Final

Guidelines for verification of high resolution soil sealing layer

- Qualitative assessment -

Prepared by:

Chris Steenmans

Ana Sousa

03.12.2007

Version 1.0

European Environment Agency

Introduction

This document provides the guidelines for the verification of the high resolution soil sealing layer, based on a qualitative assessment of the mapped area. As agreed at the Eionet workshop on quality control and validation of land cover data (Copenhagen, 12-13 November 2007), these guidelines should help National Reference Centres on Land Cover (NRCs) to support EEA in doing the verification of the soil sealing layer that is being produced in the frame of GMES land monitoring fast track service precursor.

The soil sealing data is produced by a consortium of European service providers under contract with EEA and is based on the classification of the IMAGE2006 satellite data. The overall objective is the production of a seamless European high resolution core land cover dataset of built-up areas, including degree of soil sealing, for the reference year 2006. Built-up areas are characterized by the substitution of the original (semi)-natural cover or water surface with an artificial, often impervious, cover. This artificial cover is usually characterized by long cover duration (FAO Land Cover Classification System, 2005). Impervious surfaces of built-up areas account for 80 to 100% of the total cover. A per-pixel estimate of imperviousness (continuous variable from 0 to 100 percent) will be provided as index for degree of soil sealing for the whole geographic coverage. The data will be produced in full spatial resolution, i.e. 20 m by 20 m, which provides the best possible core data for any further analysis. The classification accuracy per hectare (based on a 100 m x 100 m grid) of built-up and non built-up areas should be at least 85%, for the European product.

The verification task will run from end November 2007 (when the first country deliveries are expected) until October 2008 (deadline for the last country to be delivered by the contractor) and should support EEA in accepting or rejecting the delivery of the country datasets produced by the service provider.

This qualitative assessment supported by NRCs is part of the grant agreement between EEA and participating countries in the GMES project land monitoring fast track service precursor/CLC2006.

NRCs are invited to carry out this assessment and to give feedback to the Agency within 4 weeks after reception of the data. If it is not possible to perform the verification task within these 4 weeks, it is expected that it will be completed before the end of the grant agreement, according to Article I.2 (Duration).

If countries would like to do additional checks or a quantitative assessment based on statistical validation, they are welcome to do so and to share the results with EEA.

Guidelines are provided for the preparatory work, the inventory of reference data that will be used, the description of the geometric and thematic quality and the overall qualitative assessment. NRCs should use this document template to report on the verification of the data, by filling in the grey boxes: insert free text in the “Text Form Fields” ( ); tick the “Check Box Form Field” (☐); and select from “Drop Down Form Field” (Please, select). Feel free to add additional text or illustrations (e.g. examples from screenshots).

A quantitative assessment or final validation of the European dataset will be carried out by EEA in collaboration with Eionet during late 2008-2009 (project details to be confirmed during the second half of 2008). This European validation will be based as much as possible on the results of national validations. NRCs are invited to inform EEA about planned activities (if any) at national level. Preliminary recommendations for such a statistical validation (quantitative assessment) are attached in annex for information.

Note: After filling in the template save it as a word document: filename: countryISOcode.doc (e.g. AT.doc).

1. Preparatory work

1. Upload the data that will be made available by EEA via ftp server or sent by mail. Please inform EEA on reception of the data;
2. Check for available reference data that will be used during the verification;
3. List the experts/expertise that are involved in the verification task:

Expert name	Field of expertise	Institution
G. Hazeu	CLC2000, CLC2006, national land cover, remote sensing	Alterra
J. Oldengarm	national land cover dbs	Alterra

The average time needed for this verification is estimated at one person/day per10.000 km^2. Please note that this time can vary depending on the experience of the interpreter, the availability of the reference data and the complexity of the landscape. The table below gives an indicative estimate for the EEA member countries.

Country	Area (km^2)	Person days	Country	Area (km^2)	Person days
Austria + Liechtenstein	83.855	9	Lithuania	65.200	7
Belgium	30.520	3	Luxembourg	2.586	<1
Bulgaria	110.994	11	Malta	316	<1
Cyprus	9.251	1	Netherlands	41.526	4
Czech Republic	78.864	8	Norway	323.878	33
Denmark	43.075	4	Poland	312.683	31
Estonia	45.200	5	Portugal	88.935	9
Finland	338.145	34	Romania	237.500	24
France	543.965	55	Slovakia	20.251	5
Germany	357.028	36	Slovenia	49.035	2
Greece	131.957	13	Spain	504.782	51
Hungary	93.030	9	Sweden	449.964	39
Iceland	102.820	10	Switzerland	41.293	4
Ireland	70.282	7	Turkey	789.452	79
Italy	301.245	30	United Kingdom	244.082	25
Latvia	63.700	6			

2. Reference data

Please list the reference data that is used for this verification:

1. Topographic maps

☐ No ☒ Yes Year: 2006 Area: Please, select:

If only a subset, then please specify the area(s):

2. Aerial orthophotos

☐ No ☒ Yes Year: 2006 Area: Please, select:

If only a subset, then please specify the area(s):

3. Very High Resolution satellite data

☒ No ☐ Yes Year: Area: Please, select:

If only a subset, then please specify the area(s):

4. CLC2006

☐ No ☒ Yes

5. Other

Name: BBG2000 Year: 2000 Area: Please, select:

If only a subset, then please specify the area(s):

BBG2000 is the land use database of the Central Office of Statistics

Name: Year: Area: Please, select:

If only a subset, then please specify the area(s):

Name: Year: Area: Please, select:

If only a subset, then please specify the area(s):

Name: Year: Area: Please, select:

If only a subset, then please specify the area(s):

Comments concerning the reference data used (if any):

B. Geometric quality

Please provide your qualitative assessment of the geometric quality of the data. The objective of this task is to perform a visual analysis of the soil sealing dataset concerning its co-registration when put in overlay with other reference datasets.

1. Check geometric accuracy:

Is there a visible shift? ☐ Yes ☒ No

If yes:

a. Is there a systematic shift? ☐ Yes ☐ No

b. Is there a local shift? ☐ Yes ☐ No

Where?

Please indicate the region, place name, coordinates or other description of location:

2. Is the used projection correct? ☐ Yes ☒ No

GCS Bessel 1841 (datum: D_Bessel_1841) is slightly different from the one used in the Netherlands (GCS Amersfoort met datum: D_Amersfoort)

3. Comments concerning geometric issues (if any), or in case the geometric quality could not be checked, please provide a short explanation:

C. Thematic quality

Please provide your qualitative assessment of the thematic quality of the data. The objective of this task is to perform a visual comparison between available reference data and the soil sealing dataset. You are requested to verify for a number of land cover classes (similar to the CLC classes at levels 2 or 3) to check if any errors in the data can be identified. Please note that many land cover classes can include sealed surfaces, especially for features <25 ha.

For this part of the verification, it is recommended to use a binary mask (built-up/non-built-up area) that can be used in overlay with the reference data:

1. Apply a lookup table to map all pixels > 80% degree of soil sealing as built-up area;
2. Perform the checks on pixels > 80% degree of soil sealing by screening for each of the land cover classes if built-up or non built-up areas are correctly mapped. Feel free to add screenshots with examples to illustrate the quality judgement.

For your qualitative assessment, following examples of check boxes can be ticked:

☐ "excellent" meaning that you expect that the accuracy of the built-up data is reaching almost 100%; no errors could be found in the areas that were verified.

☐ "good" meaning that you are confident that the classification results are at least 85 % correct; only sporadic errors were encountered in the areas that were verified.

☐ "acceptable" meaning that you estimate that in most of the verified areas the classification results will probably reach an accuracy of 85 %; some minor errors could be detected in the areas that were verified.

☐ "insufficient" meaning that you do not expect that the classification results will reach the minimum of 85 % accuracy; you encountered several errors in different regions.

☐ "very poor" meaning that you are confident that the classification results are bad with regard to presence of built-up area; most of the areas verified are wrongly mapped.

Urban fabric:

a. Did you check if built-up/non built-up areas are correctly mapped within urban fabric (e.g. houses, buildings, streets, etc.)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality of the mapped built-up area within the urban fabric?

☐ very poor ☒ insufficient ☐ acceptable ☐ good ☐ excellent

a. Short description of errors found (if any):

Omission errors:

Figure 1 shows a general pattern of omission errors. Especially areas with a low density of buildings or a lot of green areas between the buildings have a low accuracy (Figure 2 and 3). Also areas with recent urban extensions are missing in the soil sealing layer (Figure 4).

Figure 1. General pattern of omission errors for villages in the Netherlands (province Friesland)

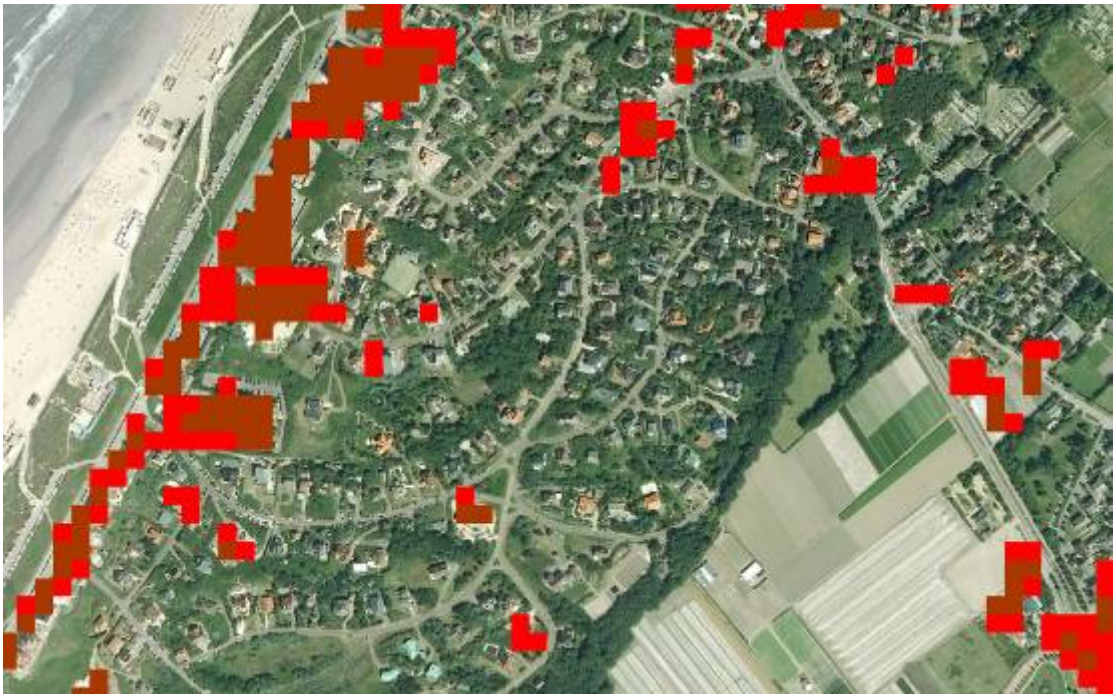

Figure 2. Holiday park along the beach in province Zuid-Holland

Figure 3. Omission errors for a village in the province of Noord-Brabant. Buildings are surrounded by trees.

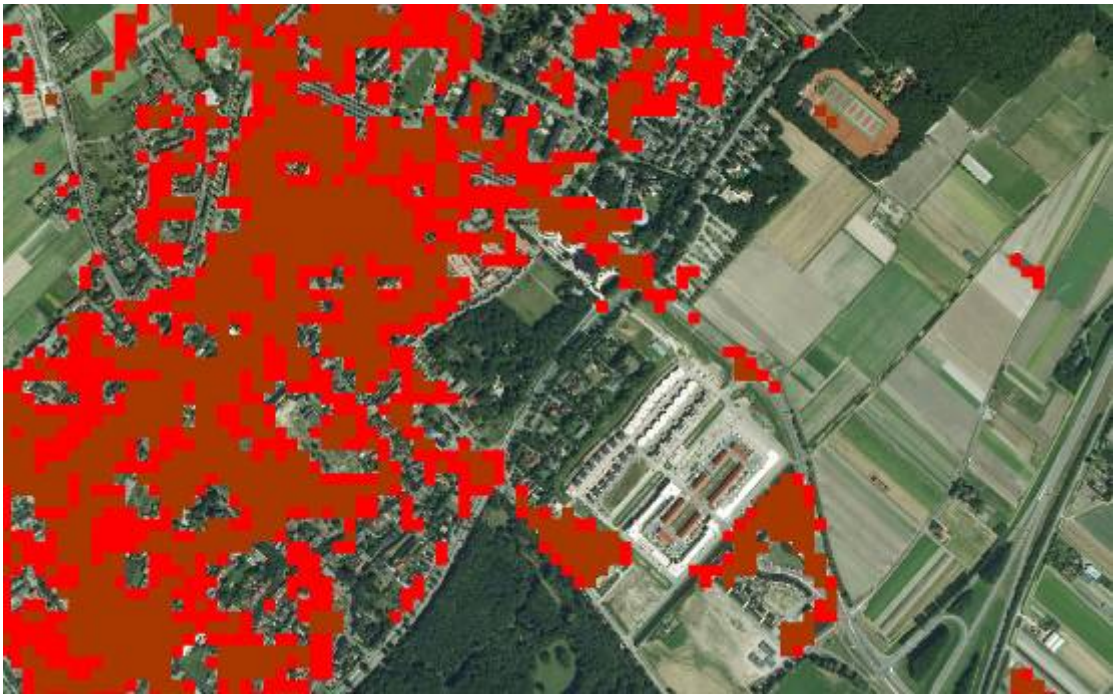

Figure 4. Recent urban extensions are not mapped as sealed areas (province of Zuid-Holland.

<u>Commission error:</u>

This type of errors were not encountered.

Industrial or commercial units:

a. Did you check if built-up/non built-up areas are correctly mapped within industrial or commercial units (e.g. parking lots, buildings, etc.)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

b. Short description of errors found (if any):

Omission error:

Black roofs are often not classified as sealed areas (Figure 5).

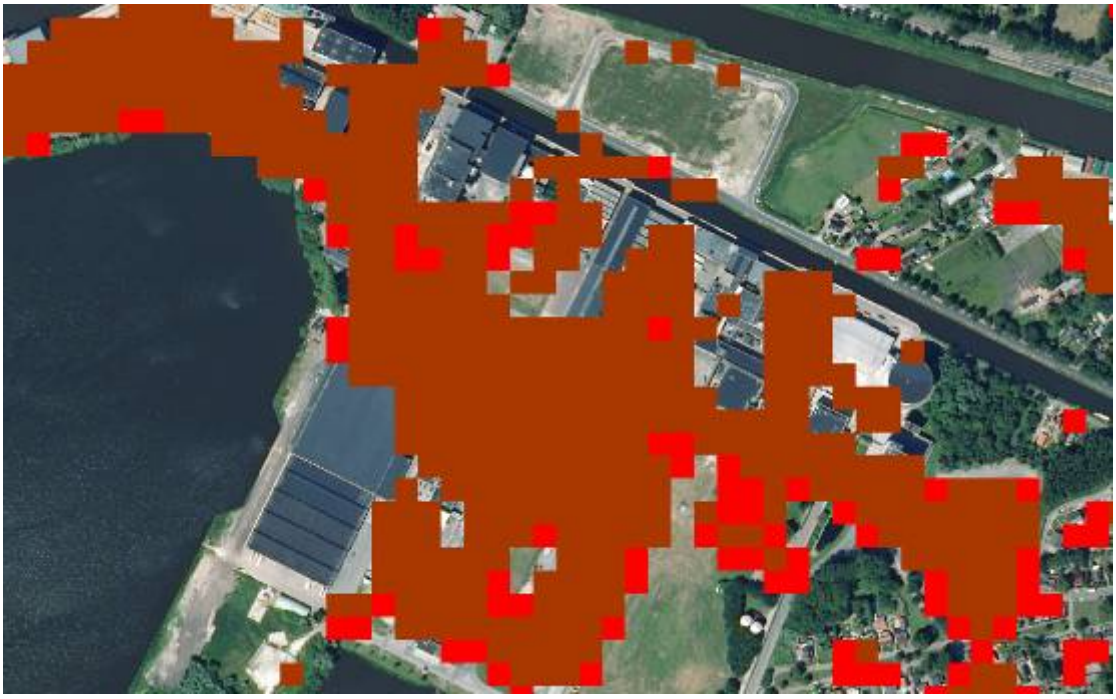

Figure 5. Black roofs not classified as sealed areas (province Groningen).

Commission error:

Only sporadically. In most cases only small areas (Figure 6).

Figure 6. Small areas are incorrectly classified as sealed areas. For example construction site in province of Gelderland.

Road and rail networks and associated land:

a. Did you check if built-up/non built-up areas within road and rail networks and associated land are correctly mapped (e.g. railway stations, highways >20 m width, etc.)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

c. Short description of errors found (if any):

Omission error:

Highways are not consequently mapped on all locations.

Figure 7. Highways are irregularly and inconsequently mapped as soil sealed for more than 80% (provinceZuid-Holland).

<u>Commission error:</u>

Not found.

Port areas:

a. Did you check if built-up/non built-up areas in port areas are correctly mapped (e.g. installations, dykes, etc)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☒ good ☐ excellent

d. Short description of errors found (if any):

<u>Omission error:</u>

Buildings with black roofs (Figure 8) and dykes(Figure 9) in port areas are not well mapped.

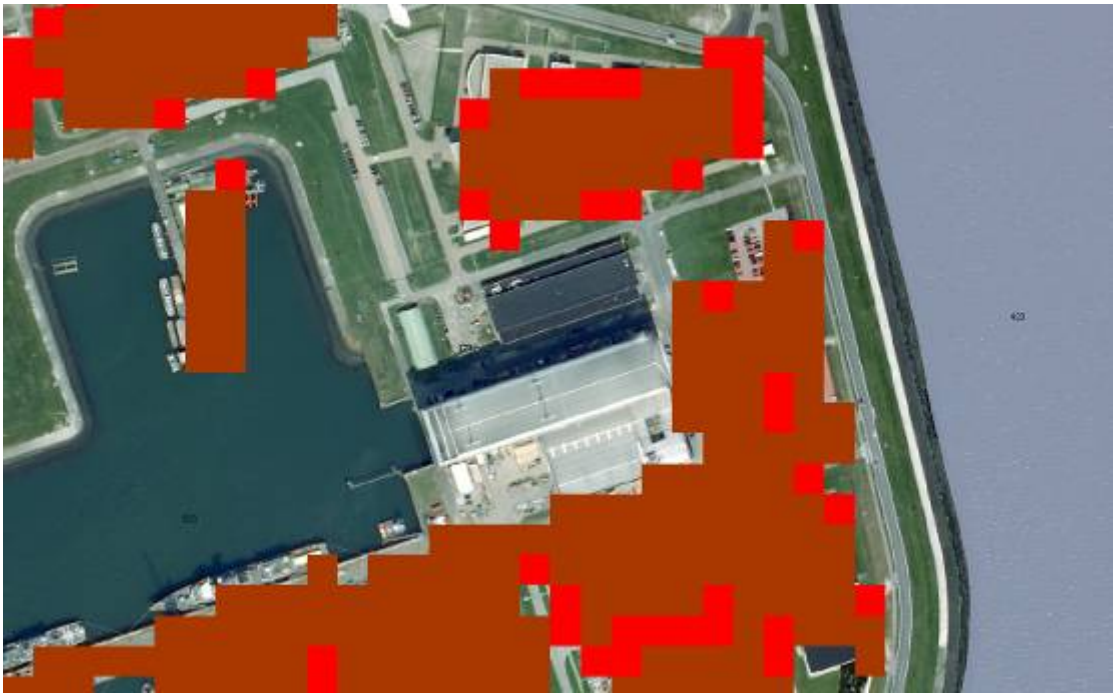

Figure 8. Buildings with black roofs in port area of province of Noord-Holland are not mapped as sealed areas (>80%).

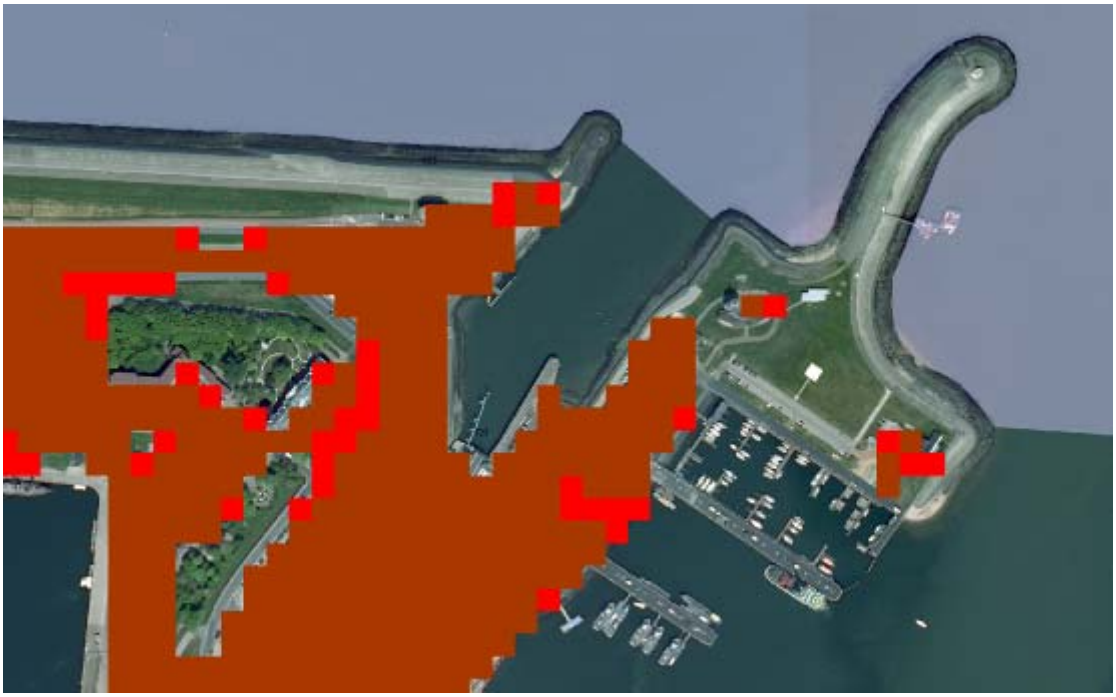

Figure 9. Dykes in the port area in Noord-Holland are not mapped as >80% soil sealed.

<u>Commission error:</u>

Not encountered.

Airports:

c. Did you check if built-up/non built-up areas in airports are correctly mapped (e.g. runways, buildings, etc)?

☒ Yes ☐ No ☐ Not possible

d. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☒ good ☐ excellent

e. Short description of errors found (if any):

Omission error:

Sporadically airstrips are not fully mapped as >80% soil sealed (Figure 10).

Figure 10. Airstrip near Rotterdam in province of Zuid-Holland. The airstrip is not completely mapped.

Commission error:

Not encountered.

Mine, dump and construction sites:

a. Did you check if built-up/non built-up areas in mine, dump and construction sites are correctly mapped (e.g. buildings, infrastructure, etc)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

f. Short description of errors found (if any):

Ommission error:

Not found.

Figure 11. Construction sites already mapped as sealed areas in the province of Noord-Holland.

Comission error:

Figure 11 shows that construction sites are inconsequently mapped. A lot of bare ground is mapped as sealed. Also BBG doesn't show build areas.It's not totally clear why some areas are mapped as sealed while other areas with the same structure are not.

Arable land:

a. Did you check if built-up/non built-up areas in arable land are correctly mapped (e.g. bare soil, large farm houses, roads>20m width, etc)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☒ insufficient ☐ acceptable ☐ good ☐ excellent

g. Short description of errors found (if any):

Ommision error:

Figure 12 shows the omissions of sealed areas in agricultural areas (arable land). Mainly the areas are inconsequently mapped as sealed or non-sealed.

Figure 12.Inconsequently mapped small stripes of buildings (ribbon building) along rivers/canals in the province of Drenthe.

Figure 13. Some small areas in agricultural areas are unjustified mapped as sealed (province of Limburg).

<u>Commission error:</u>

Figure 13 shows that there are several areas that are mapped as soil sealed arable land, but according to aerial photographs and Top10 they are not.

Heterogeneous agricultural areas:

a. Did you check if built-up/non built-up areas in heterogeneous agricultural areas are correctly mapped (e.g. buildings, roads >20m, etc)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

h. Short description of errors found (if any):

Omission errors:

Figure 14 shows omission errors which mostly take place in areas that are sparsely populated.

Figure 14. Sparsely populated areas in the class complex cultivation patterns (province of Drenthe).

Commission errors:

Bare soils (construction sites?) in classes 242/243 are sometimes mapped as sealed areas.

Figure 15. Bare soils in the province of Limburg that are unjustly classified as sealed areas.

Forest:

a. Did you check built-up/non built-up areas in forests are correctly mapped (e.g. clear-cuts, roads, etc.)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

i. Short description of errors found (if any):

Omission errors:

Figure 16. shows that not every building is mapped as built-up (more than 80% soil sealed). This occurs in areas that are scarcely populated and in areas where buildings are (partly) hidden by forest areas.

Figure 16. Omission errors in the province of Friesland.

Commission errors:

They are not present when looking for areas with sealing between 80 – 100 %.

Scrub and/or herbaceous vegetation associations:

a. Did you check if built-up/non built-up areas in scrub and/or herbaceous vegetation areas are correctly mapped (e.g. dry vegetation, rock outcrop, etc.)?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☒ good ☐ excellent

j. Short description of errors found (if any):

Omission errors:

Figure 17 shows that the left building within this area is not mapped, while the right building is mapped. Perhaps it is too small. This is frequently found in areas where there are not a lot of buildings.

Figure 17.A frequently encountered omission error in sparsely populated natural grassland areas (province of Zuid-Holland).

<u>Commission errors:</u>

Figure 18 shows that there are several areas mapped as built-up, but they are not really for more than 80% soil sealed. Perhaps this is due to differences in structure and/or reflectance (bare soils)?

Figure 18. Inconsequently mapped built-up areas in natural grasslands in the province of Friesland.

Beaches, dunes and sands:

a. Did you check if built-up/non built-up areas in beaches, dunes and sand areas are correctly mapped?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

k. Short description of errors found (if any):

Omission errors:

Figure 19 shows omission errors for a dune area with holiday houses. The pattern of built-up (soil sealing >80%) looks to be random or is it due to the size of the buildings.

Figure 19. Holiday houses randomly mapped as built-up in a dune area in the province of Friesland.

Commission errors:

There are a few commissions errors found (Figure 20). These errors have to do parking areas and/or roads.. Sometimes theys are next to sand or grass that is also mapped as built-up.

Figure 20. Parking area with next to it a commission error (province of Friesland).

Bare rocks:

a. Did you check if built-up/non built-up areas in bare rock areas are correctly mapped?

☐ Yes ☐ No ☒ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☐ good ☐ excellent

l. Short description of errors found (if any):

Sparsely vegetated areas:

a. Did you check if built-up/non built-up areas in sparsely vegetated areas are correctly mapped?

☐ Yes ☐ No ☒ Not possible

c. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☐ good ☐ excellent

m. Short description of errors found (if any):

Glaciers and perpetual snow:

a. Did you check if built-up/non built-up areas in glaciers and perpetual snow areas are correctly mapped?

☐ Yes ☐ No ☒ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☐ good ☐ excellent

n. Short description of errors found (if any):

Inland wetlands:

a. Did you check if built-up/non built-up areas in inland wetlands are correctly mapped ?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☒ good ☐ excellent

o. Short description of errors found (if any):

Omission error:

Figure 21 shows that in areas where the buildings are sparse they are inconsequently mapped.

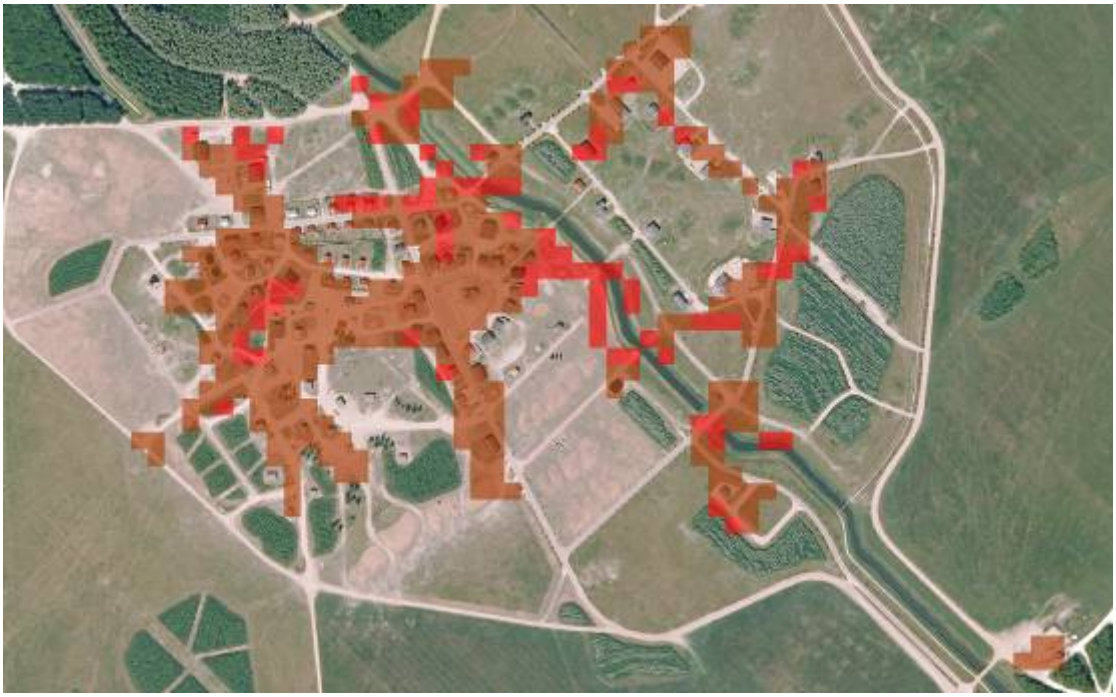

Figure 21. Buildings in a wetland area in the province of Groningen. Omission and commission errors.

Commission error:

Figure 22 shows that an area is mapped as built-up, but there are no buildings present. Reflectance of bare soil or inundated land looks like a built-up area.

Figure 22.Commission error in a wetland area in the province of Groningen.

Salines:

c. Did you check if built-up/non built-up areas in salines are correctly mapped?

☐ Yes ☐ No ☒ Not possible

d. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☐ good ☐ excellent

p. Short description of errors found (if any):

Intertidal flats:

a. Did you check if built-up/non built-up areas in intertidal flats are correctly mapped?

☒ Yes ☐ No ☐ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☒ good ☐ excellent

q. Short description of errors found (if any):

Commission error:

Figure 23 shows that some areas that are mapped as built-up while they're not. The reflectance of the bare soil has been classified as built-up area.

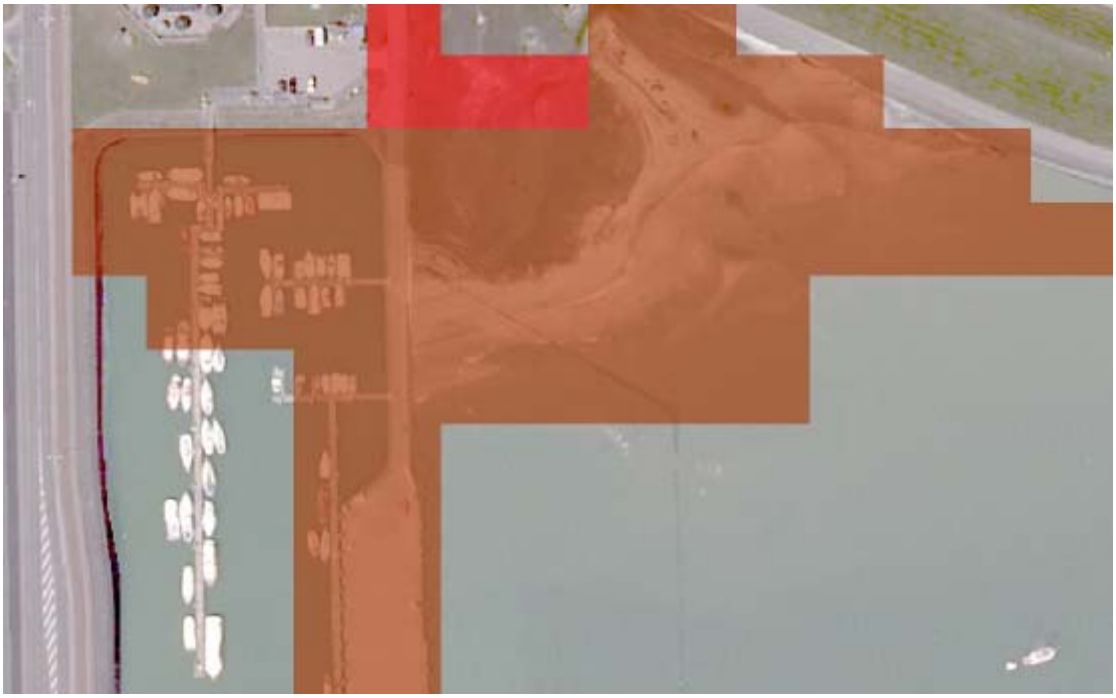

Figure 23.Intertidal area in the province of Friesland with commission errors.

Coastal lagoons:

a. Did you check if built-up/non built-up areas in coastal lagoons are correctly mapped?

☐ Yes ☐ No ☒ Not possible

b. How would you assess the quality?

☐ very poor ☐ insufficient ☐ acceptable ☐ good ☐ excellent

r. Short description of errors found (if any):

3. Comments concerning thematic content check (if any). Please indicate which part of the data was verified (full coverage or partial coverage, etc.):

Total coverage was checked at randomly chosen locations.

D. Overall qualitative assessment of the dataset

The overall qualitative assessment is meant to support EEA in our contractual procedures with the service provider regarding the acceptance of the dataset. While the previous thematic quality assessment was looking at class by class, this section should provide your assessment of the quality for the whole territory.

How would you assess the overall quality of the mapped built-up/non built-up areas for the dataset provided?

☐ very poor ☐ insufficient ☒ acceptable ☐ good ☐ excellent

Please provide your final comments and additional remarks concerning overall qualitative assessment (e.g. difference in quality between regions e.g. mountains, agglomerations, coastal zones, etc), if any:

1. The qualitative assessment is based on soil sealing levels of 80% or higher. Taking all percentages (1-100%) of soil sealing into account the overall assessment would be upgraded. For example insufficient would be acceptable.
2. Pattern of pixels with more than 80% soil sealing looks to have a random pattern. Why a pixel next to a pixel with more than 80% sealing is not sealed in the same amount? This is often the case in areas that are sparsely populated (not densely urbanised) or partly covered with forest.
3. Reflectance of bare soil/sand is often classified as built-up.
4. Black roofs are often not mapped as built-up.

E. Quantitative validation

Are you planning to carry out a statistical validation (quantitative assessment) of the national dataset?

☐ Yes ☒ No

If yes, it would be helpful to provide us information about the timing, methodological approach or any other additional information which might be available:

We are willing to do it but at the moment time and money are not lacking.

Are you willing to contribute to the final validation of the European dataset (actions scheduled from the second half of 2008 onwards)?

☒ Yes ☐ No

Filled in by Gerard Hazeu and Judith Oldengarm

Telephone number: ++31 317 481928

Email address: gerard_hazeu@wur.nl

Date: March 21st 2008

Thank you!