

# **Verification of high resolution soil sealing layer, Germany**

## **- Qualitative assessment -**

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## Introduction

This document reports the **results of qualitative assessment of the HR soil sealing layer covering Germany**. It is integrated in the forms due to the “Guidelines for Verification of the High Resolution Soil Sealing Layer - Qualitative Assessment”, prepared by Chris Steenmans and Ana Sousa, EEA. Because of the short time to give back a response on the soil sealing product in Germany, only limited reference data could be integrated in the quality assessment. A more detailed analysis is planned for the German data set.

The **EEA document** (Steenmans and Sousa, 2007) 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
Manfred Keil	Remote Sensing, Land Cover	DLR Oberpfaffenhofen, DFD
Michael Bock	Remote Sensing, Land Cover	DLR Oberpfaffenhofen, DF

## 2. Reference data

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

### 1. Topographic maps

☐ No ☒ Yes Year: around 2005 Area: Please, select:

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

Parts of Lower Saxony

### 2. Aerial orthophotos

☐ No ☒ Yes Year: 1999, 2005-07 Area: Subset

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

regions of Bavaria, e. g. Munich (WMS serices)

regions of North Rhine Westphalia (WMS serices)

regions of Schleswig-Holstein (SH) (WMS serices)

regions of Baden-Württemberg (e. g. Mannheim) (WMS serices)

regions of Mecklenburg-Vorpommern (WMS serices)

### 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: Sealing maps ( structural types) Year: 2000 Area: Please, select:

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

City of Munich (see comment below)

Name: Year: Area: Please, select:

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

Comments concerning the reference data used (if any):

For most of the quality assessments, WMS services (digital orthophotos) have been used, partly, single digital orthophotos were also available from the time period of 2005 to 2007.

(compare:

<http://deutschlandviewer.bayern.de/deutschlandviewer/GermanyViewer.html>

Other references:

Stadt München, Referat für Gesundheit und Umwelt, Versiegelung nach Strukturtypen (Map Server, checked July / August 2008)

[http://maps.geo.arch.tu-muenchen.de/Rgumapserver?rm=Mapbrowse&mapsize=400+300&layers=l0+bgl0104+bgl0200+bgl0210+bgl0450&map=versiegelung\\_2000.dfo.map](http://maps.geo.arch.tu-muenchen.de/Rgumapserver?rm=Mapbrowse&mapsize=400+300&layers=l0+bgl0104+bgl0200+bgl0210+bgl0450&map=versiegelung_2000.dfo.map)

Bayerisches Landesamt für Umwelt, 2007, Satellitengestützte Erfassung der Bodenversiegelung in Bayern

<http://www.lfu.bayern.de/themenuebergreifend/fachinformationen/flaechenmanagement/versiegelungsstudie/index.htm>

## 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

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

The HR Soil Sealing Data for Germany was delivered in four stripes, characterized by different zones of Transverse Mercator (Gauss Krueger zones 2,3,4,5), Spheroid Bessel, connected with "Datum Bessel".

The indication of "Datum Bessel" came out to be wrong, the right characterization should be: "Datum DHDN, whole country (DE), to ETRS 89" which was introduced to the data sets..

The wrong indication "Datum Bessel" lead to small shifts about 30 to 50 m when overlaying data of two neighbouring zones (with the one of "Datum DHDN, whole country (DE), to ETRS 89".

### 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



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

*Comments:*

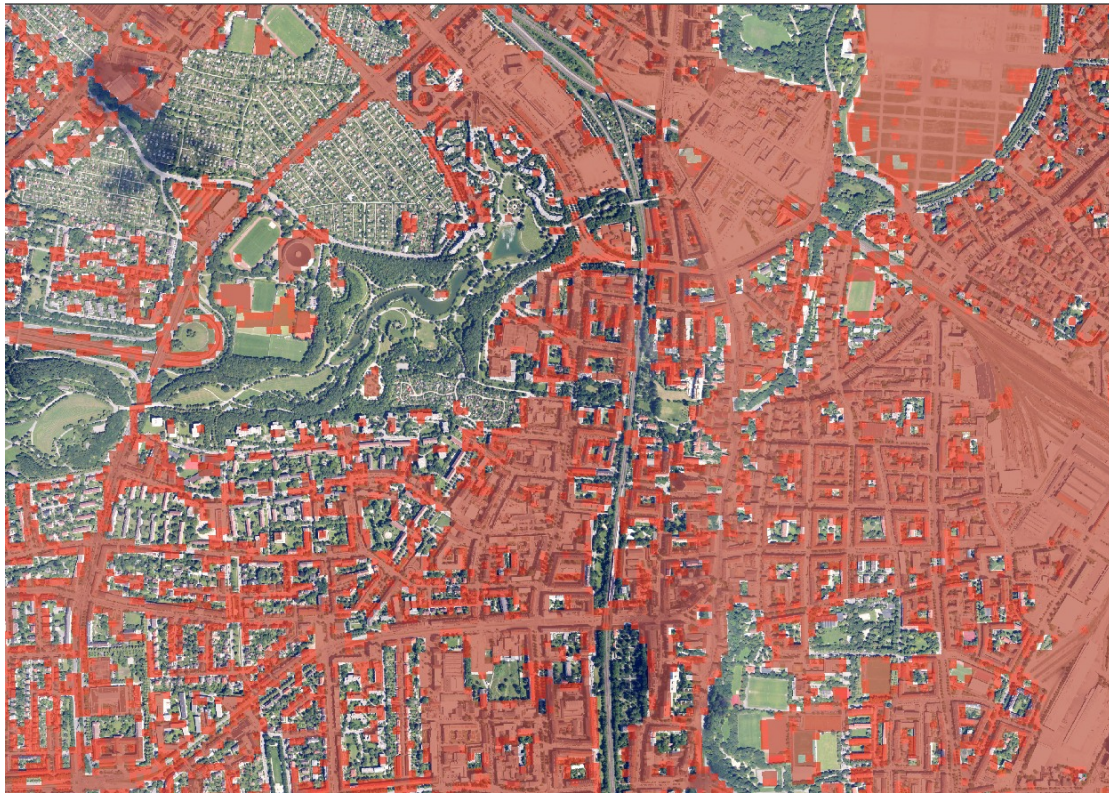
(1) **Urban fabric (denser urban):** Spatial geometry of mask is good but the 80 % mask included sealing > 70 %, and graduation above 80 % sealing is mostly insufficient - about 80 % of the build up class above 80 % is defined as 100 % sealed (saturation effects).

*Control areas:* Munich, selected towns in Bavaria, North Rhine Westphalia (NRW), Baden-Württemberg, Schleswig-Holstein (SH)



Western part of Munich





Built-up/non built-up areas detected in a Western part of Munich (sealing overlay in red colors, transparent)



Subset of block-wise sealing map (Munich; City of Munich, 2008, see above)



(2) *Urban fabric (low density, rural)*: Good: Even small housing was detected. Quality varies largely (between good and sometimes insufficient); spatial distribution of (> 80 %) sealed pixels in low-density areas is arbitrary. Sealing degree is often overrated by 20-30 %.

*Control areas*: Rural areas in Bavaria (overestimated), Lower Saxony and Schleswig-Holstein (SH)



Example of rural settlement in Bavaria



Different registration of built-up/non built-up areas (sealing overlay in red colors, transparent)



Example for a good representation of built-up/non built-up areas (sealing overlay in red colors, transparent), small community in North Rhine Westphalia

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

*Comments:*

Delineation is good, also in rural environments.

*Control areas:* Bavaria (Munich etc), NRW, SH, Baden-Württemberg (Mannheim etc.)



**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):

*Comments:*

If a minimum width of 20m is taking into account the quality is insufficient. But as it is impossible to achieve a good accuracy with 20m pixel size, 40m width were regarded as reference. Freeways are mostly mapped quite good, large railroad networks, too.

*Control areas:* Bavaria (Munich), NRW, Baden-Württemberg (Mannheim etc.)



Example for a good representation of built-up/non built-up areas including railroad network, part of Munich (sealing overlay in red colors, transparent),

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

*Comments:*

Delineation is good.

*Control areas:* Bremen, Mannheim

**Airports:**

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

*Comments:*

Delineation is good.

*Control areas:* Airports in Bavaria

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

*Comments:*

The whole mine areas are mapped, partly under or over estimated concerning degree of sealing

*Control areas:* Bavaria, NRW

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

*Comments:*

Even small farms are mapped, so sealing degree is often too high; some marginal misclassification of bare agricultural soil.

*Control areas:* Bavaria, SH, NRW

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

*Comments:*

Same as agricultural

*Control areas:* Bavaria, SH, NRW

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

*Comments:*

Good to excellent, only large roads (~30 m width) detected in wooden environment.

*Control areas:* Bavaria, Lower Saxony, NRW, SH.

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

*Comments:*

Sparsely vegetated areas including rocky outcrops sometimes mapped as sealed (only small areas checked).

*Control areas:* Bavaria, Pre-Alpine region

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

*Comments:*



Only small subset checked, here some “sealed” beach parts occurred.

*Control areas:* SH, Lower Saxony.

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

*Comments:*

Rocky or sparsely vegetated areas including rocky and pebble river shores are often mapped as sealed (same appearance as mining sites).

*Control areas:* Pre-alpine and alpine region Bavaria.



Example with river bed, pebbles and gravel pits in Southern Bavaria



Example shows misleading sealing and built-up/non built-up delineation (sealing overlay in red colors, transparent)



Other example with a river bed including pebbles and a gravel pit in Southern Bavaria



Example shows misleading sealing and built-up/non built-up delineation (sealing overlay in red colors, transparent)

**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

- b. How would you assess the quality?

☐ very poor

☐ insufficient

☒ acceptable

☐ good

☐ excellent

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

*Comments:*

Sparsely vegetated areas including rocky and pebble river shores are often mapped as sealed (same appearance as mining sites).

*Control areas:* Pre-alpine and alpine region Bavaria.

**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

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

*Comments:*

No interference detected so far

*Control areas:* Bavarian Alps (Berchtesgaden).

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

*Comments:*

No interference for wetlands (inland marshes, peat bogs).

*Control areas:* Wetlands in SH, Lower Saxony and Bavaria.

**Salines:**

- a. Did you check if built-up/non built-up areas in salines are correctly mapped?  
☐ 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):

**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

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

*Comments:*

No interference.

*Control areas:* Areas in the coastal zone SH, Lower Saxony, Mecklenburg.

**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
- c. 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.):

As stated before, up to now only some characteristic subareas could be checked concerning the quality of built-up / non built-up areas and sealing levels. Further assessments are planned.

The 80% mask for sealed areas seems to be somewhat over-estimated, even areas of about 70% seem to be integrated in this level. Eventually some “calibration” or “correction” of this level can be made. The reason will be saturation effects for high levels of sealed surfaces.

The general distribution of higher sealed areas is good.

The effects of detected built-up areas in non built-up areas (e.g. on rocky parts and river beds) are altogether (over all land cover classes) marginal.

An acceptance of the high resolution sealing layer for Germany is recommended on behalf of DLR-DFD, in agreement with UBA Dessau.

#### **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:

For settlement areas, the overall results shows acceptable up to good representations of built-up / non built-up areas.

## E. Quantitative validation

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

☐ Yes

☐ No

not yet clear

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

It could not yet be decided if a quantitative assessment of the national dataset will be performed (because of the narrow timeline to conclude the CLC2006 assessment in Germany).  
At least, a broader qualitative assessment, including additional reference areas, is planned.

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 Manfred Keil

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Email address: Manfred.Keil@dlr.de

Date: 14-August-2008

*Thank you!*