Final Report

Copernicus Land Monitoring 2014 – 2020 in the framework of Regulation (EU) No 377/2014 of the European Parliament and of the Council of 3 April 2014

Specific Contract No 3436/R0-COPERNICUS/EEA. 56950

Implementing Framework service contract No

EEA/IDM/R0/16/009/NL

Netherlands

Tasks:

1. **Verification** of 2012 reference year local component products and enrichment of Urban Atlas (if applicable)	**Y**
2. Production of **CLC** for the 2018 reference year	**Y**
3. Post-production **verification** of the High Resolution Layers (HRL's) for the 2015 reference year	**Y**
4. **Dissemination**	**Y**

1. Background

The technical proposal "Copernicus Land Monitoring Services – Netherlands (CopNL Land). CLC2018 production, verification of VHRLs 2012 and HRLs 2015" submitted in July 2017 is the basis for the work described in this final report. The work falls under Specific Contract No 3436/R0-COPERNICUS/EEA. 56950 which is the first contract under the signed Framework Service Contract EEA/IDM/R0/16/009/Netherlands for the Copernicus Land monitoring services – NRCs LC (National Reference Centres for Land Cover) Copernicus supporting activities for the period 2017-2021.

The above mentioned tasks deal with the Dutch national territory (41.528 km2) with exception of the overseas territories (BES islands, i.e. Bonaire, St. Eustatius and Saba islands). The tasks were performed by Wageningen Environmental Research (WENR) which also provides the Dutch NRC for Land Cover. The experts involved in the project were:

- Maarten Storm – metadata and dissemination
- Rini Schuiling – preparation geodatabase UA, production enrichment UA2012, quality control CLC via CLC QC tool
- Gerard Hazeu – project manager, internal control, CLC production, verification HRL and verification local components
- Wouter Meijninger – verification local components and CLC2018
- Marian Vittek – internal control verification HRL

Due to the small team a national steering committee was not needed. The results and progress were regularly communicated with the Dutch NFP, Dutch Environmental Agency (PBL), ministry of Infrastructure and Water (I&W) and the Dutch Space Agency (NSO).

Next to the technical proposal the work described here is based on the following information provided in the tender documents (and/or more recent versions provided during the duration of the project:

- Guidelines for verification of Local component products (Annex 8 of the FSC tender documents)
- CLC2006 technical guidelines (Annex 9 of the FSC tender documents)
- CLC2012 Addendum to CLC2006 Technical Guidelines (Annex 10 of the FSC tender documents)
- Updated CLC illustrated nomenclature guidelines
- Guidelines for verification of high-resolution layers produced under GMES/Copernicus Initial Operations (GIO) Land monitoring 2011-2013 (Annex 11 of the FSC tender documents)

This report presents an overview of the work of the following three tasks falling under the above mentioned first service contract:

- Verification of VHRLs with reference year 2012 (local component products) and enrichment of Urban Atlas
- Production CLC for the reference year 2018
- Post-production verification HRL for the reference year 2015

Also the dissemination of the products is described in section 5 of this report (partly a copy of Deliverable 1.7).

Adjacent to this report more detailed technical reports were delivered dealing with the different tasks.

The local components products (section 2) verified were:

1. Urban Atlas (UA) 2012 status layer
2. Urban Atlas 2012 Street Tree Layer (STL)
3. Riparian Zones LCLU 2012 status layer (RZ)
4. Riparian Zones Green Linear Elements 2012 status layer (GLE)

The UA2012 dataset was enriched with land use data from the national land use dataset BBG2012 (section 2.2).

The production of CLC for the 2018 reference year (section 3) consisted of the following products:

1. CLC2018 dataset
2. Revised CLC2012 dataset
3. CLC-change 2012-2018 dataset
4. Metadata description according to INSPIRE

The HRLs falling under the following topics were verified (general overview, look and feel and statistical verification) (section 4):

1. Imperviousness (IMD)
2. Forest (TCD and DLT)
3. Grassland (Grass)
4. Wetness & Water (W&W)

2. Verification of local component and enrichment of Urban Atlas (if applicable)

2.1 Verification local component

The aim of the country verification was two-fold:

1. To provide complementary information to the systematic quantitative validation results provided by the European validation exercise.
2. Support the best possible familiarization with VHR land cover data by national actors while performing systematic & thematic quality assessment on the data in a harmonized way.

The verification of the Copernicus local component products included a combined look and feel and a quantitative validation assessment. The protocol followed in the verification is described in Chapter 4 of the draft guidelines for local component products of 2012 (Annex 8 of the FSC tender documents). LACO-WIKI was used for the verification of the local products.

The products verified were:

1. Urban Atlas (UA) 2012 status layer
2. Urban Atlas 2012 Street Tree Layer (STL)
3. Riparian Zones LCLU 2012 status layer (RZ)
4. Riparian Zones Green Linear Elements 2012 status layer (GLE)

The local component product Natura 2000 (N2K) was not available for the Netherlands.

A random stratified sampling was performed with at least a minimum number of samples per LC/LU class (minimum 10 samples for the layers UA, RZ LC/LU; minimum 100 samples for the single class UA STL layer; and a minimum of 25 samples per RZ GLE layer class). On basis of the minimum number of samples LACO-WIKI generated two vector layers:

1. Layer of randomly selected sample polygons
2. Layer of sample points (one point in each sample polygon)

Google Earth and Bing Map imagery, Open Street Map, Copernicus 2012 data and national aerial photos, topographical and land cover/use data were used as reference data for the verification/validation of the products.

These layers were displayed over the reference data and the interpreter was asked to provide information on the following characteristics:

- Correctness of LC/LU code around the sample point
- Correctness of delineation of the sample polygon
- Comment as a free text characterizing the sample polygon
- Flag for interesting potential screenshots

The final report delivered contained detailed information on the metadata and an overall characterization of the dataset and different classes (area covered, number of selected samples per LC/LU class, correctness of LC/LU code and correctness of delineation, characterization of the class and examples of typical mistakes).

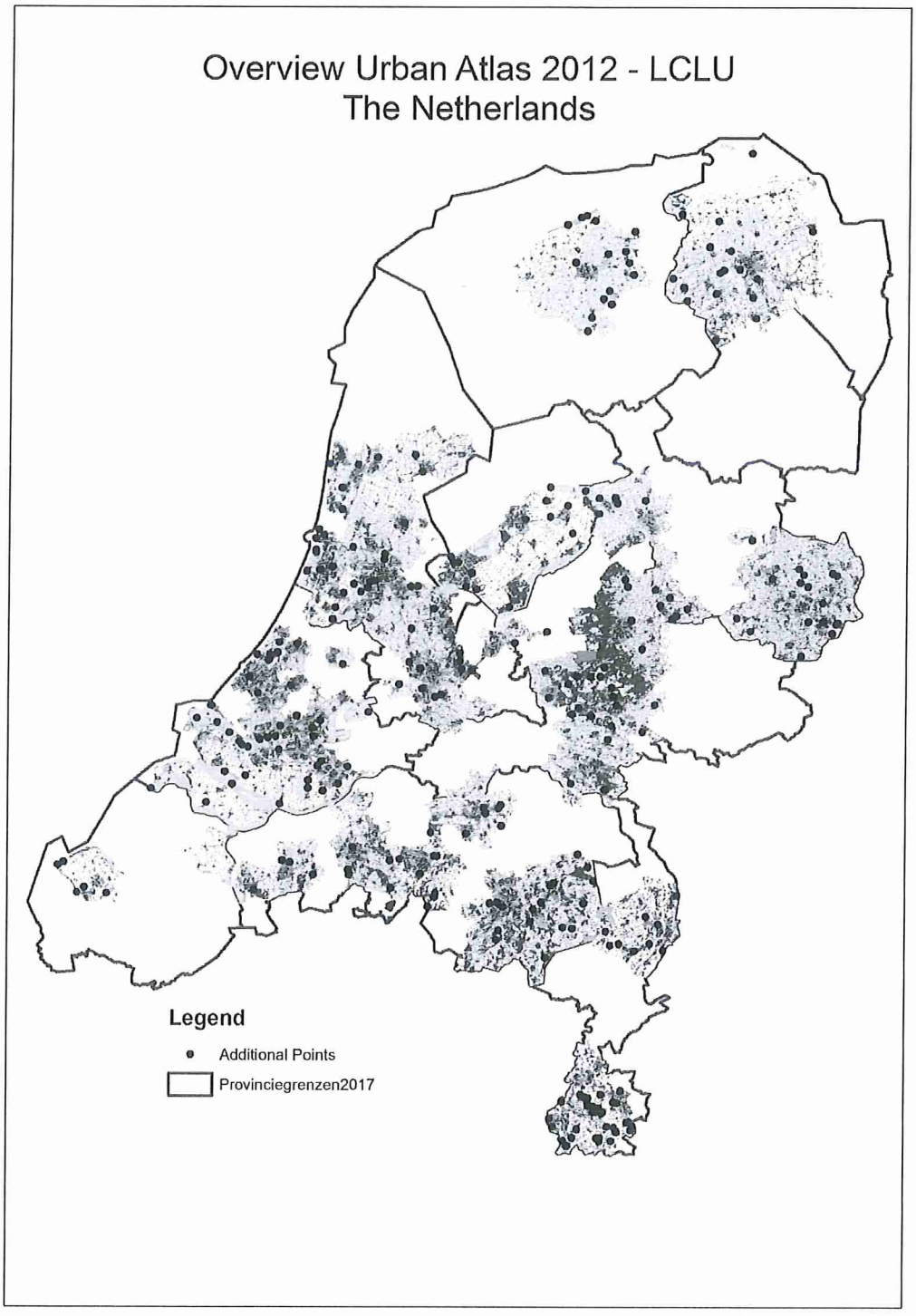

Figure 1. Overview of the areas covered by UA2012 and the sample points.

UA2012 and UA2012 Street Layer (STL)

The UA2012 dataset covers approximately 17220 km2 which is 41.5% of the territorial land surface of the Netherlands (including large water bodies) (see Figure 1). In total 270 samples were selected divided over 27 UA classes. Table 2 presents an overview of the number of correctly classified samples

per UA2012 class and their user and producer accuracies. The overall accuracy of the UA2012 dataset was 74.4% with low user accuracies for the classes 11100, 11240, 13300, 22000, 24000 and 25000 (lower than 50%). Of which all classes cover less than 1% of the area except class 11100. The inaccuracy of class 11100 is due to the fact of the overestimation of imperviousness in the city centres of the Netherlands. Classes 13400 and 25000 had extreme low producer accuracies. The STreet Layer (STL) has an overall accuracy of 83%. More detailed information on typical mistakes can be found in the detailed task reports, delivered February 6th, 2018. Furthermore the UA2012 dataset is characterised by unnecessary polygons that do not reflect the landscape. They seem to be an heritage of datasets that were merged.

Riparian Zone (RZ) LC/LU and RZ Green Linear Elements (GLE)

The RZ2012 dataset covers approximately 93330 km2 which is 22.5% of the territorial land surface of the Netherlands (including large water bodies) (see Figure 2). In total 590 samples were selected divided over 68 RZ classes. Not all classes had the minimum of 10 samples due to the fact they occupy really small surfaces. Table 2 presents an overview of the number of correctly classified samples per RZ2012 class and their user and producer accuracies. 354 samples were classified correctly which resulted in an overall accuracy of the RZ2012 dataset for The Netherlands of 89.1%.

Table 1. Overview of results related to the accuracy or correctness of LC/LU classification for the UA201 and UA2012 Street Layer datasets of The Netherlands (in red: UA2012 classes covering less than 1% of the total area covered by UA2012).

		number of samples	number of samples (correct)	overall accuracy (%)	overall accuracy (CI)	user accuracy (%)	user accuracy (CI)	producer accuracy (%)	producer accuracy (CI)
Urban Atlas 2012 dataset		270	191	74.4	1.3	-	-	-	-
11100	**Continuous urban fabric (IMD ≥ 80%)**	10	3	-	-	30.0	29.9	100.0	0.0
11210	**Discontinuous dense urban fabric (IMD 50% - 80%)**	10	9	-	-	90.0	19.6	62.5	16.8
11220	**Discontinuous dense urban fabric (IMD 30% - 50%)**	10	8	-	-	80.0	26.1	68.1	26.5
11230	**Discontinuous Low Density Urban Fabric (S.L. 10% - 30%)**	10	6	-	-	60.0	32.0	84.7	18.3
11240	**Discontinuous Very Low Density Urban Fabric (S.L. < 10%)**	10	3	-	-	30.0	29.9	100.0	0.0
11300	**Isolated structures**	10	8	-	-	80.0	26.1	90.2	11.9
12100	**Industrial, commercial, public, military and private units**	10	9	-	-	90.0	19.6	95.0	5.2
12210	**Fast Transit Roads and associated land**	10	9	-	-	90.0	19.6	100.0	0.0

12220	Other roads and associated land	10	10	-	-	100.0	0.0	99.1	1.8
12230	Railways and associated land	10	10	-	-	100.0	0.0	100.0	0.0
12300	Port Areas	10	10	-	-	100.0	0.0	97.1	5.5
12400	Airports	10	9	-	-	100.0	19.6	100.0	0.0
13100	Mineral extraction and dump sites	10	5	-	-	50.0	32.7	100.0	0.0
13300	Construction sites	10	2	-	-	20.0	26.1	100.0	0.0
13400	Land without current use	10	7	-	-	70.0	29.9	5.2	9.0
14100	Green urban areas	10	8	-	-	80.0	26.1	28.8	40.7
14200	Sports and leisure facilities	10	10	-	-	100.0	0.0	98.4	3.1
21000	Arable land (annual crops)	10	7	-	-	70.0	29.9	63.4	31.5
22000	Permanent crops	10	3	-	-	30.0	29.9	99.6	0.9
23000	Pastures	10	6	-	-	60.0	32.0	78.1	17.9
24000	Complex and mixed cultivation farms	10	1	-	-	10.0	19.6	93.1	15.1
25000	Orchards	10	3	-	-	30.0	29.9	1.0	1.3
31000	Forests	10	1	-	-	100.0	0.0	99.6	0.4
32000	Herbaceous vegetation associations	10	8	-	-	80.0	26.1	84.9	25.4
33000	Open spaces with little or no vegetation	10	9	-	-	90.0	19.6	100.0	0.0
40000	Wetlands	10	8	-	-	80.0	26.1	73.7	26.1
50000	Water	10	10	-	-	100.0	0.0	93.9	7.5
	Street Layer 2012 dataset	100	83	83.0	-	-	-	-	-

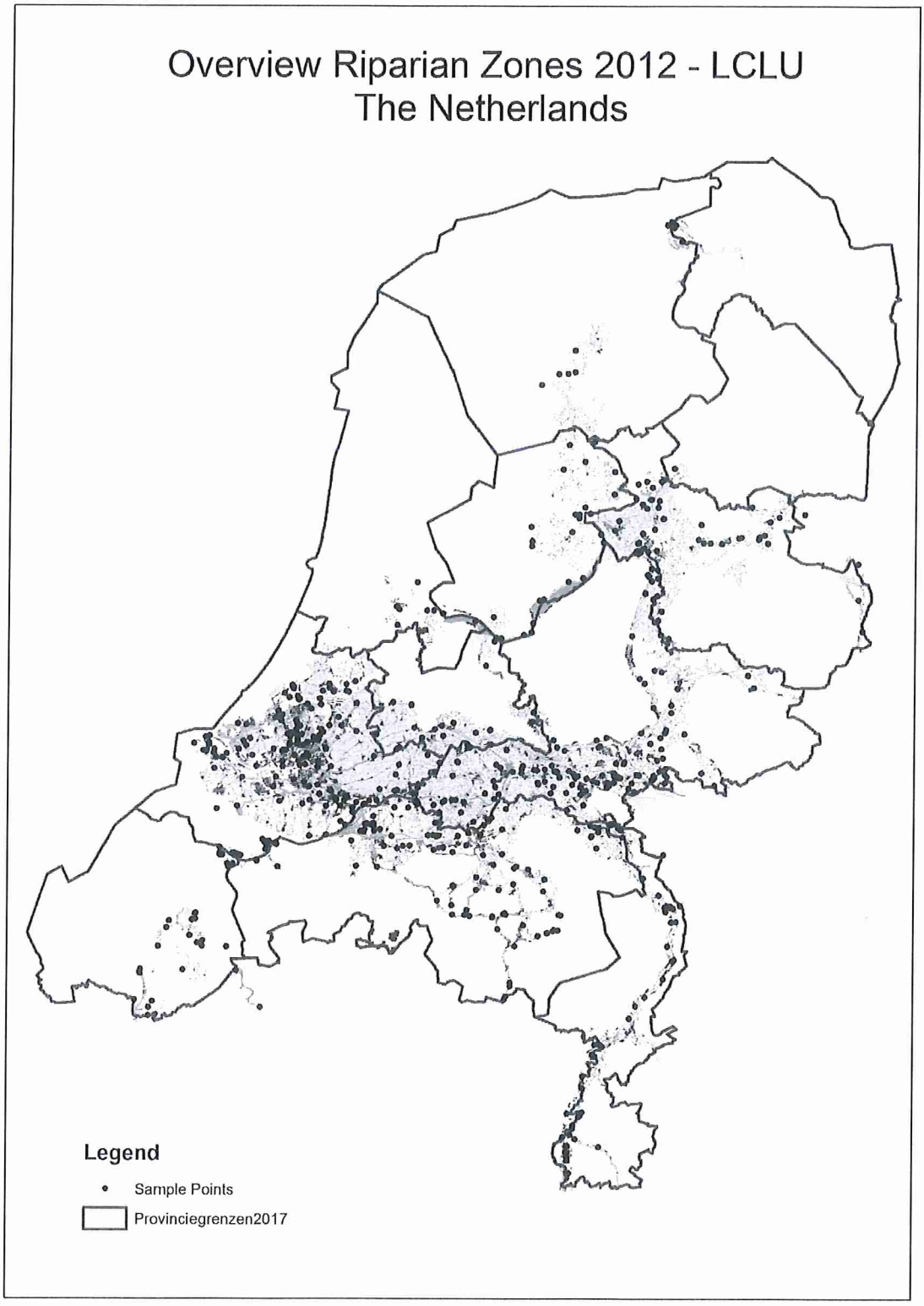

Figure 2. Overview of the areas covered by RIZ2012 and the sample points.

Table 2 presents an overview of the number of correctly classified samples per RZ2012 class and their user and producer accuracies. The table shows the 68 LC/LU classes present in the Dutch RZ LC/LU

dataset. Out of the 68 classes 10 classes over which 75 samples were distributed were judged as incorrectly classified because of the MAES level 1-3 codes (classes ending with 0). A comment was made "more detailed classification" and MAES level 4 code is put as correct code. The following classes have an user accuracy of 0%: 6212, 6221, 7211, 7211, 7212, 8121 and 9112. The classes 1311, 1412, 1421, 2321, 3211, 4111, 4212, 6111, 7111 and 8111 have an user accuracy lower than 50%. Other major findings/considerations were:

- Cemeteries are classified as class 1113 and not as 1411/2, which seems strange to us.
- Definitions for beaches (6211) and river banks (6213) has to be more detailed /specific. Sand banks along the river with "beach infrastructure" are called beaches. The others are classified as river banks. Sand along estuaria and sea are seen as beaches.
- Classes 7211 and 7212 are nearly absent in the Dutch Riparian zone dataset. Class 7211 is not existing in The Netherlands. No active exploitation. Class 7212 (restoration of peat bogs) is appearing in some very specific places.
- Classes 1121/2121 and 1113 are sometimes difficult to separate. Farmhouses with large buildings are classified as 1113 (and sometimes as 1121). Also greenhouses are classified as 2121 but in some cases as 1113 (garden centre?).
- Classes 9214 are sometimes difficult to separate from 9211. When to call it an intensively managed fishpond? What is intensively managed? Land use data and/or visible "fishing" infrastructure needs to be present.
- Class 9215 is separated from class 9211 on basis of land use data and visible extraction infrastructure.
- Salt marshes (class 8111) are only possible if salt water is present, which often is not the case -> incorrect classifications. During the validation, the Oosterschelde is only seen as estuaria where intertidal flats are possible (class 8121). The other parts in Zeeland province are class 9111.
- During the validation mesic grasslands are seen as natural grassland. Grasslands in NL with low intensity use/management/restrictions are seen as mesic grasslands.
- Class 6221 Bare rocks and rock debris is not existing in The Netherlands. The selected samples were all wrongly classified.
- Class 6212 Dunes is existing in The Netherlands, however all selected samples were wrongly classified as class 6212. The dune area is relatively small in the Dutch Riparian Zone 2012 dataset.

More detailed information on the characterization of the classes and typical mistakes with examples can be found in the delivered task reports which were delivered by February 6th, 2018.

Table 2. Overview of results related to the accuracy or correctness of LC/LU classification for the 68 classes of the Riparian zones LC/LU dataset of The Netherlands.

		number of samples	number of samples (correct)	overall accuracy (%)	overall accuracy (CI)	user accuracy (%)	user accuracy (CI)	producer accuracy (%)	producer accuracy (CI)
Riparian Zones 2012 dataset		590	354	89.1	1.8	-	-	-	-
1111	**Continuous urban fabric (in-situ based or IM.D. >80-100%)**	10	4	-	-	40.0	32.0	100.0	0.0
1112	**Dense urban fabric (IM.D. >30-80% + industrial, commercial, public, military and private units)**	10	10	-	-	100.0	0.0	82.3	0.0

1113	Industrial or commercial units	10	9	-	-	90.0	19.6	98.6	0.0
1120	1.1.2.0 Low density urban fabric (IM.D. 0-30%) (1120)	6	0	-	-	0.0	0.0	0.0	0.0
1121	Low density urban fabric (IM.D. 0-30%)	10	8	-	-	80.0	26.1	97.2	0.0
1210	Transport infrastructure (CLC2012/CLC2006)	1	0	-	-	0.0	0.0	0.0	0.0
1211	Road networks and associated land	10	9	-	-	90.0	19.6	87.4	0.0
1212	Railways and associated land	10	10	-	-	100.0	0.0	60.1	0.0
1213	Port areas	10	10	-	-	100.0	0.0	69.5	0.0
1214	Airports	10	9	-	-	90.0	19.6	100.0	0.0
1311	Mineral extraction, dump and construction sites	10	4	-	-	40.0	32.0	97.4	0.0
1321	Land without current use	10	7	-	-	70.0	29.9	32.2	0.0
1411	Green urban areas T.C.D. ≥ 30%	10	8	-	-	80.0	26.1	38.8	0.0
1412	Green urban areas T.C.D. < 30%	10	3	-	-	30.0	29.9	46.2	0.0
1420	Sport and leisure facilities	7	0	-	-	0.0	0.0	0.0	0.0
1421	Sports and leisure facilities T.C.D. ≥ 30%	10	4	-	-	40.0	32.0	46.9	0.0
1422	Sports and leisure facilities T.C.D. < 30%	10	9	-	-	90.0	19.6	94.7	0.0
2111	Non-irrigated arable land	10	10	-	-	100.0	0.0	94.0	0.0
2121	Greenhouses	10	8	-	-	80.0	26.1	100.0	0.0
2211	Vinyards	3	3	-	-	100.0	0.0	100.0	0.0
2221	High stem fruit trees (extensively managed)	10	9	-	-	90.0	19.6	100.0	0.0
2222	Low stem fruit trees and berry plantations	10	7	-	-	70.0	29.9	100.0	0.0
2321	Complex cultivation patterns	10	4	-	-	40.0	32.0	100.0	0.0
2331	Land principally occupied by agriculture with significant areas of natural vegetation	3	2	-	-	66.7	65.3	100.0	0.0
3000	Woodland and forest	10	0	-	-	0.0	0.0	0.0	0.0
3111	Riparian and fluvial Broadleaved forest	10	8	-	-	80.0	26.1	89.9	0.0
3131	Other natural & semi natural broadleaved forest	10	8	-	-	80.0	26.1	63.2	0.0
3151	Highly artificial broadleaved plantations	10	10	-	-	100.0	0.0	33.6	0.0
3211	Riparian and fluvial coniferous forest	10	4	-	-	40.0	32.0	100.0	0.0
3231	Other natural & semi natural coniferous forest	10	5	-	-	50.0	32.7	100.0	0.0
3311	Riparian and fluvial mixed forest	10	7	-	-	70.0	29.9	59.7	0.0
3331	Other natural & semi natural mixed forest	10	7	-	-	70.0	29.9	100.0	0.0
3341	Highly artificial mixed plantations	1	1	-	-	100.0	0.0	100.0	0.0
3411	Transitional woodland and scrub	10	5	-	-	50.0	32.7	79.7	0.0

3412	Lines of trees and scrub	10	9	-	-	90.0	19.6	25.5	0.0
4000	Grassland	10	0	-	-	0.0	0.0	0.0	0.0
4110	Managed grasslands without trees and scrubs	10	0	-	-	0.0	0.0	0.0	0.0
4111	Managed grasslands with trees and scrubs (T.C.D. ≥ 30%)	10	2	-	-	20.0	26.1	100.0	0.0
4112	Managed grasslands without trees and scrubs (T.C.D. < 30%)	10	10	-	-	100.0	0.0	93.4	0.0
4212	Mesic grasslands with trees (T.C.D. ≥ 30%)	10	3	-	-	30.0	29.9	54.9	0.0
4222	Mesic grasslands without trees (T.C.D. < 30%)	10	9	-	-	90.0	19.6	86.6	0.0
5000	Heathland and scrub	10	0	-	-	0.0	0.0	0.0	0.0
5111	Heathlands and Moorlands	10	10	-	-	100.0	0.0	45.1	0.0
6111	Sparsely vegetated areas	10	2	-	-	20.0	26.1	100.0	0.0
6210	Beaches, dunes, sands	1	0	-	-	0.0	0.0	0.0	0.0
6211	Beaches	10	8	-	-	80.0	26.1	54.2	0.0
6212	Dunes	3	0	-	-	0.0	0.0	0.0	0.0
6213	River banks	10	10	-	-	100.0	0.0	26.0	0.0
6221	Bare rocks and rock debris	2	0	-	-	0.0	0.0	0.0	0.0
7000	Wetland	10	0	-	-	0.0	0.0	0.0	0.0
7111	Inland fresh water marshes without reeds	10	4	-	-	40.0	32.0	50.7	0.0
7112	Inland freshwater marshes with reeds	10	7	-	-	70.0	29.9	98.2	0.0
7211	Exploited peat bog	1	0	-	-	0.0	0.0	0.0	0.0
7212	Unexploited peat bog	3	0	-	-	0.0	0.0	0.0	0.0
8111	Salt marshes without reeds	10	3	-	-	30.0	29.9	2.7	0.0
8121	Intertidal flats	10	0	-	-	0.0	0.0	0.0	0.0
8221	Estuaries	10	5	-	-	50.0	32.7	100.0	0.0
9000	Rivers and lakes	10	0	-	-	0.0	0.0	0.0	0.0
9111	Permanent interconnected running water courses	10	10	-	-	100.0	0.0	84.7	0.0
9112	Intermittently running water courses	5	0	-	-	0.0	0.0	0.0	0.0
9113	Highly modified natural water courses and canals	10	8	-	-	80.0	26.1	24.6	0.0
9121	Permanent separated water bodies belonging to the river system	10	10	-	-	100.0	0.0	24.2	0.0
9211	Permanent natural water bodies	10	8	-	-	80.0	26.1	92.2	
9212	Temporary natural water bodies	4	2	-	-	50.0	56.6	100.0	0.0
9213	Ponds and lakes with completely man-made structure	10	7	-	-	70.0	29.9	14.5	0.0
9214	Intensively managed fish pond	10	10	-	-	100.0	0.0	100.0	0.0
9215	Standing water bodies of extractive industrial sites	10	9	-	-	90.0	19.6	19.8	0.0

10111	Marine (other)	10	6	-	-	60.0	32.0	0.8	0.0

Next to the existence of MAES level 1-3 that has to be converted into MAES level 4, the RZ2012 dataset also contains geometric errors (i.e. slivers) due to the integration of datasets. The RZ2012 dataset still needs to be cleaned up.

The GLE 2012 status layer occupies 4776.8 ha which is 0.01% of the national territory. For each of the four classes (Trees as linear structures or as patches, Hedge rows & scrubs as linear structures or as patches) 25 samples were selected. Out of the total of 100 samples 86 were correctly classified resulting in an overall accuracy of 89.4%. Table 3 shows the accuracies for the different classes. More detailed information on correctness of delineation of the GLE, characterization of the classes and typical mistakes with examples can be found in the delivered task reports (delivered February 6th, 2018). A general observation is that a lot of the linear structures are missed (omission errors), patches are often part of larger structures or are missed and the patches/linear structures seems to be shifted (shadow effect?).

Table 3. Overview of results related to the accuracy or correctness of classification for the GLE 2012 status layer.

GLE classes Riparian Zones		Number of polygons	Area (ha)	%	Samples (correct)	user accuracy (%)	user accuracy (CI)	producer accuracy (%)	producer accuracy (CI)
Trees	Linear structures	5323	755.6	15.82%	19	76.0	17.1	65.1	30.6
	Patches	26793	3761.1	78.74%	23	92.0	10.9	97.8	2.3
Hedgerows & scrubs	Linear structures	1258	169.6	3.55%	24	96.0	7.8	57.4	22.5
	Patches	673	90.5	1.89%	20	80.0	16.0	100.0	0.0

Critical findings and potential use

Short comings of the datasets and possible improvements are:

- The RIZ2012 datasets contains still MAES level 1-3 classes which has to be converted into MAES level 4. A consistent nomenclature is needed and a better description of some of the LCLU classes.
- Geometric errors (i.e. slivers) are existing in the RIZ2012 dataset probably due to the integration of individual datasets. The RZ2012 dataset still needs to be cleaned up.
- The RIZ2012 GLE dataset is characterized by the fact that i) a lot of the linear structures are missed (omission errors), ii) patches are often part of larger structures or are missed and iii) the patches/linear structures seems to be shifted (shadow effect)
- Analysis of UA2006-2012 changes were not taken into account. Changes in LCLU between both datasets need also to be verified.

As far as we know the datasets UA2012 and RZ2012 are not used in national applications in the Netherlands. However, probably EEA knows more about it from the information provided when the data is downloaded.

2.2 Enrichment Urban Atlas 2012 (UA2012)

The enrichment of Urban Atlas (UA) 2012 for the Netherlands dealt with all Functional Urban Areas (FUAs) for which UA2012 data is existing. Al Urban Atlas FUAs were integrated into one database. The total database consist of 386950 polygons. Total area of UA2012 is 1721983 ha. The dataset has as projected coordinate system RD_New and as projection Double_Stereographic. The integrated UA2012 dataset for The Netherlands is intersected with the dataset Bestand Bodemgebruik (BBG2012) (see Figure 3). The dataset was delivered to EEA on December 5th, 2018.

The enrichment is based on information coming from the national land use dataset Bestand Bodemgebruik (BBG2012). The national BBG2012 classes are converted/translated into the Land Use Attributes level 2 (LUA) as they are defined by EAGLE (see Table 4 and 5). Using BBG2012 only a selected number of LUA level2 can be discerned for The Netherlands (see Table 6).

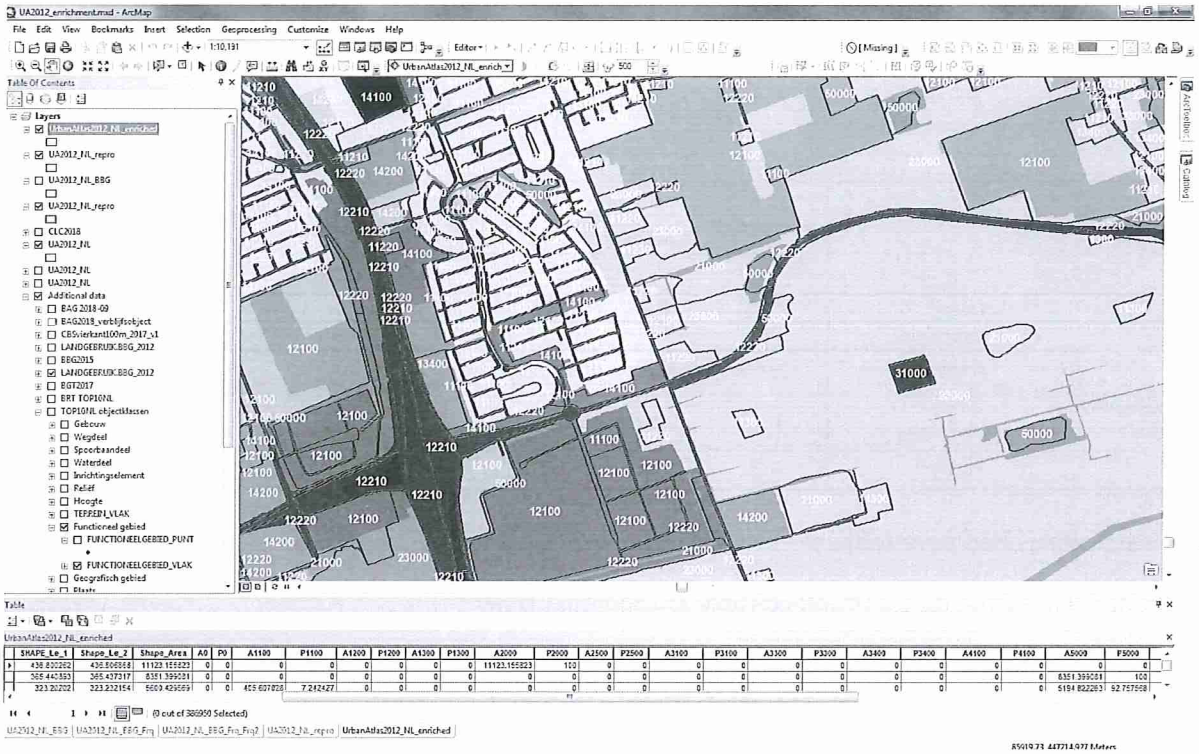

Figure 3. The UA2012 polygons are transparent (red line) with their respective codes are on top of the BBG2012 dataset where each class is represented by a different colour.

For each UA2012 polygon the percentage and the area for each LUA present in The Netherlands are summed up and presented in the attribute table of the dataset. The attributes starting with an A present the area and the attributes with P presents the % of each LUA class per UA polygon. The code 0 is for all UA polygons fallen (partly) in sea/ocean category of BBG2012 category (i.e. no inland water) and code 9999 are sliver polygons on the border with Belgium or Germany where no BBG2012 is existing.

Table 4. Explanation of the different land use attribute (LUA) classes as defined by EAGLE (level 1/2).

Level 1 class	LU_Level_1_code	Level 2 class	LU_Level_2_code
Primary Production	1000	Agriculture	1100
		Forestry	1200
		Mining and Quarrying Quarrying extraction sites	1300
		Aquaculture and Fishing	1400
		Other Primary Production	1500
Secondary Production	2000	Raw Industry	2100
		Heavy End Product Industry	2200
		Light End Product Industry	2300
		Energy production	2400
		Other Industry	2500
Tertiary Production	3000	Commercial Services	3100
		Financial, Professional and Information Services	3200
		Community Services	3300
		Cultural, Entertainment and Recreational Services	3400
		Other Services	3500
Transport networks, Logistics and Utilities	4000	Transport networks	4100
		Logistics and Storage Services	4200
		Utilities	4300
Residential Use	5000	Permanent Residential Use	5100
		Residential Use with Other Compatible Uses	5200
		Other Residential Use (Non-Permanent)	5300
Other Uses	6000	Transitional Areas	6100
		Abandoned Areas	6200
		Natural Areas Not In Other Economic Use	6300
		Areas Where Any Use Allowed	6400
		Areas Without Any Specified Planned Use	6500
		Not Known Use	6600
Inland Water Functions	7000	Drinking Water	7100
		Irrigation Water	7200
		Fire-fighting Water	7300
		Artificial Snow Water	7400
		Water Retention Area	7500
		Water Energy Reservoir	7600

Extracted from the EAGLE matrix Land Use attributes:
https://land.copernicus.eu/eagle/content-documentation-of-the-eagle-concept/manual/content-documentation-of-the-eagle-concept/b-thematic-content-and-definitions-of-eagle-model-elements/part-ii-land-use-attributes

Table 5. Conversion from BBG2012 codes to LUA level 2 codes as defined by EAGLE.

Main class	Class	Lower limit (ha)	Description	LUA level 1	LUA level 2
1 Transport					
	10	None	Railroad	4000	4100
	11	None	Main road	4000	4100
	12	1	Airport	4000	4100
2 Built-up area					
	20	1	Residential	5000	5000
	21	1	Retail trade, hotel and catering	3000	3100
	22	1	Public institutions	3000	3300
	23	1	Socio-cultural facility	3000	3300
	24	1	Industrial area and offices	2000	2000
3 Semi built-up area					
	30	1	Dumping site	2000	2500
	31	0,1	Car wreck site	2000	2500
	32	0,1	Cemetery	3000	3300
	33	0,5	Mining area	1000	1300
	34	1	Building site	6000	6100
	35	1	Other semi built-up area	6000	6500
4 Recreation					
	40	1	Park and public garden	3000	3400
	41	0,5	Sports ground (incl. car parks)	3000	3400
	42	0,1	Allotment garden	3000	3400
	43	1	Area for daytrips	3000	3400
	44	1	Holiday recreation	3000	3400
5 Agriculture					
	50	1	Greenhouses	1000	1100
	51	1	Other agricultural usage	1000	1100
6 Woodland and Nature					
	60	1	Woodland	1000	1200
	61	1	Dry natural area	6000	6300
	62	1	Wet natural area	6000	6300
7 Inland water					
	70	None	"IJsselmeer/Markermeer"	7000	7000
	71	None	Enclosed estuary	7000	7000
	72	None	"Rijn & Maas"	7000	7000
	73	None	"Randmeer "	7000	7000
	74	1	Water reservoir	7000	7100
	75	1	Water with recreational usage	3000	3400
	76	1	Water where minerals are extracted	1000	1300
	77	1	Area for storing industrial water	7000	7500
	78	1	Other inland water	7000	7000
8 Tidal waters					
	80	None	"Waddenzee, Eems, Dollard"	0	0
	81	None	"Oosterschelde"	0	0
	82	None	"Westerschelde"	0	0
	83	None	"Noordzee"	0	0
9 Foreign countries					
	90	None	Foreign countries		

Table 6. Area of different LUAs based on BBG2012 for all FUAs being part of the UA2012 dataset for The Netherlands.

LUA	Area (ha)	%
0	1942	0.11%
1100	989010	57.43%
1200	172215	10.00%
1300	2776	0.16%
2000	53100	3.08%
2500	1514	0.09%
3100	7438	0.43%
3300	20080	1.17%
3400	70876	4.12%
4100	62452	3.63%
5000	150549	8.74%
6100	22390	1.30%
6300	66855	3.88%
6500	1482	0.09%
7000	97935	5.69%
7100	1067	0.06%
7500	176	0.01%
9999	125	0.01%
Total	1721982.9	100.00%

Out of the 33 LUA (level 2) only 16 LUAs exist in The Netherlands. Main LUA is Agriculture (1100) which occupies more than 57% of the UA2012 area for The Netherlands. Of minor importance are classes Other Industry (2500), Areas without Any Specified Planned Use (6500), Drinking Water (7100) and Water Retention Areas (7500). They are occupying less than 0.1% of the total UA2012 area (see Table 6).

3. CLC2018

3.1 Organisation of work at national level

Setting

The production of CLC2018, CLC2012rev and CLCchanges2012-2018 took place in the premises of WENR. Due to the relatively small surface area of The Netherlands the work was centralised and performed by a relatively small team (see under section 1). No training was needed as the team had already experience with the production of former CLC versions. Because of the small team no project meetings or steering committee meetings were needed.

The work started February 2018 after a correction for the geometrical shift of the original delivered CLC2012 database by EEA. Verification of the CLC2012revised and CLCchange2012-2018 by the CLC technical team took place in March 2018. Almost 10.000km^2 which is 23% of the national territory was checked (provinces Friesland, Groningen and Drenthe). Second verification took place in June 2018 (same area as in first verification). Suggestions and remarks were implemented by the national team. Final databases (CLC2018, CLC2012rev and CLCchanges 2012-2018) and metadata were delivered by August 31st, 2018. Quality control by QC CLC tool and uploading at CDR of the CLC datasets took place. Final technical acceptance report was issued September 4th, 2018.

Overview of the production process

After receiving a geometrically corrected CLC2012 database pre-processing started with creation of a file geodatabase CLC2018_NL with a feature class CLC18_NL_overall, i.e. a copy of CLC12_NL, which is the basis for updating CLC. Topology was created on the feature dataset for indicating gaps and overlaps in the database, several domains (CLC codes and change types) were created for different fields (CLC2012new, CLC2018, CHA1218 (change type), CLC12change, CLC18change) to prevent introduction of non-exiting codes. Interchange was not used as support package for the production of the CLC2012rev and CLC2changes 2012-2018. An own methodology was developed to monitor changes and revise CLC2012. For this polygons were labelled with a newly revised CLC2012, CLC2018 code and by a the type change like:

- no change (UN)
- improvement (IM)
- technical change (TC)
- change (CH)
- change and improvement (CI)

Also the polygons were labelled with a CLC code for 2012 and 2018 indicating their real changes. This code pair (CLC12change, CLC18change) could be different to the CLC2012 and CLC2018 fields as changes between 5ha and 25ha have to be aggregated to neighbouring polygons.

The workflow consisted of identification of changes, delineation of changes, improvement of CLC2012, internal control, improvement of change delineation. The last two actions were repeated until an internal qualitative quality standard was reached for the working unit i.e. a province.

The interpreter identified and delineated the land cover changes between the years 2012 and 2018 and the major improvements needed for the CLC2012. Changes were identified by comparing IMAGE2012 with IMAGE2018 and aerial photos of 2012 with aerial photos of 2016/17. The CLCchange 2006-2012 database was used as additional data source. At the same time, the interpreter revised the CLC2012 database and recorded the land cover for the years 2012, 2018, type of change (as defined

above) and the change code pair (CLC12change, CLC18change) in different fields of the attribute table. The land cover CLC code in the CLC2012, CLC2012new and CLC2018 fields is equal to each other if there was no change or improvement detected. During the delineation of the changes the interpreter had to keep in mind the mapping rules of a minimum mapping unit of 5ha and a width distance of minimal 100m. Questions or doubts on interpretations were indicated in the remark field.

The internal verification involved the following actions:

- delineated changes and the change codes were verified,
- changes/improvements with remarks were checked and adjusted,
- too small changes, questionable changes and/or unreal changes were removed,
- missed changes and/or improvements were added.

Finally, combinations of CLC codes for the attribute fields CLC2012, CLC2012new, CLC2018 were compared with the code in the change type field. For example, polygons with different CLC2018 and CLC2012new codes with no change code in the change type field were checked again and corrected.

The verification by the CLC technical team (TT) dealt with an area of 10.000 km^2 in the North of The Netherlands (provinces Groningen, Friesland and Drenthe). The first verification evaluated CLC2012revised and CLCchanges 2012-2018 as conditionally accepted respectively rejected. Final verification was evaluated as accepted/conditionally accepted for both the CLC2012revised and the CLCchange2012-2018 database. After each of the verifications remarks and comments were implemented for the entire Netherlands. Major issues discovered during the verification were the following:

- Overestimation of construction sites (CLC class 133) leading to overestimation of changes (CLC2012revised)
- Omitted residential (112) and industrial areas (121) (CLC2012revised)
- Natural features (31x, 32x) had to be mapped/cut off the larger agricultural polygons (2xx). The agriculture classes needed to be mapped more precisely (CLC2012revised)
- Natural grasslands (321) should not include parcels under agricultural management (overestimation of natural grasslands) (CLC2012revised)
- Forest polygons included some semi-natural classes (32x and 412) which should be mapped individually (CLC2012revised)
- Gravel & sand extraction sites (mineral extraction sites (131)) with associated water body have to be mapped by considering the generalisation rules in Nomenclature Guidelines as water body (512) (CLC2012revised)
- Several miscoded, false and omitted changes were found as CLC2012 was not sufficiently revised (CLCchanges 2012-2018)
- Overestimation of the change 133-321 (CLCchanges 2012-2018)
- Overestimation of forest growth (324-31x), but clearcut (31x-324) was not mapped at all (CLCchanges 2012-2018)
- Improper use of technical changes (TC) due to using other production methodology (CLCchanges 2012-2018)

For more detailed description of the comments/remarks made by the TT we refer to the verification reports.

After interpretation, internal quality control and external verification the final databases were produced out of the "production" database CLC18_NL_overall by selection rules and dissolve actions.

Final databases CLC2012rev (CLC12_NL), CLC2018 (CLC18_NL) and CLCchanges 2012-2018 (CHA18_NL) with their metadata were uploaded to the QC CLC tool. After correction the datasets were accepted (see CLC2018 Technical Control-DTBA report issued on September 4th, 2018). Afterwards datasets were uploaded to EEA's CDR.

Main difficulties and solutions

The original CLC2012 dataset delivered by EEA was geometrically shifted due to the use of incorrect projection parameters. After correction of the database interpretation of CLC could take place.

Due to integration of the national CLC2012 database with neighbouring countries Belgium and Germany some incorrect slivers, smoothed polygons, incorrect thematic classification and unexpected polygons (along the coast, especially classes 331, 321 and 423) appeared in the national dataset delivered by the EEA. These errors has to be corrected.

CLC2012 consisted of several shortcomings discovered during the verification by CLC TT. Improving/revising CLC2012 was more time consuming than expected. Focus was on correct change mapping between 2012 and 2018. Special focus during the revision of CLC2012 was given to the classes mineral extraction sites (131), construction sites (133), agricultural areas (2**), natural grasslands (321), transitional woodland (324).

Extension of land in province of South-Holland (Europoort), conversion of agricultural land into newly forested (Bentwoud, Waalbos, Wolvenpolder, Zuidpolder) areas and natural grassland (321)/inland marshes (411) (e.g. Biesbos/province Zeeland) are striking and special changes between 2012-2018.

No accuracy assessment for the CLC2012rev, CLC2012-2018 and CLC2018 databases due to lack of time.

Some observations regarding the QC CLC tool:

- Along the borders with Belgium and Germany 587 polygons in CLC2012rev and CLC2018 exist that are not fulfilling the condition of a MMU of 25 ha.
- Also 173 change polygons smaller than 5ha are existing in CLCchanges 2012-2018 due to the fact they are part of complex changes.
- Another 341 change polygons with the same code for 2012 and 2018 need to be marked as technical changes, although they are real changes. For example, a small area (<25ha) in 2012 was construction site (class 133) but was aggregated to neighbouring urban area (class 112) due to the MMU of 25ha. In 2018 this construction site has changed from construction site (class 133) to urban area (class 112). The real change is from class 133 to 112 (change pair CLC12change-CLC18change is 133-112). However, the CLC2012rev and CLC2018 class are both 112 and are marked as TC which is incorrect!
    - Also examples (areas smaller than 25ha) exist where the change pair (e.g. CLC12change – CLC18change is 211-133) reflecting the real change is different from the combination of CLC2012rev (class 211) and CLC2018 (class 112). In this case the change polygon is smaller than 25ha and isolated, i.e. the area of class 133 is too small to be an individual polygon in CLC2018. The polygon has to be aggregated to the neighbouring polygon with class 112. These changes were marked as regular/real in contrast to the example above, which is an inconsistency in the QC CLC tool!
    - So the change pair (a-b) is reflecting the real change (>5ha) which can be different to the CODE_12 or CODE_18 which reflects the CLC class in the databases CLC12_NL resp. CLC18_NL.

Due to incompatible formats and/or metadata editors (in-house vs INSPIRE) for storing the metadata some difficulties had to be solved to accept the databases by the QC CLC tool.

3.2 Ancillary data used in the project

The following ancillary data (satellite imagery or in-situ) were used:

1. Satellite imagery

Sentinel 2 images from 27/03/2017, 26/05/2017 and 28/09/2017 as main sources (supplemented with other imagery (as supplied by service provider) if needed. IRS image of 26/07/2012 was used as reference for the 2012 situation.

2. Aerial photographs (2012 and 2016/2017) with 25-50cm spatial detail
3. National land cover and land use data, LGN7 (2012) (www.lgn.nl) with 25m^2 spatial detail and BBG (2012/2015) at scale 1:10.000.
4. Topographical maps (1:10.000) of 2017.
5. Land Parcel Information System (LPIS) – Basis Registratie Percelen BRP2017 data
6. Google Earth
7. CLC2012 and CLCchanges 2006-2012
8. Elevation data - Algemeen Hoogtebestand Nederland AHN2 (untill 2014) /AHN3 (2015-2018)

4. Post-production verification of the High Resolution Layers (HRL's) for the 2015 reference year

The verification of the HRLs 2015 followed the procedure that is in line with the approach tested and used during the verification of the HRLs 2012 (see Annex 11 of FSC tender specifications). The updated verification guidelines for HRLs 2015 were used as basis for the verification. The aim of the verification was the identification of systematic classification errors and the omission/commission errors for the different HRLs.

The methodology used was a visual inspection of the randomly selected samples in a limited number of critical strata. Existing national in-situ data (national land cover data, topographical dataset and LPIS data), aerial photography and/or detailed VHR satellite imagery (=< 1m) were used for the inspection of the full resolution HRL products (20m×20m).

The verification consisted of a general overview of the data quality and a look and feel verification of 6 - 10 randomly selected samples in critical strata aiming to identify systematic classification errors. Each strata is classified as excellent, good, acceptable, insufficient or very poor. For a limited number of HRLs a statistically-based quantitative verification was applied.

The HRLs falling under the following topics were verified:

- Imperviousness (IMD)
- Forest (TCD and DLT)
- Grassland (Grass)
- Wetness & Water (W&W)

4.1 General overview

HRL IMD

The built-up surface area coming from HRL IMD and the LGN7 dataset are of the same order of magnitude (see Table 7). Comparing them with the national topographical dataset (Top10NL) shows more dissimilarity, however the Top10NL is overestimating the built-up area. General feeling is that the HRL IMD 2015 classification was more "strict" or rigorous as the HRL IMD 2012.

HRL TCD/DLT

The area covered by trees (>=30% TCD) is by far higher than given by the national reference data (see Table 7). Also it is much higher than the 422 kHa from HRL TCD 2012. Also the tree nurseries, orchards and fruit cultivation are not consistently mapped and well incorporated in the HRL TCD 2015.

HRL Grassland

The total area of grassland in the HRL reflects exactly the surface area of our national LPIS data (BRP2015) (see Table 7). However, the spatial match between HRL Grassland and the BRP2015 is far from 1:1. Next to this spatial mismatch there exist a large discrepancy between the total area of grassland in The Netherlands (based on LGN7 and/or Top10NL) and the area mapped as grassland by the HRL Grassland. As not all grasslands are included in the BRP2015 (e.g. not all pastures (agricultural grasslands) and natural grasslands, no salt marshes, no grasslands in the dunes and heathlands) the total amount of 1368.2 kHa in the national LGN7_BRP2015 dataset is much higher.

Table 7. Areas of built-up, tree cover, dominant leaf type, grassland and permanent water coming from HRLs and national reference data (in kHa).

HRL		HRL	LGN7_BRP2015	BRP2015	Top10NL_2017
Imperviousness		403.5	428.2	-	660.1*
Tree Cover Density**		583.7	448.5	-	425.9
Dominant Leaf Type	deciduous	427.4	272.6	-	249.8***
	coniferous	172.7	148.3	-	154.3***
Grassland		1026.9	1368.2****	1020	1379.3
Water & Wetness*****		284.8	373.8	-	393.2

* sum of urbanised areas, infrastructure and remaining land use which is an overestimation as not all remaining land use is built-up
** national data include tree nurseries, orchards and fruit cultivation. Areas presented for the national datasets should be lower as not all fruit cultivation should be seen as forest
*** mixed forest is added in equal proportions to deciduous and coniferous forest
**** pastures, natural grasslands, salt marshes, grasslands in dune areas and heathland
***** permanent water

HRL Water & Wetness

The amount of permanent water in the HRL Water & Wetness is lower than the areas covered with permanent water in the national datasets LGN7 and Top10NL (see Table 7). Temporary water can't be verified with national data as it is not existing in those datasets. Comparing temporary and permanent wet areas with national data is difficult due to the fact HRL and national class definitions are not matching. Also the HRL is not including the total coastal zone of The Netherlands which makes comparison with national data difficult. However, it can be concluded that temporary wet areas are highly overestimated and permanent wet areas are underestimated in the HRL.

4.2 Look and feel

HRL IMD

The HRL is mapped fine although it seems imperviousness is mapped more strict/rigorous in 2015 compared to 2012. Greenhouses are missed or incompletely mapped, roads/railways are underestimated, and a large area SW of Utrecht is completely missed. The HRL is judged as **good-acceptable**.

HRL TCD and DLT

Overestimation of forest in the HRL TCD. One important source for commission errors are the greenhouses and areas along rivers mapped as forest. Forest is quite well mapped in forested landscapes with large tracks of forest. Overestimation of forest occurs in the mixed/mosaic landscapes (agriculture/forest). Also the inclusion of tree nurseries, orchards and fruit cultivation causes lots of problems. Now there are lots of omission errors due to inconsequently mapped orchards, fruit cultivation and tree nurseries. The quality of the HRL TCD is judged as **acceptable(-insufficient)**.

HRL Grassland

Large areas under grassland are missed mainly in agricultural areas where arable land is the dominant land cover. In landscapes dominated by pastures there are not a lot of omissions nor commissions. In the HRL the saltmarshes are only partly mapped resulting in underestimations, which is also the case in the areas with dunes along the coast. Peatbogs are inconsequently mapped. Overall judgement is **acceptable-insufficient**.

Table 8. The look and feel judgement for different strata for the four HRLs.

HRL	Strata	Judgement
Imperviousness	Sport and Leisure facilities	Acceptable
	Agricultural areas - greenhouses	Acceptable-insufficient
	Discontinuous urban fabric	Good-acceptable
	Construction sites	Good
	Road and rail networks	Acceptable-insufficient
	Beaches, dunes and sands /intertidal flats	Good
	Industrial and commercial sites	Good-acceptable
	Overall	Good-acceptable
Tree Cover Density	Urban vegetation	Acceptable
	Forest along rivers	Acceptable-insufficient
	Sport and Leisure facilities	Acceptable-insufficient
	Forest along rivers	Good-acceptable
	Swamp areas	Acceptable-insufficient
	Agricultural areas	Acceptable-insufficient
	Moors and heathland	Good-acceptable
	Greenhouses	Insufficient
	Overall	Acceptable(-insufficient)
Grassland	Arable land	Good
	Pastures	Acceptable-insufficient
	Natural grasslands	Good-acceptable
	Heathland and peatbogs	Acceptable-insufficient
	Urban areas	Acceptable
	Sport and Leisure facilities	Acceptable
	Salt marshes	Acceptable
	Dunes	Acceptable
	Overall	Acceptable-insufficient
Water & Wetness	Canals/small rivers	Acceptable-insufficient
	Water bodies	Good
	Heathland	Insufficient
	Peatbogs	Acceptable-insufficient
	Dune areas	Insufficient
	Arable land/pastures	Acceptable-insufficient
	Harbours	Acceptable-insufficient
	Inland marshes	Acceptable
	Salt marshes	Insufficient
	Intertidal flats	Very poor-insufficient
	Beaches	Insufficient
	Overall	Good-acceptable*

* Permanent water is judge as good-acceptable, all other classes are seen as insufficient

HRL Water & Wetness

The HRL is judged as **good-acceptable** if looking only at permanent water. Only some omission errors in cities and harbours (e.g. boats/tankers mapped as none permanent water). If taking all other classes (i.e. temporary water, permanent and temporary wet) into account the dataset would be judged as **insufficient**.

Permanent water has omissions in cities and harbours, and smaller lakes and rivers in country side are missed and they often are mapped as temporary water or as temporary/permanent wet.

4.3 Statistical verification

The commission errors for the HRLs were based on 250 samples randomly selected out of respectively the built-up map (>=30 imperviousness), tree cover map (>=30% tree density) and permanent water (from the HRL Water & Wetness). The omission errors and producer accuracies presented in the Table 9 were based on 300 samples at random selected out of a sub-selection (only areas > 10000m2) of the omission strata prepared per HRL.

Table 9. Commission and omission error rates, producer and user accuracies, uncertainty and number of samples per HRL.

	Commission					Omission				
HRL	samples	in-correct	uncertainty (%)	commission error rate (%)	user accuracy (%)	samples	in-correct	uncertainty (%)	omission error rate (%)	producer accuracy (%)
Imperviousness	250	33	4.2	13.2	86.8	300	102	5.4	34	66
Tree Cover Density	250	49	4.9	19.6	80.4	300	195	5.4	65	35
Dominant Leaf Type	201*	14	3.5	7	93	-	-	-	-	-
Permanent water	250	1	0.8	0.4	99.6	300	127	5.6	42.3	57.7

* The samples used in the TCD statistical verification were also used in the DLT verification except the 49 incorrectly classified samples used for the statistical verification

The user accuracies in general are fine (>80%). Only permanent water from the HRL Water & Wetness was verified. Permanent water is mapped clearly well, however lots of omissions exist. The mapping of HRL IMD is also fine. There are also lots of omissions, mainly related to missed greenhouses and underestimation of roads and railways. The HRL TCD is acceptable-insufficient, commissions in the greenhouse strata and along rivers should improve. According to the HRL TCD/DLT definition tree nurseries and fruit cultivation are included. However, this inclusion causes lots of omissions (or commissions if they should not be included). The HRL DLT is fine with an user accuracy of 93%. The omission error and/or producer accuracy for the DLT HRL could not be determined due to the lack of good reference data. No statistical verification of the HRL Grassland layer was foreseen.

For each of the HRL a verification report was delivered giving a general overview of the quality of the dataset, a look and feel assessment and if applicable a statistical verification. The reports were delivered to EEA at February 28th, 2019.

Critical findings

The following main conclusions can be drawn with regard to the HRLs 2015:

- Overlap between HRLs. Areas are sometimes mapped twice (or more) as e.g. forest and grassland. Of course it is possible that pixels with less than 100% of one land cover can be mapped twice. However, if an area is mapped e.g. as grassland it can't be forest,

imperviousness or permanent water. Errors encountered are e.g. areas with more than 80% IMD and also mapped as grassland, or an area with 100% IMD and >60% TCD at same location, or >80% TCD and permanent water at same location.

- No verification of the change layers (IMC, IMCC) generated between the different years HRL IMD was produced (2006, 2009, 2012 and 2015). Accepted status product are no guarantee for correct change products!!!!!!
- More strict/rigorous mapping of HRL IMD 2015 compared to HRL IMD 2012 resulting in underestimation of imperviousness which will have its consequences for the change mapping.
- Large overestimation of forest or tree cover in HRL TCD.
- Inconsequently mapping of tree nurseries, orchards and fruit plantations in the HRL TCD. Better definition is needed to make a good verification with national data possible.
- Large underestimation of grasslands in HRL Grassland.
- Permanent water fine, but other classes of HRL Water & Wetness have insufficient quality to be used at national scale.
- Coastal mask used in the production of the HRLs is outdated. New harbour areas are missed, intertidal flats not included, large "inland" water bodies missed, salt marshes partly included etc.
- The geometric co-registration was hampered with first delivery of HRL products. The transformation parameters used were not fit to produce the HRL layers without a geometrical shift compared to the national in-situ data used.

5. Dissemination

The following activities were undertaken to give all Copernicus Pan-European and Local Land products more publicity at national level:

- Several meetings at Dutch Environmental Agency and WENR informing Dutch Ministry of I&W, governmental and non- governmental research institutes, Dutch NRCs and NFPs and Dutch partners in different ETCs about Copernicus
- Meeting "Copernicus Land Monitoring Service (CLMS) – User Workshop 2018" organised by Dutch Space Organisation (NSO) to inform the Dutch remote sensing community about Copernicus in general and especially about Copernicus Land (June 2018)
- Poster presentation "Monitoring Land Use Changes along Dutch Rivers" at the EARSeL conference (EARSeL LULC/NASA LCLUC workshop) in Chania, Crete (July 2018)
- News item on the WENR intranet site to make researchers aware about the release of CLC2018 and the other Copernicus Land products (foreseen March 2019)

Download services were not implemented as the funds available through the contract are not sufficient to actually host them and maintain them as a national download service. To increase visibility for Dutch users, we have, as a mitigation/lower cost option made the metadata available via our Dutch National Geoportal (NGR).

Data and metadata are disseminated via the Dutch National Geoportal (NGR) http://nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/home and in-house via a shared server that can be approached via ArcCatalog. Metadata for all CLC versions, HRL layers and Urban Atlas 2012 and Riparian Zones 2012 data are available via NGR (http://www.nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/search?facet.q=orgName%2FWageningen%2520Environmental%2520Research&isChild='false'&resultType=details&any_OR__title=copernicus&fast=index&_content_type=json&from=1&to=20&sortBy=relevance). Metadata for the HRLs will be updated for the new versions that are available at the moment. If someone wants to use the data they can download it from https://land.copernicus.eu/ or contact WENR. Download links in NGR point to the specific download page of a specific product.

6. Conclusions

Next to the conclusions, critical findings and main difficulties already made under the different topics "Verification Local Components", "CORINE Land Cover 2018 (CLC2018)" and "Verification HRL2015" (sections 2, 3 respectively 4), we have the following suggestions/remarks for the future Copernicus services:

- Delivery in the correct national projections/transformations of CLC and HRL datasets would be helpful for potential users.
- During the project some HRL layers were updated. We used the v2 of the HRLs that were downloaded in October/November 2018. Slight variations could exist with later versions as indicated by Tobias Langanke's mail from 17/12/2018. The use of "freezed" versions is recommended.
- Integration of all FUA per country into one UA2012 dataset will be helpful for some potential users.
- Integration of all different HRLs per country would be useful. Description of the overlaps between HRL datasets and the gaps existing in such an integrated dataset is recommended.
- Integration of all local component datasets. If a common nomenclature (up till a certain aggregation level) for all local component datasets is available a product that integrates the different datasets spatially will be helpful for potential users.
- A detailed LC/LU datasets based on local components extended in such a way that the entire country is covered has the potential to be used more at national level than the CLC datasets.

7. References

No additional literature was used apart from the guidelines and product specification provided by EEA and/or available on the website https://land.copernicus.eu/.

Done at Wageningen

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Signature: