Accuracy of Built-up Area Mapping in Europe at Varying Scales and Thresholds
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Abstract: The paper provides an accuracy assessment of the Soil Sealing Layer (SSL), a map of impervious surfaces in most of Europe (Fig. 1). It focuses on the extent of mapped built-up area and the accuracy of built-up area mapping as a function of the soil sealing threshold applied, the spatial resolution used, and the spatial configuration of built-up areas mapped. The results from the stratified random sampling comparison of SSL with aerial orthophotos derived for Slovakia are compared with those for other countries and complemented by “complete coverage” comparisons in three 6x6 km study areas in Slovakia (Fig. 2).

1. INTRODUCTION
One of the main purposes of the Soil Sealing Layer (SSL) 2006 (EEA 2010) developed within the Global Monitoring for the Environment and Security (GMES) programme is to serve as a source of high spatial resolution land cover data for disaggregation of socioeconomic statistics (EEC Land 2008). An example of such disaggregation is the model-based estimation of population density in 2008). An example of such disaggregation is the model-based estimation of population density in

2. SOIL SEALING LAYER
Similarly to the CLC2006, SSL2006 is also derived from IMAG2000. It is based on satellite sensor imagery from Envisat ASAR (100 m ground sampling distance) and IRS-1D LISS IV (32 m GSD) from 2000 to 2010 year-to-year sampled in 20 m ground resolution using multi-resolution template matching with geometrical correction

Table 1: Frequencies (%) of 12 soil sealing categories at 100 m spatial resolution. Labels of the 12 bars for the samples (in the EEA SES-09-003 Service Element) Land project, 2 p. (http://www.gmes-gseland.info/com/promo/ImperviousAreas_Sept08.pdf)

Figure 2. Soil Sealing Layer (SSL): yellow - 0% and red - 100% sealing

Figure 3. Frequencies (%) of 12 soil sealing categories at a function of soil sealing

Figure 4. Examples of discrimination (anti-correlation) at 100 m spatial resolution. Labels of the 12 bars for the samples (in the EEA SES-09-003 Service Element) Land project, 2 p. (http://www.gmes-gseland.info/com/promo/ImperviousAreas_Sept08.pdf)

Figure 5. The spatial and spectral configuration of mapped and non-mapped classes in Dubnica (DB), Poprad (PP) and Myjava (MY). Figure 3 (c1-g6), Figure 5 (a1-d2, a4-d5) and the errors of soil sealing mapping (e3-f6, e6-f9)

5. CONCLUSION
The objective of this paper was to provide an assessment of the accuracy of SSL before its further use in modelling, particularly in population downsampling. Specifically, it focuses on:

- The extent of mapped built-up area as a function of the soil sealing threshold and the spatial resolution in Europe and Slovakia (Fig. 3)
- The accuracy of built-up area mapping at 100 m sealing threshold and 100 m in Slovakia and other European countries: Table 1, Fig. 4
- The extent of mapped built-up area and the accuracy of built-up area mapping as a function of the soil sealing threshold and the spatial configuration of built-up areas mapped in Dubnica (DB), Poprad (PP) and Myjava (MY): Fig. 3 (c1-g6), Fig. 5 (a1-d2, a4-d5) and the errors of soil sealing mapping (e3-f6, e6-f9)

6. ACCURACY ASSESSMENT
For the purpose of the second objective, random stratified sampling design, as suggested by Mecha and Bitman (2008), was applied to the 100 m grid cells of SSL in Slovakia with 250 samples drawn from Strata 1 (80% soil sealing in SSL) and 2,000 from Strata 2 (80% soil sealing in SSL). A regular square grid of 100 points in a 2m area was overlaid on top of such corresponding sample plot in the reference dataset (Geodis Slovakia and Eurosense 2003 and Google Earth historical imagery) and the percentages of pixels overlapping with impervious surfaces in each plot was calculated. The resulted real 388 Strata 1 samples had soil sealing >80% in the reference dataset and some of the Strata 2 samples had soil sealing <80% in the reference dataset. The respective commission and omission errors for SSL were estimated using the methodology developed by Mecha and Bitman (2008) and compared with the results of quantitative assessments in other European countries (Table 2). The suitability of the reference datasets (Geodis Slovakia and Eurosense 2003 and Google Earth historical imagery) was further supported by the case of MY. Although the commission and omission errors at 100 m spatial resolution and 80% threshold in this study area were practically 0%, there are only 30 non-zero 20 m pixels (with mean soil sealing value of 24%) in the reference dataset (Geodis Slovakia and Eurosense 2003 and Google Earth historical imagery). The percentage of commission errors in DB and PP at almost all combinations of thresholds 1% to 90% and spatial resolutions 20 m to 300 m, they were again larger in DB than in PP (see Table 2). This is in spite of the fact that the underlying IMAG2000 had failed in one of the data requirements (both acquisition dates within the country-specific vegetation period in PP, but not in DB). The tendency observed in the comparison of DB and PP (i.e. that the more dispersed (low) is the settlement pattern, the more erroneous is its representation in SSL) was further supported by the case of MY. Although the commission and omission errors at 100 m spatial resolution and 80% threshold in this study area were practically 0%, there are only 30 non-zero 20 m pixels (with mean soil sealing value of 24%) in the reference dataset (Geodis Slovakia and Eurosense 2003 and Google Earth historical imagery). Hence, it is concluded that the SSL is reliable when used in population downsampling, which is the central purpose of this paper.

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