

Final

# **AUSTRIA: verification of high resolution soil sealing layer**

**- Qualitative assessment -**

**Prepared by:**

Gebhard Banko

**04.01.2008**

Version 1.0

Umweltbundesamt

## 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).

## 0. Remarks

### definitions

The definition of soil sealing as defined in the EEA-guidelines for the verification and the definition used for the production of the soil sealing layer varies significantly.

#### EEA:

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.

#### production (EEA-FTSP-Sealing\_CountryDeliveryReport-AT\_F1v0.pdf)

Built-up area therefore comprises pixels that are fully or partly covered by houses, roads, **mines and quarries** and any other facilities, including their auxiliary spaces, **deliberately installed for the pursuit of human activities**. Built-up area does not include any fully vegetated pixels, even if they are closely related to these activities (such as city parks and gardens), or any other unvegetated non-built-up open spaces covered with bare soil, sand, glacier, bare rocks or water.

Discussion: The question for the verification that remains is, if a row of classes is considered as sealed area:

- forest and agricultural roads
- mines and quarries
- vegetated street slope
- parking lots without artificial cover
- ....

### data sets

The dataset delivered refers to the 20\*20m continuous sealing layer. However the verification process calls for the verification of the 100\*100m built-up mask. Depending on the algorithm used for the generalization of the 100\*100m mean values and using a 80% threshold the result may vary. Therefore we would recommend to distribute both datasets –

- the original 20\*20 m continuous layer and the
- 100\*100m mean sealing layer

to the countries for final validation.

### 80% threshold

The threshold for built-up area in the amount of 80% sealed area is to our opinion not applicable to normal settlement structures in Europe. With a 80% threshold on a 100\*100m cell mainly industrial areas, commercial units and the core-centres of larger cities are captured. Whereas the main parts of normal settlement structures have sealing values between 25-75%. These settlement structures are not represented in this “built-up” dataset with the 80% threshold.

Qualitative assessment HR soil sealing layer

Therefore the current 100\*100m dataset with the 80% threshold applied is not meaningful for a Austrian-wide usage.

## 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:

<b>Expert name</b>	<b>Field of expertise</b>	<b>Institution</b>
Gebhard Banko	land cover classification	Umweltbundesamt
Martin Hölzl	aerial image interpretation	Umweltbundesamt
Robert Höller	aerial image interpretation	Umweltbundesamt

The average time needed for this verification is estimated at one person/day per 10.000 km<sup>2</sup>. 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.

<b>Country</b>	<b>Area (km<sup>2</sup>)</b>	<b>Person days</b>	<b>Country</b>	<b>Area (km<sup>2</sup>)</b>	<b>Person days</b>
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:

Please, select:

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

### 2. Aerial orthophotos

No                       Yes                      Year: 2001-2007                      Area: Full

Country

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:                      Year:                      Area: Please, select:

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

Name:                      Year:                      Area: Please, select:

Qualitative assessment HR soil sealing layer

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):

aerial images as orthofotos with a resolution of 1\*1m were used for the validation. They are updated in a 5-year cycle for the whole country and are available for the project, as the Austrian ministry for agriculture co-finances the CLC project and acquires the aerial images together with the federal provinces for the control of agricultural measures.

## 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 – in Liechtenstein       No –  
in Austria

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:

100m shift ONLY in Liechtenstein. In Austria geometry is very well.
---

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:

projection for Liechtenstein should be checked, as we have reported a 100 m shift in Liechtenstein
--

### C. Thematic quality

**COMMENT: in Austria a semi-quantitative approach was used. FÖMI selected more than 2.500 sample points – results are documented under E**

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):

**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):

**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):

**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):

**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):

**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):

**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):

**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):

**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):

**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):

**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?

Qualitative assessment HR soil sealing layer

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.):



#### **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:

## 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:

Description:

The Umweltbundesamt together with FÖMI applied the recommendations (Recommendations\_GMES-HR-soil\_sealing\_final031207.doc) for the quantitative assessment high-resolution soil sealing layer.

SAMPLING:

- stratification
  - areas >1.600 m of altitude are excluded from the sampling procedure
  - rule based on a 250\*250m DHM
- sampling:
  - 500 samples in classe built-up ( $\geq 80\%$  sealing in 1 ha grid cell)
  - 2.000 samples in rural areas
  - additional 129 samples in class 1-79% sealed

- interpretation

phase 1: training of interpreter

- \* appr. 20 urban cells and 20 rural cells
- \* usage of Orthofotos 1m resolution ( $\geq 2000$  reference year)
- \* creation of a interpretation grid 10\*10 m within the 100\*100m cells
- \* calculation of % sealing value for 1 ha cell by counting in total 100

sealed points (regular 10\*10m grid)

phase 2: visual interpretation

- \* max. 500 urban cells and 2.000 rural cells
- \* estimation of sealing percentage by counting sealed points in a 10\*10m grid (total 1000 points per 1 ha cell)
- \* usage of Orthofotos 1m resolution ( $\geq 2000$  reference year)
- \* documentation of orthofoto date (year) for each interpretation cell

phase 3: control of interpreter-trends

- \* every 50. cell will be double checked by the same interpreter, without that the interpreter knows, that he is interpreting the cell the second time.
- \* comparison of the two interpretation values of the same interpreter
- \* trend correction of interpreter

phase 4: accuracy assesement

\* only those points will be used for accuracy assessment, where the orthofoto is +/- 2 years around 2006, in exceptional cases +/- 3 years

\* applying ETC-LUSI formulas for calculating confusion matrices and error estimates

RESULTS: see also attached EXCEL-file

confusion matrix:

	Interpreter		
Raster	0	80	Total
0	2012	3	2015
80	123	373	496
Total	2135	376	2511

errors:

		reliability
overall accuracy	95,0%	
<b>comission errors</b>	<b>24,8%</b>	<b>+/- 2 %</b>
omission errors	0,6%	impossible
P class	0,4%	
exclusion areas	17%	mountains

CONCLUSIONS:

Due to the very low total coverage of the built-up area in Austria (only around 0,4 %) the omission error can NOT be calculated with a realistic amount of samples.

The commission error is 24,8+/-2 % is higher than the foreseen error threshold of 15%. Therefore the database should be corrected.

DISCUSSION:

As this was the first time the recommended quantitative assessment of the quality of the soil sealing layer was carried out, the results should be taken with care. On the one side definition problems still have to be discussed, and on the other side reference data issues have to be evaluated carefully. For the above mentioned confusion matrix only aerial images from 2000 onwards were used. But in dynamic areas major mistakes can result from a time lage of 4-5 years. the interpreters encountered a row of examples, where e.g. in the neighbourhood of quarries it is very likely that the quarry got enlarged in the last 4-5 years, but this was not visible on the aerial image, but most likely the satellite image from the reference year 2006 showed already an increased area.

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

x  Yes                       No

Qualitative assessment HR soil sealing layer

Filled in by Gebhard Banko

Telephone number: +43-1-31301-3330

Email address: gebhard.banko@umweltbundesamt.at

Date: 7.1.2008

*Thank you!*