data Center (DFD) participated in CLC2012 concerning the second product of CLC2012, the change layer of land cover between 2006 and 2012, describing the development of land cover categories (with 5 ha MMU). Due to the methodological modification, the change layer could not be deduced directly by BKG using the conventional CLC2006 and DLM-DE 2012 or the resulting CLC2012. Direct changes could be achieved only by comparing DLM-DE 2009 and DLM-DE 2012 for the period from 2009 to 2012. Therefore, the task of DLR-DFD in this project was to model changes between 2006 and 2009 in the detailed geometry of DLM-DE 2009. For this reason, a database "CLC2006_Backdating" had to be created by a backward look from DLM-DE 2009 to the situation of land cover / land use in 2006 (Keil et al 2015a, Keil et al 2015b, Keil et al 2015c).

Since about June 2012, the geo-service center of the German Federal Agency for Cartography and Geodesy (BKG) offers now for free also the CORINE Land Cover 2012 (10 ha) product for Germany in an enhanced spatial resolution of 10 ha minimum mapping unit (in addition to the product of 25 h MMU, used for the integration in the European database). As remarked, this dataset is based on the generalization of the land cover model LBM-DE2012 (1 ha MMU).



Land cover map CLC2000 of Germany (UBA / DLR) - Copyright © 2007 Deutsches Zentrum für Luft- und Raumfahrt (DLR). Alle Rechte vorbehalten.

The CORINE Land Cover database for Germany comprises 37 classes in a hierarchy of 3 levels. The classes are listed below:

ARTIFICIAL SURFACES

URBAN FABRIC

- 111 Continuous urban fabric
- 112 Discontinuous urban fabric

INDUSTRIAL, COMMERCIAL AND TRANSPORT UNITS

- 121 Industrial, commercial and public units
- 122 Road and rail networks and associated land
- 123 Port areas
- 124 Airport

MINES, DUMPS AND CONSTRUCTION SITES

- 131 Mineral extraction sites
- 132 Dump sites
- 133 Construction sites

ARTIFICIAL NON-AGRICULTURAL VEGETATED AREAS

- 141 Green urban areas
- 142 Sport and leisure facilities

AGRICULTURAL AREAS

ARABLE LAND

- 211 Non-irrigated arable land

PERMANENT CROPS

- 221 Vineyards
- 222 Fruit trees and berries plantations

PASTURES

- 231 Pastures

HETEROGENEOUS AGRICULTURAL AREAS

- 242 Complex cultivation patterns
- 243 Land principally occupied by agriculture, with significant areas of natural vegetation

FOREST AND SEMINATURAL AREA

FORESTS

- 311 Broad-leaved forest
- 312 Coniferous forest
- 313 Mixed forest

SCRUBS AND/OR HERBACEOUS VEGETATION

- 321 Natural grassland
- 322 Moors and heathland
- 324 Transitional woodland-scrub

OPEN SPACES WITH LITTLE OR NO VEGETATION

- 331 Beaches, dunes, sand
- 332 Bare rock
- 333 Sparsely vegetated areas
- 334 Burnt areas
- 335 Glaciers and perpetual snow

WETLANDS

INLAND WETLANDS

- 411 Inland marshes
- 412 Peat bogs

COASTAL WETLANDS

- 421 Salt marshes
- 423 Intertidal flats

WATER BODIES

INLAND WATERS

- 511 Water courses
- 512 Water bodies

MARINE WATERS

- 521 Coastal lagoons
- 522 Estuaries
- 523 Sea and ocean

2 Brief Description of the Projects CORINE Land Cover 2000 and CORINE Land Cover 2006

2.1 Project objectives

In the European Union's CORINE Land Cover 2000 Program (CLC2000), land use and land cover information was to be brought up-to-date for all of Europe with the help of satellite data. This activity was based on a uniform methodology and a classification key which has been harmonized since the first survey was undertaken in 1990. The goal was to create a common database which permits comparisons of land cover and land use as well as identification of any changes occurring in the time interval between 1990 and 2000, and made possible ecological appraisals with their consequences for regional planning both at European and national level.

A further update of the data base CORINE Land Cover was performed between 2007 and 2010. The reference year was 2006. One main aspect of CLC2006 in the European context was the derivation of changes between 2000 and 2006.

2.2 Methodology

Within the framework of the European CLC2000 project the data base of the first survey 1990 was updated for all of Europe using the year 2000 as a base year, and changes with respect to CLC1990 were mapped.

Identification of land use changes was accomplished by visual interpretation supplemented by automated processes in a GIS supported system. The classification for Germany includes 37 land cover classes in three hierarchical levels. The main categories are developed areas, agricultural land, forests and natural landscapes, wetlands, and water bodies. The recording scale is 1:100,000, whereby newly identified areas have to be included if over 25 ha in size, and changes in land use if the new borders alter the area by at least 5 ha. Areas of linear form such as rivers are to be included if wider than 100 m.

The datasets for the year 2000 were uniformly orthorectified Landsat-7 data from 1999-2001 for all of Europe (responsible institution: JRC, in the Image2000 project). At DFD, the CLC1990 vector database and the satellite data from the 1990 activities were adjusted to these orthorectified data. The significant result of CLC2000 were two data sets: an up-to-date mapping of land cover, CLC2000, and mapping of changes with respect to CLC1990. In addition, any corrections found to be needed to the 1990 data set as a result of the interpretation process were published within a CLC1990 revised data set.

The update of the CLC dataset regarding the reference year 2006 was done using a database of SPOT-4, SPOT-5 and IRS-P6 LISS-3 data, which have been collected on behalf of ESA under the name IMAGE2006. Besides a summer coverage (data between 2005 and 2007), an additional coverage, a spring coverage, was built-up, which was to enable an improved separation of arable land and pasture land in agriculture. The ortho-rectification of the IMAGE2006 data was done at the Remote Sensing Technology Institute (IMF), located at DLR in Oberpfaffenhofen.

The update CORINE Land Cover 2006 was done mainly due to the same specifications as for CLC2000. However, the change layer CLC2006_Change was in the foreground. In CLC2006_Change, also changes with the minimum of 5 ha were recorded which have no effects on an extension of present areas more than 25 ha in size, or on new areas fulfilling the minimum mapping unit of 25 ha.

2.3 Project Structure

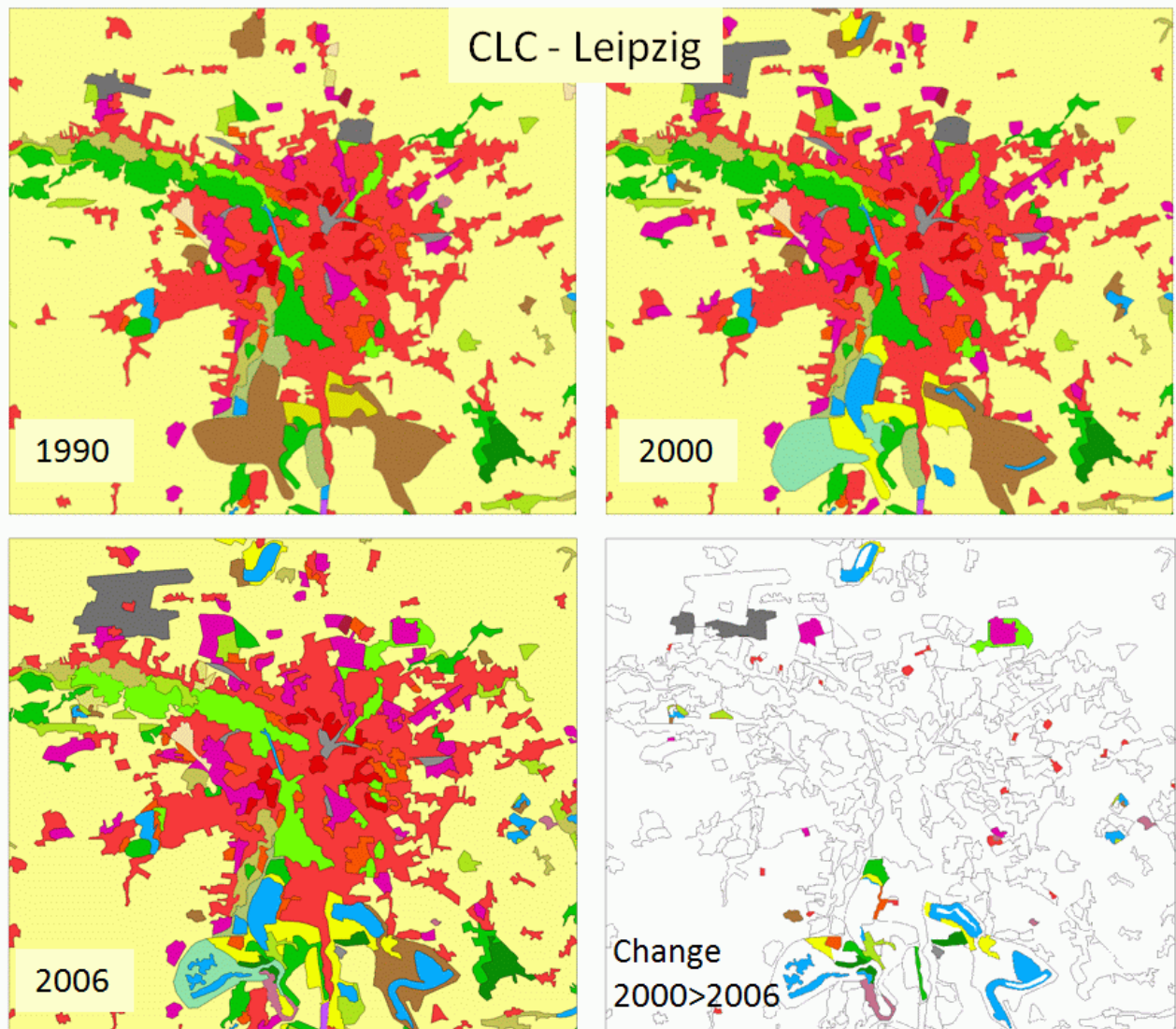
On the European level, the European Environment Agency (EEA) was responsible for the management and the coordination with the member states, assisted by the European Topic Centre for Terrestrial Environment (ETC-TE). A technical team of ETC-TE was built for the technical assistance, the training, the data integration and validation. The Joint Research Centre (JRC) of the European Commission was responsible for the subproject Image2000. The Image2000 team performed the selection, acquisition and ortho-rectification of the satellite data (Landsat-7 ETM+) assisted by the national project team.

At national level, project teams were built which performed the interpretation of satellite data, the mapping of land cover and land cover changes, the quality assurance and the validation. Responsible for the management and the performance of the German subproject was the German Remote Sensing Data Center of DLR in Oberpfaffenhofen, on behalf of the Federal Environmental Agency as national responsible institution. By a tender process, the companies EFTAS and GAF AG as well as a consortium of Infoterra GmbH, Hugin GmbH and Delphi IMM were integrated in the German CLC2000 project.

The German CLC2000 project was funded in the frame of the UBA F+E project under the number FKZ 201 12 209 with a share of funding by the European Union.

The update CORINE Land Cover 2006 for Germany was funded in the frame of the UBA F+E projects under the number FKZ 3707 12 200 and FKZ 3708 12 200.

2.4 An exemplary result



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3 Brief Description of the Project CORINE Backdating - "Backdating" of DLM-DE of the Reference Year 2009 to the Year 2006

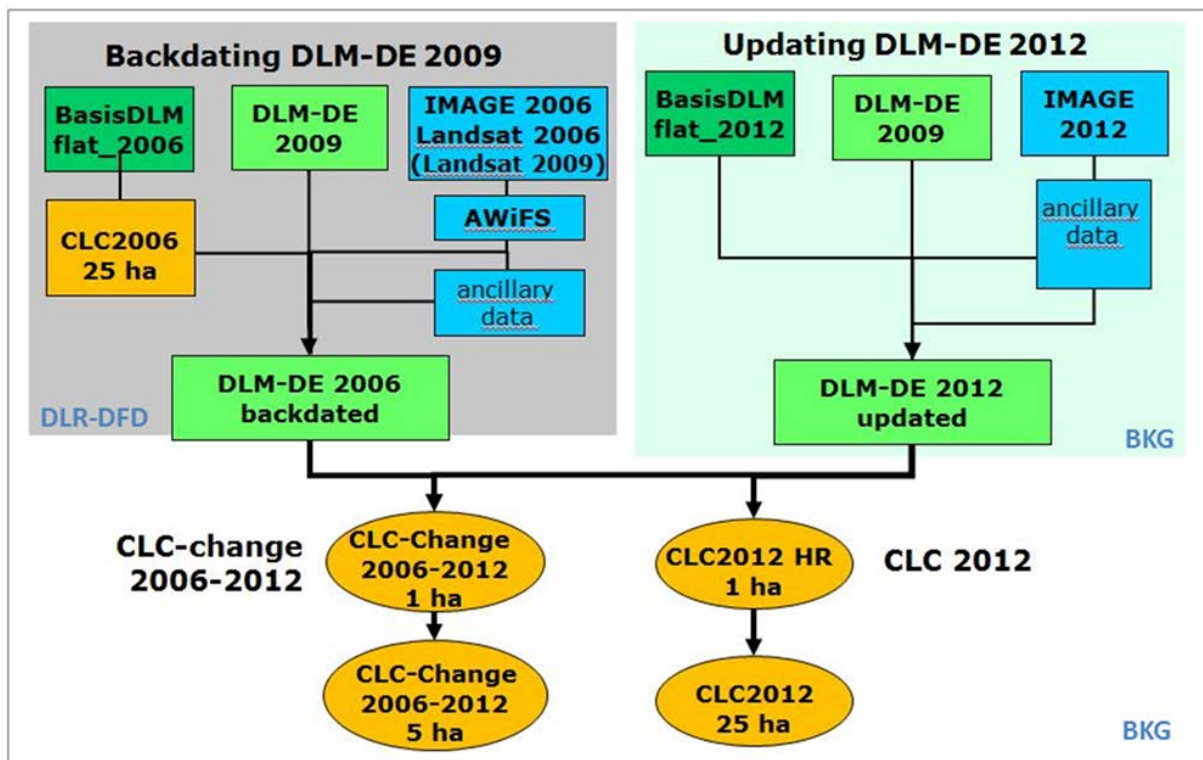
3.1 Project objectives

For the update 2012 of land cover according to CORINE Land Cover classes, a specific national approach has been chosen in Germany. This approach uses the more accurate geometry of the Official Topographical Cartographic Information System ATKIS of the land survey authorities. The "Digital Land Cover Model" DLM-DE, derived from ATKIS, was applied as base for the deduction of CLC classes. In the responsibility of the German Federal Agency for Cartography and Geodesy (BKG), the DLM-DE 2009 database was built-up for the reference year 2009 with a minimum mapping unit (MMU) of 1 ha. DLM-DE 2009 was the starting layer for BKG, to create an updated database DLM-DE 2012 (called now LBM-DE 2012) by the integration of updated Basis-DLM information from the Fed-

eral countries and in addition satellite image information from the status of July 2012. Using methods of generalization, this database was transferred into the CLC2012 database (CORINE Land Cover 2012, having 25 ha MMU due to the EU specifications).

Besides CLC2012, a change layer of land cover between 2006 and 2012 was needed which describes the development of land cover categories (with 5 ha MMU). The update of DLM-DE 2009 to the year 2012 granted only directly the deduction of changes between 2009 and 2012. A comparison of changes of the conventionally derived CLC2006 (with 25 ha MMU) with DLM-DE 2009 or LBM-DE 2012 would have mainly yield differences because of different geometries. Therefore it was necessary to derive spatial information on the changes between 2006 and 2009 regarding the more detailed geometry of DLM-DE 2009.

The modelling of changes between 2006 and 2009 in the detailed geometry of DLM-DE 2009 was task of DLR's German Remote Sensing Data Center (DFD). For that purpose, a database "CLC2006_backdating" had to be created by a "backward look" from DLM-DE 2009 to the situation of land cover / land use in 2006. The combination of sub-projects at DLR-DFD and BKG to derive all necessary products can be derived by the data flow below.



3.2 Methodology

The backdating was done by an approach including the 46 most common change classes (based on the changes between 2000 and 2006). As far as possible, automatic or semi-automatic methods were used.

Concerning the expected large number of changes within agricultural areas, it was very helpful to use multi-seasonal satellite data of the AWiFS time series from 2005 / 2006. The multi-seasonal data delivers information about the different phenological behavior of arable fields in comparison to grasslands. Temporal statistic values acquired from the NDVI vegetation index (from AWiFS) were

used for a separation of arable land against grassland. In addition, high resolution geo-information products created within the GMES / Copernicus program were used, e. g. two variants of the soil sealing layer 2006. Furthermore, interim layers derived from high resolution thematic raster products were generated for the status 2006, e. g. a water mask and several forest layers.

For the derivation of change areas concerning the main change classes, a combination of several approaches was applied: Particularly the calculation of zonal statistics; segmentations of high resolution LISS-III data (summer and spring) of the IMAGE2006 database and Landsat summer data, using the geometry of the polygons of DLM-DE 2009, and a combination of geometric segmentation information and thematic raster information of the status 2006. Final steps of interactive checks and manual corrections significantly improved the automatically created change database. An area-wide product of the status of 2006, called CLC2006_backdating, was delivered to BKG. The product comprises the polygons of modelled changes larger than 1 ha and a combined data base.

3.3 An exemplary Result

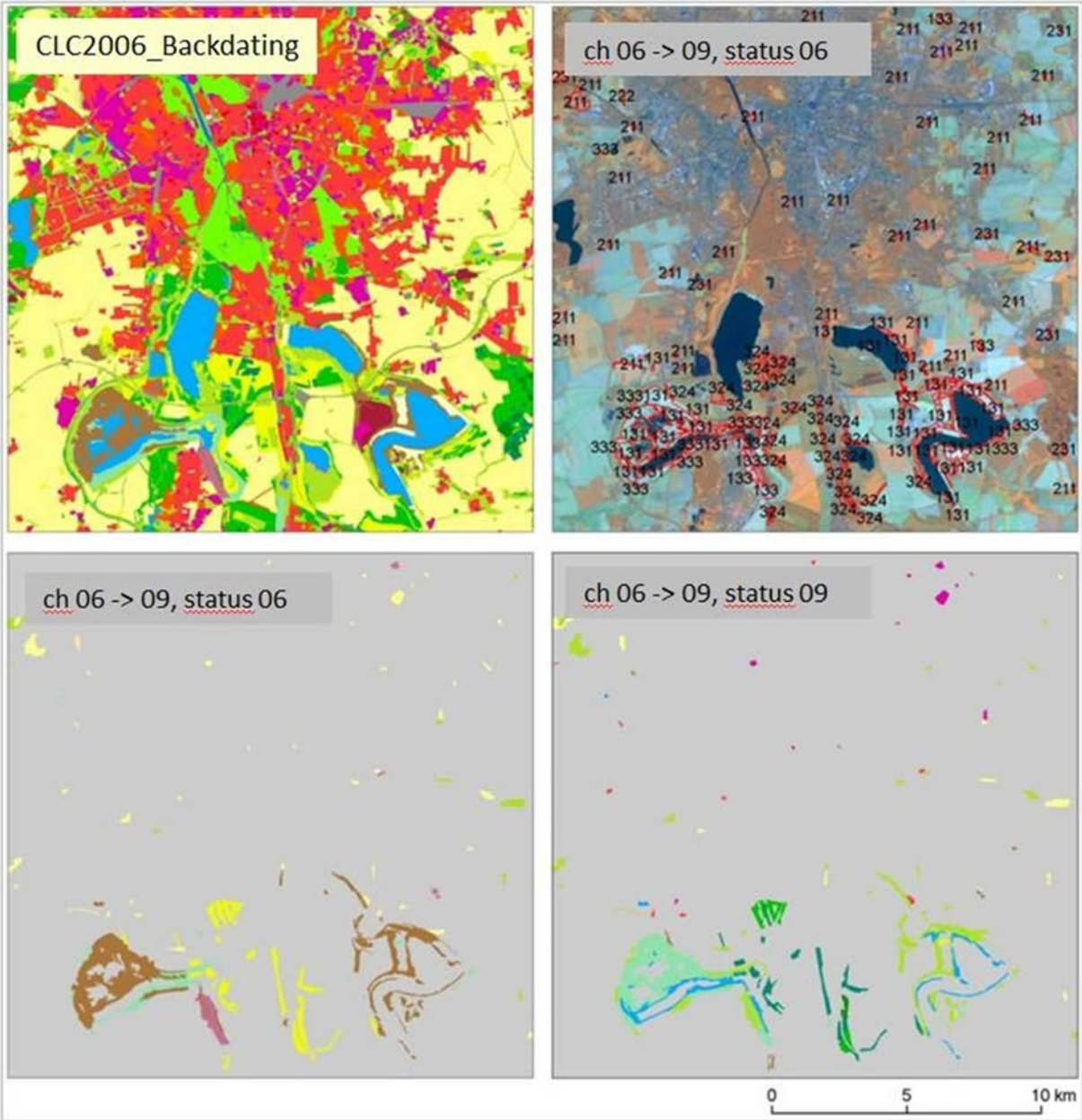


Figure: Exemplary results of CLC2006_Backdating for the South of Leipzig region and the new Leipzig lakelands: Development of numerous water bodies and recreation areas as a result of re-cultivation and re-naturation of former lignite open-pit mines. Upper left: CLC2006_Backdating dataset, color codes see CLC legend; upper right: LISS-III summer scene with overlay of change areas and the codes for the status 2006; lower left: changes between 2006 and 2009 in the status of 2006; lower right: changes between 2006 and 2009 in the status of 2009 (color codes see CLC legend as well). Source satellite data: Copyright ANTRIX, Euromap / GAF AG (LISS-III).

The project "Updating the Land Use and Land Cover Database CLC for the Year 2012 - "Backdating" of DLM-DE of the Reference Year 2009 to the Year 2006" was funded under the registration number UBA FKZ 3712 12 282 by the Federal Environment Agency. It was performed in a co-operation of DFD with BKG, UBA and the European Environment Agency (EEA) in Copenhagen.

4 Reports & Publications:

Keil, M., Esch, T., Divanis, A., Marconcini, M., Metz, A., Ottinger, M., Voinov, S., Wiesner, M., Wurm, M., Zeidler, J. (2015a): Updating the Land Use and Land Cover Database CLC for the Year 2012 - 'Backdating' of DLM-DE of the Reference Year 2009 to the Year 2006. Final Report at the German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), Oberpfaffenhofen, on behalf of the Federal Environment Agency. TEXTE 37/2015. Environmental Research of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety; Project No. (FKZ) 3712 12 282 Report No. (UBA-FB) 002086/E. Publisher: Umweltbundesamt, Dessau-Roßlau, Germany.

[> Report as pdf-file](#)

Keil, M., Esch, T., Divanis, A., Marconcini, M., Metz, A., Ottinger, M., Voinov, S., Wiesner, M., Wurm, M., Zeidler, J. (2015b): Aktualisierung der Landnutzungs- und Landbedeckungsdaten CLC für das Jahr 2012 - 'Backdating' des DLM-DE vom Referenzjahr 2009 zurück auf das Jahr 2006. Abschlussbericht am Deutschen Zentrum für Luft- und Raumfahrt e.V., Deutsches Fernerkundungsdatenzentrum, Oberpfaffenhofen, im Auftrag des Umweltbundesamtes. TEXTE 36/2015. Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit; Forschungskennzahl 3712 12 282 UBA-FB 002086. Herausgeber: Umweltbundesamt, Dessau-Roßlau.

[> Report as pdf –file \(in German\)](#)

Keil, M., Esch, T., Feigenspan, S., Marconcini, M., Metz, A., Ottinger, M., and Zeidler, J. (2015c): Creation of a High-Resolution Product CLC2006_Backdating by a backward look from the Digital Land Cover Model DLM-DE2009 to 2006 - A Contribution to the German CORINE Land Cover 2012 Project within a Bottom-Up Approach, Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XL-7/W3, 1093-1100, doi:10.5194/isprsarchives-XL-7-W3-1093-2015, 2015. <http://www.int-arch-photogramm-remote-sens-spatial-inf-sci.net/XL-7-W3/1093/2015/isprsarchives-XL-7-W3-1093-2015.html> .

Keil, M., Bock, M., Esch, T., Metz, A., Nieland, S., Pfitzner, A. (2010): CORINE Land Cover Aktualisierung 2006 für Deutschland. Abschlussbericht zu den F+E Vorhaben UBA FKZ 3707 12 200 und FKZ 3708 12 200, Deutsches Zentrum für Luft- und Raumfahrt e.V., Deutsches Fernerkundungsdatenzentrum Oberpfaffenhofen, Januar 2010.

[> Report as pdf-file](#)

Keil, M., Kiefl, R., Strunz, G. (2005a): CORINE Land Cover 2000 - Germany. Final Report. German Aerospace Center, German Remote Sensing Data Center Oberpfaffenhofen, July 2005.

[> Report as pdf-file](#)

Keil, M., Kiefl, R., Strunz, G. (2005b): CORINE Land Cover 2000 - Europaweit harmonisierte Aktualisierung der Landnutzungsdaten für Deutschland. Abschlussbericht zum F+E Vorhaben UBA FKZ 201 12 209, Deutsches Zentrum für Luft- und Raumfahrt e.V., Deutsches Fernerkundungsdatenzentrum Oberpfaffenhofen, Mai 2005.

[> Report as pdf-file \(in German\)](#)

EEA (2000): CORINE Land Cover Technical Guide - Addendum 2000. European Environment Agency

[> document as pdf-file](#)

5 Collection of links:

In the following, a collection of links is added to deliver further information on organizations and on products concerning land cover in Germany and Europe.

Links to new land cover & land use products

CORINE Land Cover:

Dienstleistungszentrum BKG - Homepage (2016): Startseite > Open Data > CORINE Land Cover 10 ha (CLC10 2012)

[> www.geodatenzentrum.de](http://www.geodatenzentrum.de)

Umweltbundesamt, 2016: Themen: Boden, Landwirtschaft, Flächensparen, Böden und Landschaften erhalten, CORINE Land Cover CLC

[> www.umweltbundesamt.de](http://www.umweltbundesamt.de)

CLC2012 at Geoportal.de

[> www.geoportal.de](http://www.geoportal.de)

EUROPÄISCHES DATENPORTAL EUROPEAN DATA PORTAL (2016): Kataloge GDI-DE CORINE Land Cover 2012, 10 ha

[> www.europeandataportal.eu](http://www.europeandataportal.eu)

Land Cover Model LBM-DE:

Bundesamt für Kartographie und Geodäsie - German Federal Agency for Cartography and Geodesy, 2016: Land cover model for Germany (LBM-DE)

[> www.bkg.bund.de](http://www.bkg.bund.de)

Digital Land Cover Model for Germany LBM-DE2012

[> PDF](#)

Digital Land Cover Model for Germany DLM-DE2009

[> PDF](#)

Copernicus Land Monitoring Services:

Home Page

[> land.copernicus.eu](http://land.copernicus.eu)

Copernicus Land Monitoring Services - CORINE Land Cover:

[> Product](#)

Copernicus Land Monitoring Services - High Resolution Layers

[> Product](#)

CORINE Land Cover (Deutschland) as EOC Geoservice

EOC Geoservice News

[> Geoservice news](#)

CORINE Land Cover 2000 and 2006 as EOC Geoservice (Raster data product derivatives 100 m)

[> Corine land cover](#)

CORINE Land Cover 2000 and 2006 WMS Service

[> Land WMS](#)

Additional links to CORINE Land Cover

German Federal Environmental Agency (UBA)

[> http://www.umweltbundesamt.de](http://www.umweltbundesamt.de)

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

[> http://www.bmu.de/](http://www.bmu.de/)

European Environment Agency (EEA)

[> www.eea.europa.eu](http://www.eea.europa.eu)

Data and Maps at the European Environment Agency

[> www.eea.europa.eu](http://www.eea.europa.eu)

CORINE Land Cover 2006 seamless vector data at the European Environment Agency

[> www.esa.int](http://www.esa.int)

IMAGE2006 "Virtual Mosaic" of ESA

[> www.esa.int/spaceinimages](http://www.esa.int/spaceinimages)

Image 2000 & Corine Land Cover 2000 Project at Joint Research Centre

[> image2000.jrc.ec.europa.eu](http://image2000.jrc.ec.europa.eu)