



Delivery Report Liechtenstein

EEA-FTSP-Sealing_CountryDeliveryReport-LI

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document presents the country delivery report of EEA's Fast Track Service Precursor Sealing Product of Denmark.

According to the Tender Specifications, this report corresponds to deliverable 5 (38 Country delivery reports).

1.2 APPLICABLE DOCUMENTS

ITD-0490-PRO-0006	Proposal responding to EEA's Invitation for Tender, Technical Offer including Management Part –Issue 1

1.3 REFERENCE DOCUMENTS

EEA/IDS/07/001	Tender Specifications "GMES Fast Track Service on Land Monitoring", EEA, 2006
ISO9001	ISO 9001: 2000 Standard
ITD-QMS-POL-0001_Infoterra_Quality_Policy	Quality Policy Statement
QMS-ITD-MA-0011_QMSManual_I3.1	Quality Management System (QMS) Manual
ITD-UMS-POL-0001_Infoterra_Environmental_Policy	Declaration of Enterprise Environmental Policy
ITD-QMS-STD-0001-ControlOfDocumentation	Control of Documentation and Data
QMS-ITD-ST-0001_CSM	Customer Satisfaction Measurement
QMS-ITD-PR-0003_PM_ProductDevelopment_I4	Project Management, Product (Prototype) Development and Production

2 DATA SPECIFICATIONS

2.1 TECHNICAL PRODUCT SPECIFICATION

Content
<i>Raster dataset of built-up and non built-up areas including continuous degree of soil sealing ranging from 0 - 100% in full spatial resolution (20 x 20 m) with the associated metadata.</i>
Geographic coverage
<i>Country of Liechtenstein (LI)</i>
<i>Coverage [km²]: 160 km² (plus additional buffer of 200 meters outside of country border)</i>
Input data sources
<p><u>Input data provided by ESA:</u></p> <ul style="list-style-type: none"> ▪ <i>Orthorectified satellite data coverage for Europe (Image2006), acquired primarily in the reference year 2006 (+/- 1 year), covering two dates, used sensors SPOT 4 and 5 (HRVIR) and IRS-P6 LISS-III:</i> <ul style="list-style-type: none"> • <i>20 m resampled (with cubic convolution interpolation)</i> • <i>4 spectral bands</i> • <i>Max. 5% cloud coverage</i> • <i>Covering 2 dates, at least 6 weeks apart from the respect. scene selected for the first coverage</i> • <i>Orthorectified towards national projection systems (used DTM unknown)</i> • <i>Delivery on a country by country basis foreseen</i> • <i>Metadata to each scene</i> <p><u>Input data provided by EEA</u></p> <ul style="list-style-type: none"> ▪ <i>Dataset with national country borders (to be used for clipping the data at a national level) as defined and provided by the EEA</i> <p><u>Ancillary input data</u></p> <ul style="list-style-type: none"> ▪ <i>National Corine Land Cover 2000 data in vector format to be used for the stratification of the QA sample plots</i>
Methodology
<i>Supervised classification of built-up areas with following visual improvement of classification result and derivation of degree of soil sealing based on calibrated NDVI</i>
Geometric resolution
<i>Pixel resolution 20 x 20 m</i>

Coordinate Reference System
<i>Lambert_Conformal_Conic</i>
<i>False_Easting: 400000,000000</i>
<i>False_Northing: 400000,000000</i>
<i>Central_Meridian: 13,333333</i>
<i>Standard_Parallel_1: 46,000000</i>
<i>Standard_Parallel_2: 49,000000</i>
<i>Scale_Factor: 1,000000</i>
<i>Latitude_Of_Origin: 47,500000</i>
<i>Datum: D_Bessel_1841</i>
Geometric accuracy (positioning scale)
<i>According to orthorectified satellite image base delivered by ESA</i>
Thematic accuracy (in %)
<i>Classification accuracy per hectare (based on 100 x 100 m grid) of built-up non built-up areas is > 85% (assessed according approach as described in chapter 4.1)</i>
Accuracy assessment approach
<i>Accuracy assessment based on random sample plots</i>
Delivery format
<i>IMAGINE Image (IMG)</i>
Data type
<i>Raster</i>
Raster coding
<i>Thematic pixel values</i>
<i>0 – Non-built up areas, water bodies inland</i>
<i>1-100 - sealing values for built-up areas</i>
<i>254 – Unclassifiable areas (clouds, shadows, etc.)</i>
<i>255 – No Data (No thematic information)</i>
Metadata
<i>According to EEA metadata standards (EEA MSGI specification)</i>
Ancillary Data – Mitigation shape file
<i>Metadata set per delivered country in vector format defining all areas which deviate from the ITT's EO data specifications (i.e. clouds, acquisition date). The vector layer is derived from image footprints and cloud cover information of Image2006 within the country border.</i>
<i>The attribute table contains information about WU identification and possible deviations from the standard</i>

specifications of Image2006:

- *[Cntr]* Country Code;
- *[SCU]* Number of Sub-Country unit containing the Working Unit;
- *[WU_ID]* Full name of the Working Unit;
- *[No_acqu]* Number of acquisitions within the WU; 0 = gap / no image available;
- *[Out_Veg]* No of acquisition dates outside of country-specific vegetation period;
- *[Below_6w]* Acquisition dates less than 6 weeks apart;
- *[Cloud_cov]* Thematic value indicating the cloud coverage: No clouds = 1; Clouds present in coverage 1 = 2; Clouds present in Coverage 2 = 3; Clouds present in both coverages = 4

2.2 ALGORITHMS USED

The aim of the image processing is to derive in a robust, reliable and reproducible way based on satellite images (Spot 4/5, IRS LISS) a raster dataset of built-up and non built-up areas including continuous degree of soil sealing ranging from 0 - 100% in full spatial resolution (20 x 20 m).

As the main challenge, the derivation of a continuous degree of soil sealing has to be solved. The proposed image processing approach is based on the fact that a reliable derivation of soil sealing degrees is not possible directly from the vegetation index. Low vegetation index values, which are characteristic for densely built-up areas are e.g. also found in bare soil areas of agricultural fields. Even when using multi-temporal satellite images with different acquisition dates in combination with bi-temporal, multi-spectral classification techniques the result may be improved, but the vegetation indices of two acquisitions are still too ambiguous.

Therefore, the proposed image processing approach will start with deriving a binary map of built-up areas and then further subdivide this area into 100 degrees of soil sealing, ranging from totally sealed surfaces (100% degree of soil sealing) up to built-up areas with extensive vegetation cover (1% degree of soil sealing). This allows the final user to aggregate the continuous values as required.

To be viable for this objective the classification methodology has to fulfil the following general criteria:

- Allow for local calibration of parameters used per working sub-area (as defined by satellite images) to overcome diversity of different regions in Europe and image immanent characteristics (such compensating for different settlement structures, ecozones, phonological and weather conditions).
- Deliver the required accuracy
- Maximise consistency and objectivity of the results all over Europe
- Maximise cost-efficiency under given constraints

- Maximise standardisation of production and working motivation of the analysts
- Secure realisation in due time.

Based on these criteria, the proposed methodological approach consists of the following main steps:

- a) Data preparation & management: Provision of spatial database of bi-temporal satellite images and derived working sub-areas ("Working Units" = WU) to be processed in the following steps
- b) Core processing, containing the 3 main processing steps:
 - (1) Hybrid automated classification with supervised and unsupervised elements, leading to binary maps of built-up area
 - (2) Manual correction of the binary built-up map to obtain the required quantitative thematic accuracy (85%) as well as good qualitative results
 - (3) Derivation of degree of soil sealing based on the NDVI (Normalised Difference Vegetation Index)
- c) Generation of sub-country / country data sets
- d) Accuracy assessment
- e) Re-projection & mosaicing, generation of seamless European dataset.

2.3 FORMAT DESCRIPTION

Delivery format
<i>ERDAS IMAGINE Image (IMG)</i> <i>Data Type: unsigned 8-bit</i> <i>Compression: Run-length encoding (ESRI)</i> <i>Number of bands: 1</i> <i>Pixel size: 20 m</i>
Data type
<i>Thematic Raster</i>
Metadata
<i>According to EEA metadata standards (EEA MSGI specification)</i>

2.4 METADATA

See European Environment Agency – Metadata Standard for Geographic Information (EEA-MSGI), Version 1.1a (18 August 2004).

The metadata is provided as XML-file and as PDF-document according to EEA Metadata Standard for Geographic Information (EEA-MSGI).

3 SUMMARY OF PRODUCTION

3.1 TIMETABLE, PRODUCTION MILESTONES

Delivery by ESA	Data Reception	Data Preparation		Received by SP	Production	
		Start	End		Start	End
20.07.2007	24.07.2007	25.07.2007	11.09.2007	11.09.2007	12.09.2007	19.10.2007

3.2 TECHNICAL PROBLEMS ENCOUNTERED, MITIGATION MEASURES

The analysis of the GIS metadata file w.r.t. to the ITT's specifications yielded the following results for Liechtenstein (total area: 175 km² incl. 200m buffer area on country borders):

- Number of acquisitions: 2, i.e. no gaps in image coverage
- Country area outside of vegetation period April-October: 0 km² (0,0%)
- Country area with acquisition dates less than 6 weeks apart: 0 km² (0,0%)
- Cloud coverage: No clouds in both coverages

4 ACCURACY ASSESSMENT REPORT

4.1 DESCRIPTION OF APPROACH

The derivation of accuracy measures as agreed with EEA includes the following steps:

1. Definition of 100 x 100 m reference grid in national projection of the respective country assessed
2. Stratification of the area based on Corine Land Cover level I. To emphasize the accuracy assessment in the urban areas, 50 % of the sample plots are placed within CLC class Artificial Surfaces, the other 50 % are placed in the remaining classes.
3. Cluster based random sampling based on 100 x 100 m reference grid, defined per single nation, number of samples adapted to nation size in km²
4. Re-projection of reference samples to allow overlay with Google Earth
5. Estimation, if reference cell will be labelled as "built-up" according to EEA definition or not (80% threshold degree of soil sealing) taking into account the visibility of objects in the satellite images used for the production of the raster product (technically possible also when using Google Earth¹)
6. Estimation of overall accuracy to generate accuracy measure (overall accuracy, user accuracy, (commission error), producer accuracy (omission error), per single nation (for internal use & validation only) and for European dataset for publication by EEA.
7. Adaptation of statistics with regard to the mitigation shape file. All sample plots falling within areas of the raster product, where the underlying IMAGE2006 data has been identified to fail the ITT's specifications, are not included in the final statistics. This includes areas where
 - Less than two coverages of EO data are available
 - One or more acquisition dates are outside the defined acquisition window
 - The acquisition dates of the two coverages used are less than six weeks apart
 - Cloud cover is present in one or more coverage

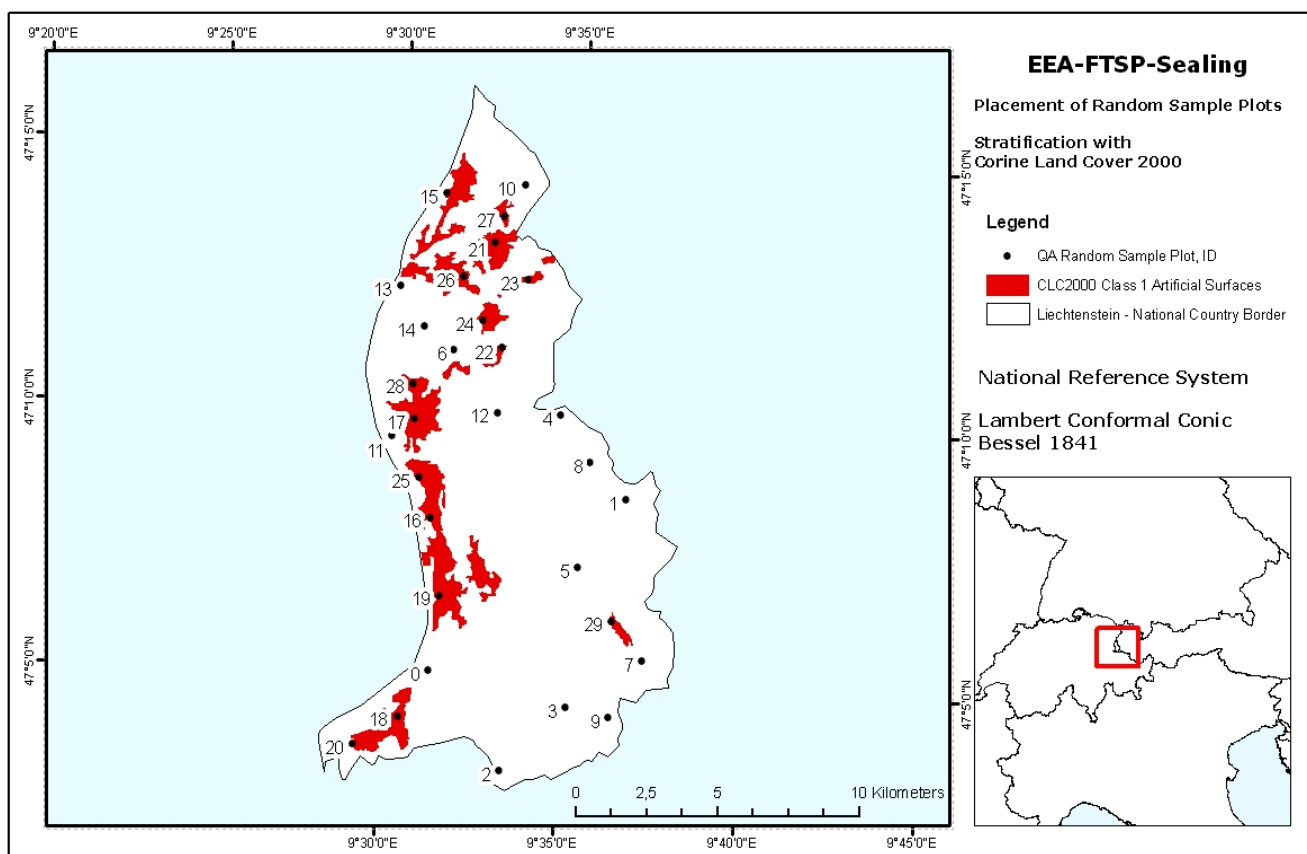
The built-up raster product which is subject to the accuracy assessment is accepted as according to the specifications if the final statistics indicate an overall accuracy of more than 85 %.

Accuracy assessment is performed per country product for internal quality control. For final acceptance by EEA, the overall accuracy of the European product is arbitative.

¹ using web-based information input to a local server

4.2 SAMPLE PLACEMENT (STRATIFICATION, NUMBER & LOCATIONS OF SAMPLE SITES)

Overall number of sample plots : 30 (15 within CLC2000 Artificial Surfaces). The figure below shows the placement of sample plots (black dots) within CLC urban areas (red areas) and outside.



4.3 FINAL RESULT

The final accuracy assessment for the country product surpassed the threshold of an overall accuracy of 85 %.

	Classification			Producer's Accuracy	Omission Error
	>80%	<80%	Σ		
Validati- on	>80%	1	1	2	50,0%
	<80%	1	27	28	96,4%
	Σ	2	28	30	
	User's Accuracy	50,0%	96,4%		
	Commission Error	50,0%	3,6%		
	Overall Accuracy	93,3%			

(see Annex 3 for detailed sample plot results)

5 DETAILED LIST OF PROVIDED DATA

- Raster dataset of built-up and non built-up areas including degree of soil sealing, 2006, in full spatial resolution (20 m x 20 m).
- ArcMap Legend File for raster data set for plotting a degree of soil sealing, aggregated to thematic classes
- ArcMap Legend File for raster data set for plotting a degree of soil sealing in a range from 1-100 %
- Mitigation shape file; metadata set per delivered country defining all areas which deviate from the ITT's EO data specifications.
- XML-Metadata of raster and vector data after EEA specifications
- EEA Metadata Stylesheet
- Report per Country with description of raster and vector data, country specific production & mitigation issues (the document at hand)
- Product inspection sheet for outgoing deliveries, ensuring product conformity of raster dataset
- National country borders in national projection

ANNEX 1: INTERPRETATION GUIDELINE FOR VISUAL CORRECTION

Objective

To produce a pixel-based high-resolution layer of built-up areas including degree of soil sealing for the EEA member states of homogeneous look & feel with an overall thematic accuracy of 85%.

Definition of Built-up Areas

Built-up areas according to the consortium definition are represented by a degree of soil sealing between 1 and 100%.

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.

(modified according to http://glossary.eea.europa.eu/EEAGlossary/B/built_up_land)

The FTS in Relation to Corine Land Cover

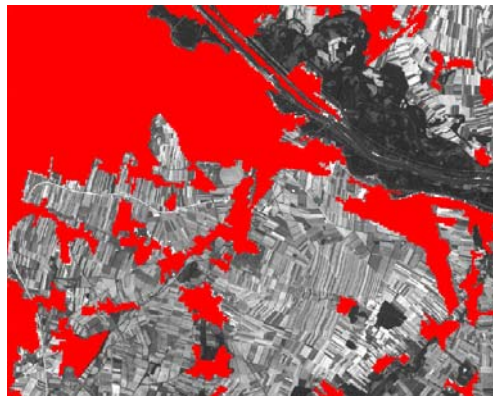
The FTS high resolution core land cover data is a complementary element of the GMES Fast Track Services. The data set will be a land cover product, reflecting actual ground cover on a pixel by pixel level rather than functional properties.

CLC level 1 class 'artificial surfaces' contains artificial surfaces and functionally related vegetated areas, reflecting the land use aspect. Therefore a significant part of this CLC level 1 class contains vegetated areas composed of fully vegetated pixels. However, in the FTS product only pixels that contain some built-up/sealed area will be included.

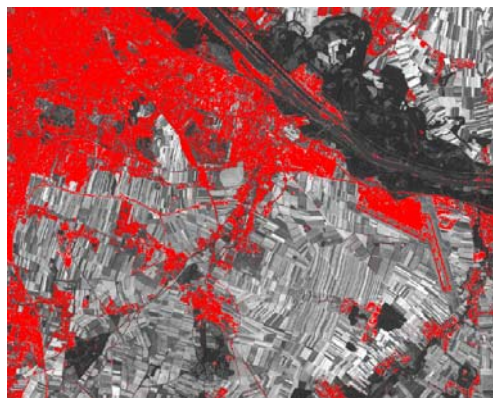
In addition, built-up pixels within all other CLC level 1 classes (which are not mapped in CLC according to the 25ha MMU) will be included according to the above definition. Fully vegetated or unvegetated non-built-up pixels will be excluded.

CLC 2000 - level 1 class "artificial surfaces"

SPOT-4 satellite image over Vienna / Austria
(green band; 20m resolution)



FTS high-resolution layer of built-up areas
(20m resolution)



Special Considerations

- The same definition of built-up areas shall apply for production and quality control.
- To ensure homogeneity across the whole of Europe, partially captured linear features outside of urban agglomerations (e.g. fragments of roads or railway lines) will not be completed by the manual post editing.
- Mines and quarries will be considered built-up areas according to the above definition.
- It is proposed to include a no-data class for unclassifiable areas (e.g., clouds) which is to be marked and identified during the process of manual interpretation.

ANNEX 2: LIST OF WORKING UNITS AND EO DATA USED

The following list provides information about the two coverages of EO data which were used to create the working units. The file name is identical to the WU identification within the mitigation shapefile's attribute table and contains the specifications of sensors, paths/rows and capture dates.

The full file name is explained in the following:

[Sensor Coverage 1]_[TrackFrame Coverage 1]_[Capture Date YY/MM/DD Coverage 1]_[Instrument Coverage 1]_ [Sensor Coverage 2]_[TrackFrame Coverage 2]_[Capture Date YY/MM/DD Coverage 2]_[Instrument Coverage 2]

Table 1: List of Working Units used for the production of Liechtenstein

Zone	Working Unit
1	lrsp6_026035_050907_l30_spot4_056255_060615_1i0

ANNEX 3: SAMPLE PLOT VALIDATION SHEET

Sample Plot 100 x100 m [ID]	FTSP Degrees of Soil Sealing [Mean Value]	FTSP Built up [TRUE / FALSE]	Reference Built up [TRUE / FALSE]	Compliance	Excluded by Mitigation Shape [TRUE / FALSE]
0	35,6	FALSE	FALSE	TRUE	FALSE
1	0,0	FALSE	FALSE	TRUE	FALSE
2	0,0	FALSE	FALSE	TRUE	FALSE
3	0,0	FALSE	FALSE	TRUE	FALSE
4	0,0	FALSE	FALSE	TRUE	FALSE
5	0,0	FALSE	FALSE	TRUE	FALSE
6	35,9	FALSE	FALSE	TRUE	FALSE
7	0,0	FALSE	FALSE	TRUE	FALSE
8	0,0	FALSE	FALSE	TRUE	FALSE
9	0,0	FALSE	FALSE	TRUE	FALSE
10	0,0	FALSE	FALSE	TRUE	FALSE
11	0,0	FALSE	FALSE	TRUE	FALSE
12	0,0	FALSE	FALSE	TRUE	FALSE
13	3,9	FALSE	FALSE	TRUE	FALSE
14	0,0	FALSE	FALSE	TRUE	FALSE
15	70,6	FALSE	FALSE	TRUE	FALSE
16	11,2	FALSE	FALSE	TRUE	FALSE
17	72,0	FALSE	FALSE	TRUE	FALSE
18	48,0	FALSE	FALSE	TRUE	FALSE
19	80,3	TRUE	TRUE	TRUE	FALSE
20	40,4	FALSE	FALSE	TRUE	FALSE
21	8,9	FALSE	TRUE	FALSE	FALSE
22	14,3	FALSE	FALSE	TRUE	FALSE
23	63,3	FALSE	FALSE	TRUE	FALSE
24	43,7	FALSE	FALSE	TRUE	FALSE
25	60,6	FALSE	FALSE	TRUE	FALSE
26	32,3	FALSE	FALSE	TRUE	FALSE
27	36,5	FALSE	FALSE	TRUE	FALSE
28	98,7	TRUE	FALSE	FALSE	FALSE
29	31,5	FALSE	FALSE	TRUE	FALSE