DIGITAL LAND USE MAP FROM ORTHOPHOTOS IN LUXEMBOURG

- Deliverable: Status 2013 / Revision December 2015 -

Technical Information

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1 General overview of the project

This report describes the deliverable of the Digital Land Use Map for Luxembourg for the reference year 2013.

The 2013 land use map, more specifically the **map of buildings and other artificial land** in and around the urban perimeter, is an update of the classifications from 2010 (2007, 2004, 2001) .

1.1 Interpretation area

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

For technical reasons, the total territory was subdivided into working units of 5x5 km.

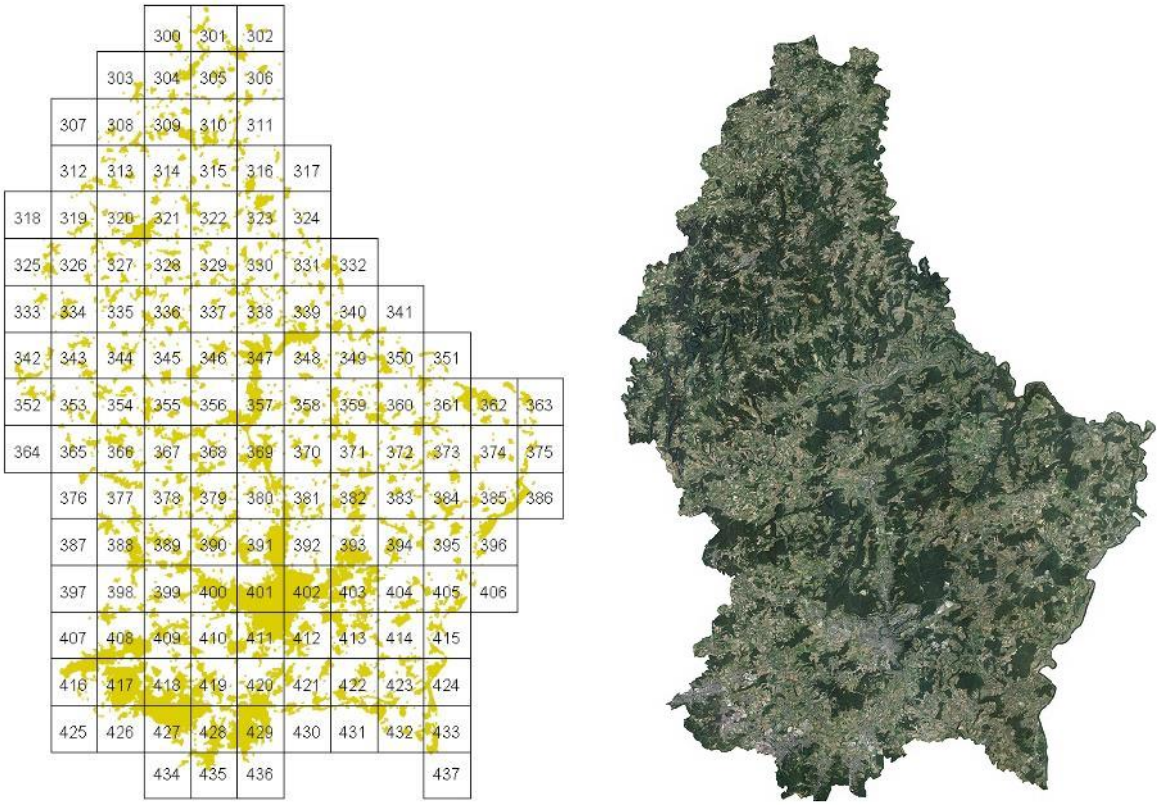

Figure 1-1 ***(left) interpretation area of Luxembourg in yellow, the cells define the working units, (right) Luxembourg in RGB-orthophoto mosaics of 2013 (Ortho2013_RGB.ecw)***

1.2 Input data sets

- Digital RGB orthophotos of the years **2013**, 2010, 2007, 2004 and 2001
- Land use map (buildings) from 2010 (LN2010)

1.3 Deliverables 2013

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

- Artificial surfaces
    - Buildings (>20 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 have been mapped as well. New important streets and construction sites, connected to the urban areas, were added.

Removed buildings (between 2010 & 2013) have been identified in a separate dataset "ID_3_Removed_Buildings/removed_buildings_2013".

1.4 Definition of thematic classes

- 1.1. Buildings ("1"): buildings of all types of use with a minimum area of 20 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 LN2013 is an update of the LN2010 classification by human photo-interpretation using images (orthophotos) from 2013 and 2010.

The most time-consuming step was the detection of changes between both aerial images. Every working unit was checked cell by cell.

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 is assigned the value “1” even when only a small area was changed.

NB: Generally, the 2010 database and the images of 2010 and 2013 were also checked for mistakes in the 2010 land use map (e.g. missing buildings, wrong outlines). If such mistakes were detected they were corrected in the new 2013 land use map. By consequence, there are changes between the 2010 and the 2013 maps that are no real but technical changes. To account for this issue and to allow a better change detection the attribute “CHANGE” was introduced. Therein, a value of “1” corresponds to a real change in class “1”. Technical changes are coded with a value of “2”.

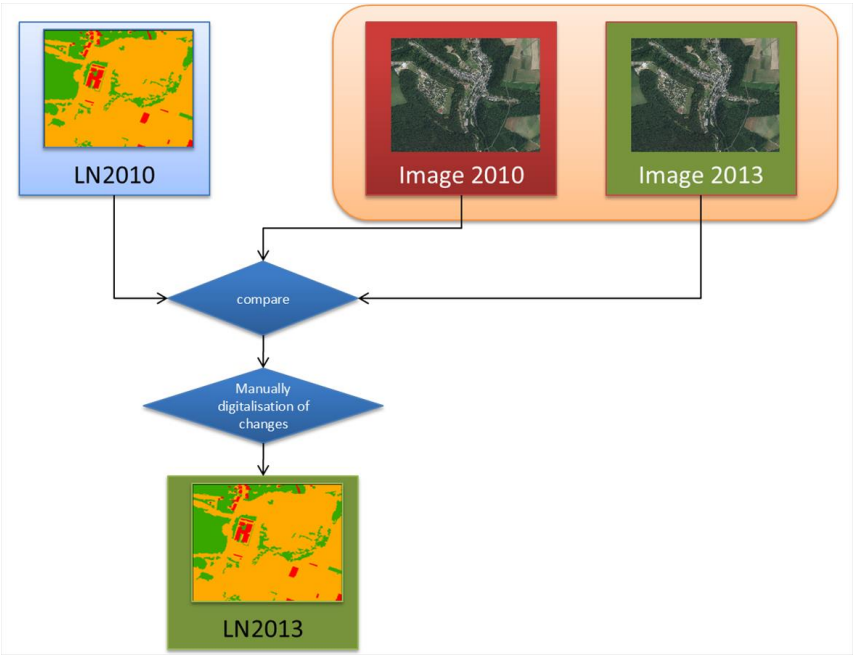

Figure 2-1 Workflow – LN2013 classification

2.1 Product limitations

Because of the construction of the different LN classifications (2013, 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 LN2013 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 (i.e. working units), smaller MMU (25m²) can exist at the borders.

3 Description of delivery

3.1 Final products

The following products are delivered:

Table 3-1 Delivery overview

ID	Product	Info	Name
1	LN2013 classification	ESRI file geo-database	LN2013_file_geodatabase_REVISION.gdb
		- 135 single polygon features (i.e. working units) - LN_2013_full_Luxembourg_REVISED	- LN & "number of working unit" & lux2013_rev - Merged classification of Luxembourg
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_2013

3.1.1 Delivery product ID 1 – LN2013

The main product is the Digital land use map for 2013. The new classification is stored in form of a file geo database (*.gdb) with three different feature datasets:

Figure 3-1 Example: File Geodatabase (LN2013.gdb)

- ID_1_LN2013 → the final classification by divided by working units
  →"LN_2013_full_Luxembourg_REVISED" a full classification cover of Luxembourg
- ID_2_working_units → the working unit grid layer
- ID_3_Removed_Buildings → the layer with all removed buildings between 2010 & 2013

The datasets are the result of a manual land use classification update of the LN2010 classification. The change features were manually updated using the new orthophotos from 2013.
This means the pixel structure follows the outlines of the orthophoto, mixed with the manually drawn features.
All together 405 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 (>20 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
- "2" technical change

	OBJECTID *	Shape *	GRIDCODE	change	area in ha	Shape_Length	Shape_Area
	4	Polygon	1	1	0,002589	22,191372	25,892904
	268	Polygon	1	2	0,006384	32,32976	63,843958
	546	Polygon	2	0	0,007425	56	74,25
	292	Polygon	1	2	0,007643	36,525272	76,426871
	180	Polygon	1	2	0,009116	38,495031	91,164272
	223	Polygon	1	2	0,009409	39,257584	94,086204
	105	Polygon	1	2	0,009999	54,539173	99,992636
	90	Polygon	1	2	0,01006	40,225558	100,597881
	5	Polygon	1	2	0,010685	58,516039	106,8484
	263	Polygon	1	2	0,011426	45,92083	114,26327
	233	Polygon	1	2	0,012098	44,305769	120,976146
	549	Polygon	1	1	0,012729	50,233532	127,288321
	359	Polygon	1	2	0,013253	61,374254	132,531985

Figure 3-2 Attribute example

The following tables show the distribution of the three different classes in the mapped area:

Table 3-2 Distribution of the three different classes

gridcode	class name	area [km²]	[%]
1	buildings	45.13	11,2
2	other artificial surfaces	94.14	23,2
3	non-artificial surfaces	265.88	65,6
Total		**405,15**	100%

3.1.2 Delivery product ID 2 – working units

Structure of the working units:

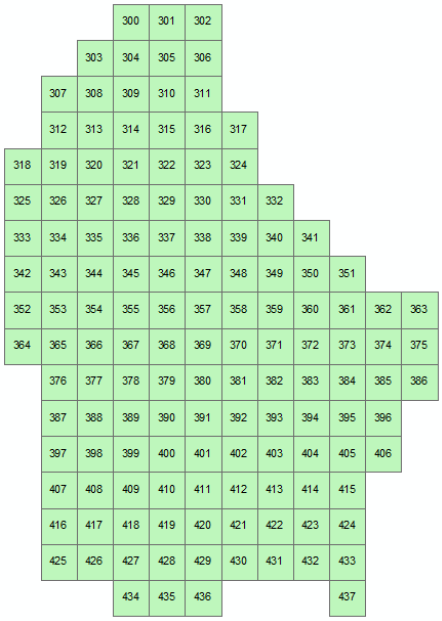

Figure 3-3 Working Units / tiles

For the production the working unit mosaics of 5x5 km tiles from the 2010 classification were used.

3.1.3 Delivery product ID 3 – removed buildings

Between 2013 and 2010 a lot of changes were mapped. Where buildings were demolished between 2010 and 2013 the removed buildings were exported to a separate layer “removed buildings”.

Figure 3-4 Example: Removed buildings