**Final**

# Guidelines for verification of high resolution soil sealing layer

## - Qualitative assessment -

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## 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** |
|---|---|---|
| Hanna Piepponen | Geoinformatics and Remote Sensing | Finnish Environment Institute (SYKE) |
| Pekka Härmä | Geoinformatics and Remote Sensing | Finnish Environment Institute (SYKE) |
| | | |
| | | |

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: Area: Full country

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

2. Aerial orthophotos

☐ No ☒ Yes Year: Area: Subset

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. CLC2000

☐ No ☒ Yes

5. Other

Name: building database Year: 2007 Area: Full country

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

Name: NDVI-index Year: 2006 Area: Full country

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

Name: Digiroad - road network Year: 2005 Area: Full country

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):

The evaluation was done by using a reference data which was formed by combining accurate data from different sources to a raster layer, so called "urban layer", with 25m cell size. The layer was created by combining together Finnish building database, roads from Finnish road network, some classes from Corine 2000 and NDVI-index which was calculated from year 2006 HR satellite images. As a result, we got the reference data, whose each pixel value indicated what kind of land use dominated in the area of pixel.

The reference data was classified by using classification shown in "*qualitative assessment -report*". Classes "urban fabric", "industrial or commercial units", "Road networks", "Port areas", "Airports" and "Mines, dumps and construction sites" were assumed to be built-up areas while other classes were assumed to be non-built-up areas. The reference data was compared to base maps and aerial images to verify it's accuracy. Verification showed that the reference data could very well recognize urban areas in Finland even though it slightly overestimated smallest built-up areas. To overcome this uncertainty values with overestimation were multiplied with 0,8.

For qualitative assessment, delivered "soil sealing" dataset was resampled to 25m and 100m resolution rasters and divided into two parts: build-up and non-build-up areas. This was done by using thresholds 80%, 50% and 25%. Also the reference dataset was resampled to 100m raster layer and divided into built-up and non-built-up areas with different thresholds.

Since the values in the classified soil sealing data with 100m spatial resolution are ranging boundlessly from 1 to 100%, the value of each pixel is given with the precision of 1%. The reference dataset has been formed from 25m raster with binary values, hence the value of each pixel in 100m generalization has the precision of only 6,25%. This uncertainty is corrected in the later analysis.

**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:

A small local shift (about 1 pixel) was found in the image taken from Puolanka. Coordinates of the bottom left corner of the image are (In Finnish Uniform coordinate system YKJ): 7160216, 3494430

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

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): The soil sealing data was systematically underestimating areas of urban fabric. This was problem especially in urban countryside and residential areas of towns. City centres and larger residential areas were found well. Threshold values had a significant impact on the results and threshold of 80% couldn't capture areas of urban fabric with sufficient accuracy.

**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): The data was able to find very well large industrial areas, but was lacking with smaller ones and those locating in the countryside and border areas.

**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): Biggest roads were classified correct, but the major part of the roads were wrongly classified. This is might due to small roads of Finland.

**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):

**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): Runways were captured almost in every airport. Green areas between the runways were always classified as non-urban. Smallest aeroports were found poorly

**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): About half of the mines, dumps and contruction sites were classified wrongly even though they were usually easy to detect even from satellite images. Peat production areas were not taken along this class.

**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): Over 99% of arable land was detected to non built-up areas and farm houses in the middle of fields were in most cases classidied as built-up areas. Some of the houses were captured only with lower values of threshold.

**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):

**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): Over 99% of forest were detected as non built areas. Roads in the middle of forest are usually very small and uncoated, hence they belongs naturally to non built-up class.

**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): Over 99% of scrubs were detected as non built-up areas

**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):

**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): Over 99% of bare rock areas were detected as non built-up areas

**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): Over 99% of sparsely vegetated areas was detected as non built-up areas

**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): Over 99% of inland wetlands were detected as non built-up areas

**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):

**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.):

The qualitative assessment was carried out by comparing the reference data (25m and100m cell size) and the classified data with thresholds of 80%, 50% and 25%. The evaluation was done first for the full coverage and later for few smaller areas. The evaluation showed, that threshold of 80% was too high for Finnish urban structure and lower threshold, for example 25% would be better in case of Finland. The value of threshold had especially high impact on the classification results of urban fabric and roads.

## 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:

The classified soil sealing data was correctly capturing all large non-urban areas whereas it was strongly underestimating the coverage of urban areas even with the lowest thresholds. There was substantial underestimation especially in residential areas, whereas large industrial areas, port areas and city centres were captured.

Part of the underestimation may be caused by differences in methods used to create the classified data and the reference data. However visual evaluation showed that in most cases the reference data is more reliable and that the underestimation of the classified data is actual. As a summary, the qualitative evaluation showed, that the classified data is suitable when mapping non-urban areas and large urban areas but it is misleading when mapping total urban areas.

## 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:

Simple quantitative validation was carried for the classified soil sealing data. More detailed information about validation and it's results are presented in attachment file "*FI_attachement.doc*"

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 Hanna Piepponen

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Date: 15.7.2008

*Thank you!*