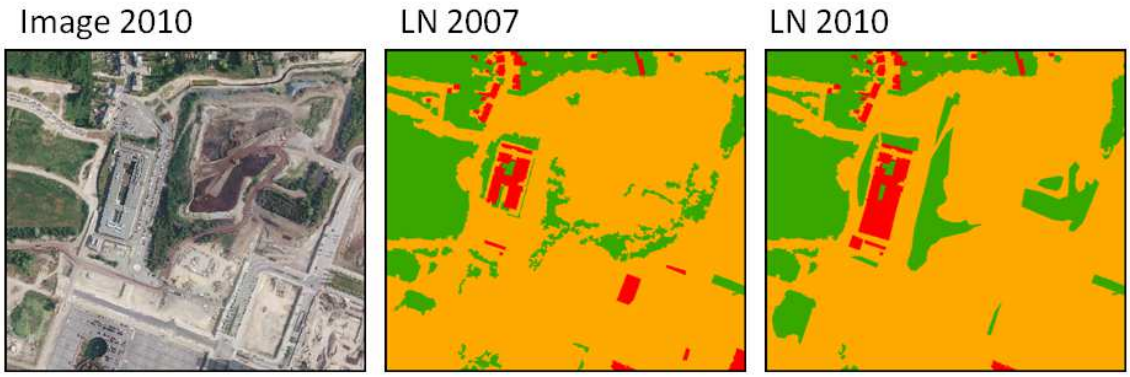
DIGITAL LAND USE MAP FROM ORTHOPHOTOS IN LUXEMBOURG

- Deliverable: Status 2010 -

Technical Information



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Inhalt

1 General overview of the project

This report describes the deliverable of the Digital Land Use Map for Luxembourg for the reference year 2010.

The 2010 land use map, more specifically the map of buildings and other artificial land in and around the urban perimeter, is an update of the 2007 (2004, 2001) classification.

1.1 Interpretation area

The interpretation area is based on the urban perimeters (delivered by CEPS) already prepared for the previous data sets.

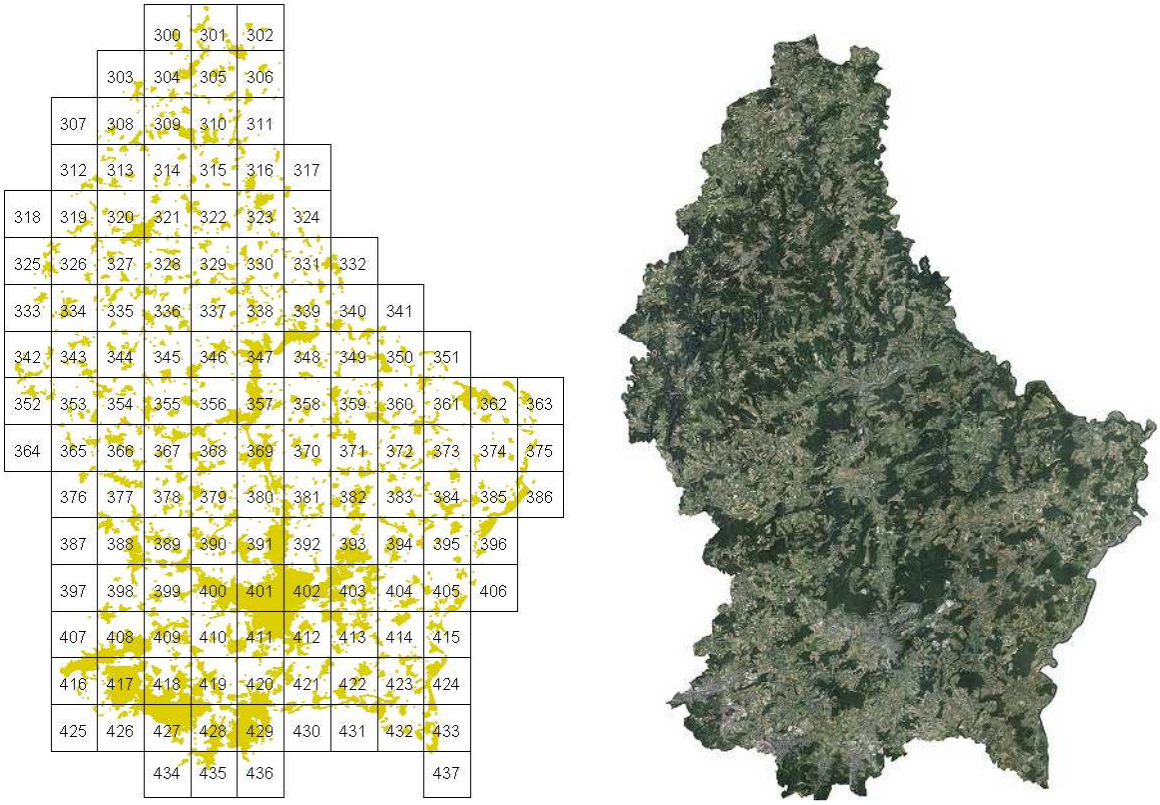


Figure 1 ***(left) interpretation area of Luxembourg in yellow, the cells define the working units, (right) Luxembourg in RGB-orthophoto mosaics of 2010 (ortho2010.ecw)***

1.2 Input data sets

- Digital RGB orthophotos of the years **2010**, 2007, 2004 and 2001
- Land use map (buildings) from 2007
- For some communes: construction permit database (vector)

1.3 Deliverables 2010

Buildings and other artificial surfaces are classified according to the following technical specifications:

- Artificial surfaces
    - Buildings (>25 m²) .....-gridcode "1"
    - Other artificial surfaces (>100 m²).....-gridcode "2"
- Non-artificial surfaces (>100 m²)..... -gridcode "3"

Linear elements (rivers, roads) are mapped if they are wider than 3m (minimum mapping width). When new buildings were found outside the LN2007 dataset, they were mapped as well (this is different to the previous versions). New important streets and construction sites, connected to the urban areas, were added.

1.4 Definition of thematic classes

- 1.1. Buildings ("1"): buildings of all types of use with a minimum area of 25 m².
- 1.2. Other artificial surfaces ("2"): roads, railways and other artificial surfaces (e.g. parking lots, construction sites, mining areas) with a minimum area of 100 m² and a minimum width of 3 m
  Road areas are classified according to their visibility in the orthophotos.
- 2. Non-artificial surfaces ("3"): those areas include all vegetated areas (e.g. gardens, meadows, pasture, forest) and other non-artificial land without vegetation (e.g. cropland, rocks, water) within the mapped area.

Also the following guaranteed quality criteria were met:

- 95% overall thematic accuracy of land use map
- 95% individual accuracy of buildings
- 90% individual accuracy of other artificial surfaces

2 Product description

The LN2010 is an update of the LN2007 classification by human photo-interpretation using images (orthophotos) from 2010 and 2007.

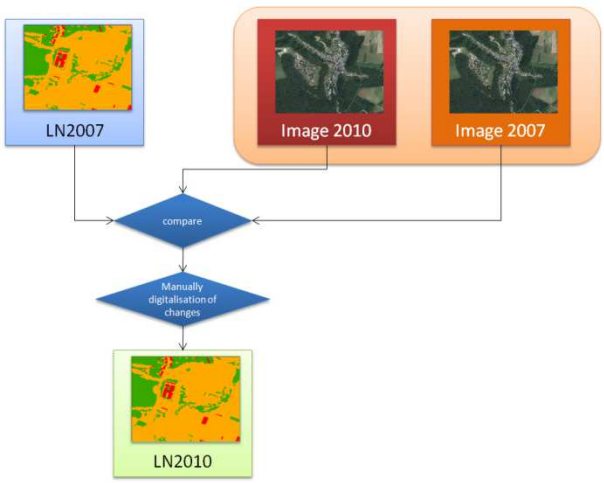


Figure 2 Workflow – LN2010 classification

The most time-consuming step was the detection of changes between both aerial images. For some communes we received the construction permits in vector format. Therefore a target-oriented update of buildings was possible for those regions.

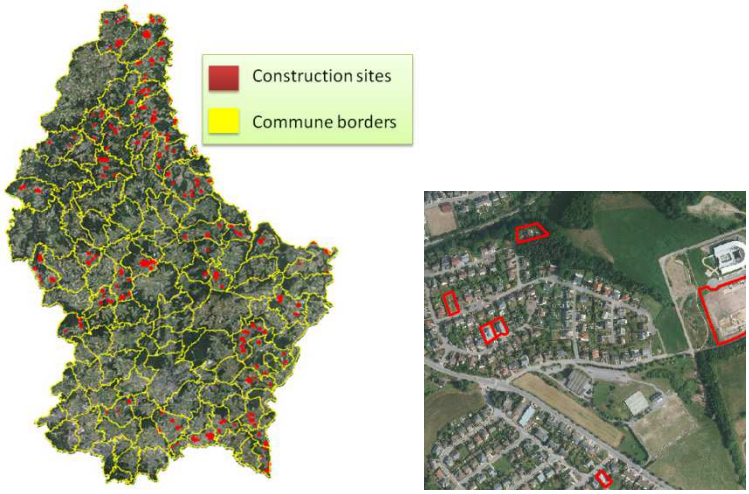


Figure 3 Location of construction sites (from construction permit database)

Unfortunately, the construction permit database was not available for all communes, as originally planned to streamline the “search” for new buildings. The target-oriented approach could be implemented for less than half of the Luxembourg communes.

A minor issue was that not for all registered building permits the construction had been finished or in some cases not even started at the time of the aerial image acquisition.

A more severe problem is related to the fact that the construction permits did not cover all actual new constructions. In all communes additional new constructions were found, often related to agricultural and industrial buildings. This last issue was a major driver in the interpretation effort.

Due to the lack of a construction permit register for the majority of the communes a much more time-consuming change detection was necessary. A second working grid (1x1km) was produced. All communes for which no construction information was available were manually checked grid-cell by grid-cell.

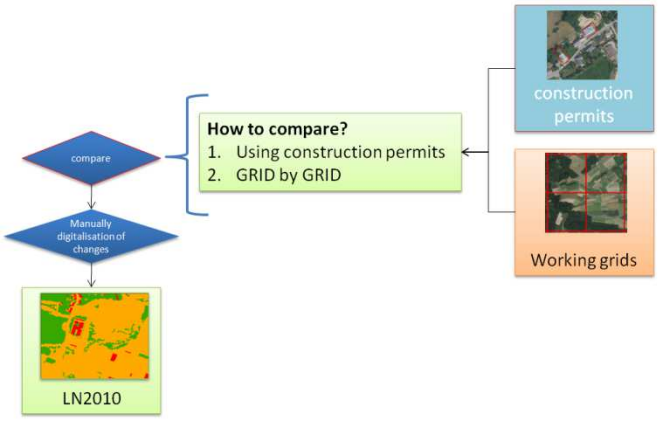


Figure 4 Workflow – change detection

All new changes in the building class (1) were attributed with "1" in the "CHANGE" attributes. Because of a subsequent dissolving of features, an entire block of connected houses gets the value "1" even when only a small area was changed.

NB: Generally, the 2007 database and the images of 2007 and 2010 were also checked for mistakes in the 2007 land use map (e.g. missing buildings, wrong outlines). If such mistakes were detected they were corrected in the new 2010 land use map. By consequence, there are changes between the 2007 and the 2010 maps that are no real but technical changes. To account for this issue and allow a better change detection the attribute "CHANGE" was introduced. Therein, a value of "1" corresponds to a real change in class "1".

2.1 Product limitations

Because of the construction of the different LN classifications (2010, 2007, ...) some limitations should be noted:

- The classification of classes 2 and 3 is restricted to the urban perimeter. Therefore only changes inside classification areas (buffers) between the years can be compared, i.e. it is not valid to say that the total of "other artificial land" in Luxembourg has an area of X hectares. The total is not known, only the part inside the urban perimeter.
- A high number of buildings has been demolished. Therefore it is possible to get a change from class 1 to class 2 (or class 3).
- The master classification is based on automatic image segmentation and the new LN2010 is digitised manually. Therefore the ground plot of buildings can be a mixture of straight, manually digitised and more natural, i.e. spectrally segmented objects.
- In some cases streets and other land elements were improved to get a better structure.
- Because of the tiling by the 5x5km GRID elements, smaller MMU (25m²) can exist at the borders.

3 Description of delivery

3.1 Final products

Following products were delivered:

Table 1 Delivery overview

ID	Product	Info	Name
1	LN2010 classification	Personal feature database	LN2010.mdb
		135 single polygon feature	*LN & "number of working unit" & lux2010*
2	Lux-GRID (working units)	1 GRID (5x5 km)	working_units_5x5km
3	Removed building	All features, which were removed are put in this file	Removed_buildings

3.1.1 Delivery product ID 1 – LN2010

The main product is the Digital land use map for 2010. The new classification is stored in form of a personal geodatabase (*.mdb) "LN2010".

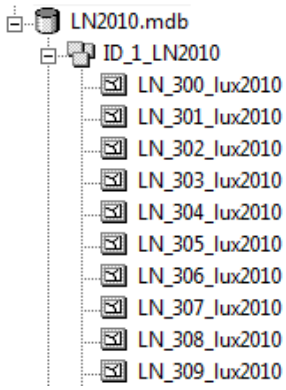
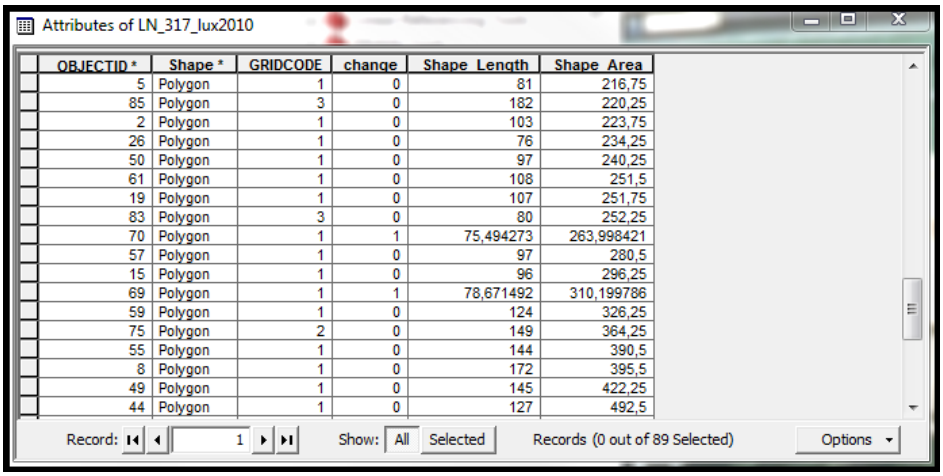


Figure 5 Example: Personal Geodatabase (LN2010.mdb)

A Personal feature database with 135 feature classes of the mapping results:
LN & "number of working unit" & lux2010.shp

The datasets are the result of a manual land use classification update of the LN2007 classification. The change features were manually updated using the new orthophotos from 2010.
This means the pixel structure follows the outlines of the orthophoto, mixed with the manually drawn features.
All together 390 km² were mapped. The final results are delivered in the national LUREF projection.
The attribute tables appear in the following structure:

- Column „ID": unique identification number for each polygon
- Column „Gridcode": land use code
  - „1" = 1.1 Buildings (>25 m²)
  - „2" = 1.2 Other artificial surfaces
  - „3" = 2 Non-artificial surfaces
- Column "Change":
  - "0" no new 1.1 buildings
  - "1" new 1.1 buildings



OBJECTID *	Shape *	GRIDCODE	change	Shape_Length	Shape_Area
5	Polygon	1	0	81	216,75
85	Polygon	3	0	182	220,25
2	Polygon	1	0	103	223,75
26	Polygon	1	0	76	234,25
50	Polygon	1	0	97	240,25
61	Polygon	1	0	108	251,5
19	Polygon	1	0	107	251,75
83	Polygon	3	0	80	252,25
70	Polygon	1	1	75,494273	263,998421
57	Polygon	1	0	97	280,5
15	Polygon	1	0	96	296,25
69	Polygon	1	1	78,671492	310,199786
59	Polygon	1	0	124	326,25
75	Polygon	2	0	149	364,25
55	Polygon	1	0	144	390,5
8	Polygon	1	0	172	395,5
49	Polygon	1	0	145	422,25
44	Polygon	1	0	127	492,5

Figure 6 Attribute example

3.1.2 Delivery product ID 2 – working units

Structure of the working units:

For production the working unit mosaics of 5x5 km tiles from the 2007 classification were used.

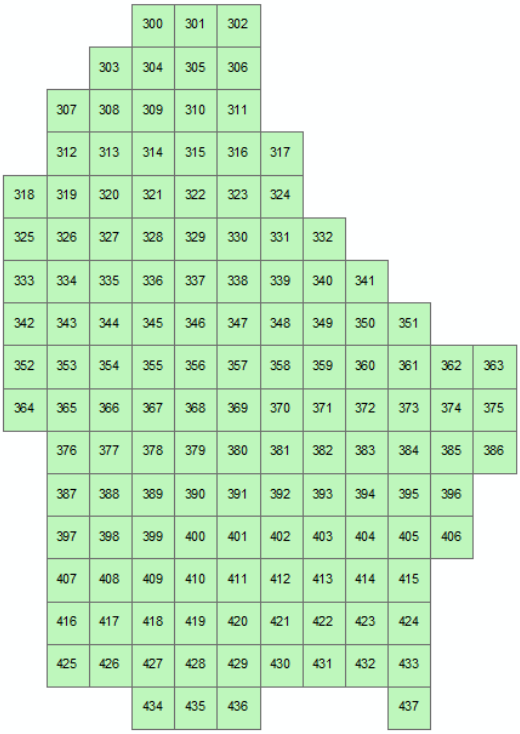


Figure 7 Working Units / tiles

3.1.3 Delivery product ID 3 – removed building

Between 2010 and 2007 a lot of changes were mapped. Where buildings were demolished between 2007 and 2010 the removed buildings were exported to a separate layer “removed buildings”.

Figure 8 Example: Removed buildings

4 Quality control

A verification of the product was done by a second interpreter. No major errors were found.

ANNEX

Table 2 Delivery of new construction information for following communes

FID	COMMUNE	Kanton	District
1	Beaufort	Echternach	Grevenmacher
2	Berdorf	Echternach	Grevenmacher
3	Bettembourg	Esch-sur-Alzette	Luxembourg
4	Betzdorf	Grevenmacher	Grevenmacher
5	Bissen	Mersch	Luxembourg
6	Boevange/Attert	Mersch	Luxembourg
7	Boulaide	Wiltz	Diekirch
8	Bous	Remich	Grevenmacher
9	Consthum	Clervaux	Diekirch
10	Dalheim	Remich	Grevenmacher
11	Ell	Rédange	Diekirch
12	Ermsdorf	Diekirch	Diekirch
13	Eschweiler	Wiltz	Diekirch
14	Flaxweiler	Grevenmacher	Grevenmacher
15	Frisange	Esch-sur-Alzette	Luxembourg
16	Goesdorf	Wiltz	Diekirch
17	Heffingen	Mersch	Luxembourg
18	Heinerscheid	Clervaux	Diekirch
19	Hesperange	Luxembourg	Luxembourg
20	Hobscheid	Capellen	Luxembourg
21	Hosingen	Clervaux	Diekirch
22	Kiischpelt	Wiltz	Diekirch
23	Larochette	Mersch	Luxembourg
24	Lenningen	Remich	Grevenmacher
25	Manternach	Grevenmacher	Grevenmacher
26	Medernach	Diekirch	Diekirch
27	Munshausen	Clervaux	Diekirch
28	Preizerdaul	Rédange	Diekirch
29	Putscheid	Vianden	Diekirch
30	Reckange/Mess	Esch-sur-Alzette	Luxembourg
31	Remerschen	Remich	Grevenmacher
32	Roeser	Esch-sur-Alzette	Luxembourg
33	Rosport	Echternach	Grevenmacher
34	Saeul	Rédange	Diekirch
35	Tandel	Vianden	Diekirch
36	Troisvierges	Clervaux	Diekirch
37	Weiswampach	Clervaux	Diekirch
38	Wellenstein	Remich	Grevenmacher
39	Winseler	Wiltz	Diekirch