

An attachment file

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Quantitative validation

Simple quantitative validation was carried out for the delivered soil sealing data. Both the soil sealing data and the reference data were generalized into 100x100m cells. Pixel values were calculated as an average of the original datasets so that each pixel had a percentage value of coverage of sealed surface. Cells were classified for built-up and non-built-up areas. This was tested with thresholds of 80%, 50% and 25%.

Visual analysis showed that recommended 80% threshold is not very applicable in the case of Finland. Finnish settlement structure is very scattered and only the largest urban areas were captured by using 80% threshold. This is demonstrated in figure 1. By applying threshold of this high, the percentage of the built-up area in Finland, according to the classified layer, would be under 0,1% even though the correct value would be over 2%. Like in Austrian case, presented in paper "*Recommendations Quantitative assessment high-resolution soil sealing layer*", the threshold of 80% is too high for Finnish settlement structure and the threshold of 25% would be more recommendable.

Two errors, commission and omission errors, were calculated. Commission error is the percentage of pixels which are classified as built-up even though the control shows that they are actually non built-up. Omission error is the percentage of pixels, which are not classified as built-up even though the control shows that they are actually built-up. The errors were calculated with following equations:

$$P_{commission} = \frac{E_{12}}{E_{11} + E_{12}}$$

(Equation 4.1.3.8 in paper "*Recommendations Quantitative assessment high-resolution soil sealing layer*")
 where E_{11} is number of correctly classified pixels and E_{12} number of wrongly classified pixels.

$$P_{omission} = \frac{E_{21}}{E_{21} + E_{22}} \cdot \frac{1 - P_{class}}{P_{class}}$$

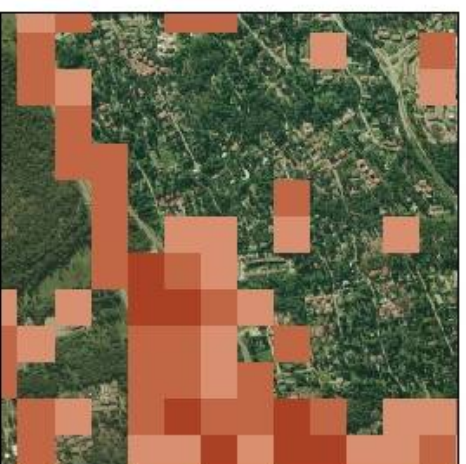
(Equation 4.1.3.21 in paper "*Recommendations Quantitative assessment high-resolution soil sealing layer*")
 where E_{21} is number of wrongly classified pixels, E_{22} number of correctly classified pixels and P_{class} built-up class as a result of classification

Overall accuracy was calculated by dividing the number of correctly classified pixels by the total number of pixels checked.

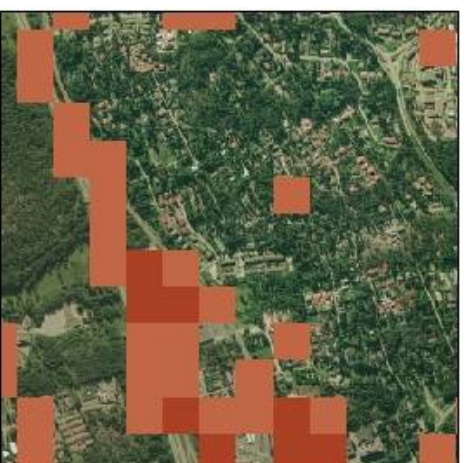
Omission and commission errors were formed by comparing the classified data and the reference data with 100x100m cell size and with same thresholds. The reference data was divided into two parts: Stratum 1 (Built-up areas) and Stratum 2 (Non-built-up areas). An evaluation was done first for whole dataset and then by using different amount (500-500000) of random samples from Stratum 1 and Stratum 2, but results were quite close to each other. Table 1 shows the errors calculated for the whole dataset.

Effect of different thresholds

Example from Espoo (Coordinates in Finnish uniform coordinate system (YKJ): 6673900, 3371355)



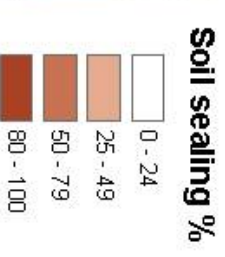
Threshold = 25 %



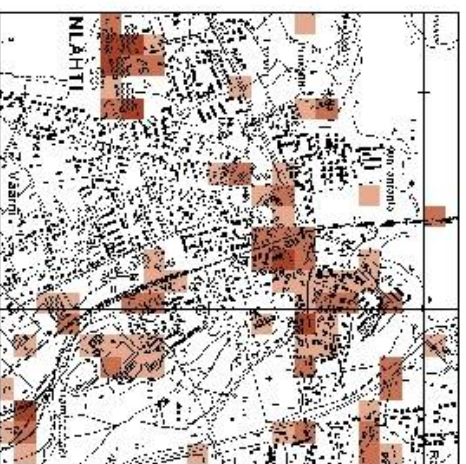
Threshold = 50 %



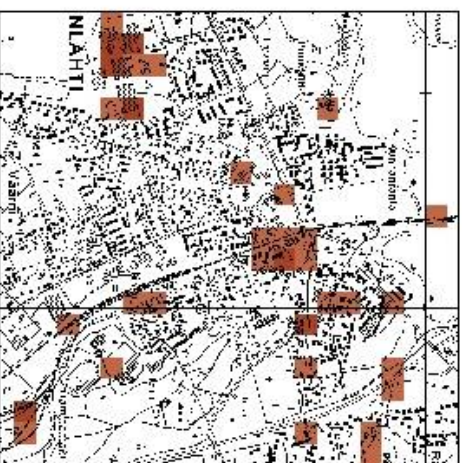
Threshold = 80 %



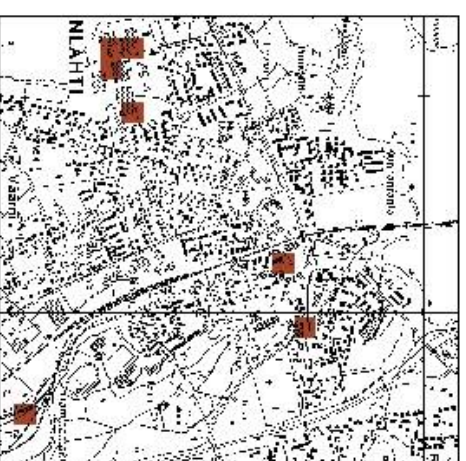
Example from Lapinlahti (6673900, 3518618)



Threshold = 25 %



Threshold = 50 %



Threshold = 80 %



Figure 1. Different thresholds of classified soil sealing data with 100m cell size demonstrated with aerial images and topographic base map.

Table 1 The error-matrix of evaluation carried out for the whole dataset, threshold = 80%

		Reference data		Sum	User's accuracy
		B	O		
Classified data	B	13614	14874	28488	47,79
	O	47714	33619123	33666837	99,86
	Sum	61328	33633997	33695325	
	Producer's accuracy	22,20	99,96		
Overall accuracy %		99,81			
Pclass		0,0018			
commission %		52,21			
omission %		77,58			

Table 1 shows that when using threshold 80% omission error is 78% so in other words the classified soil sealing data is very badly underestimating urban areas in Finland. The same result can be noticed in visual interpretation. One example of this is shown in Figure 2. The commission error of classification is also high, but this is most likely due to differences between methods used to create urban layers.

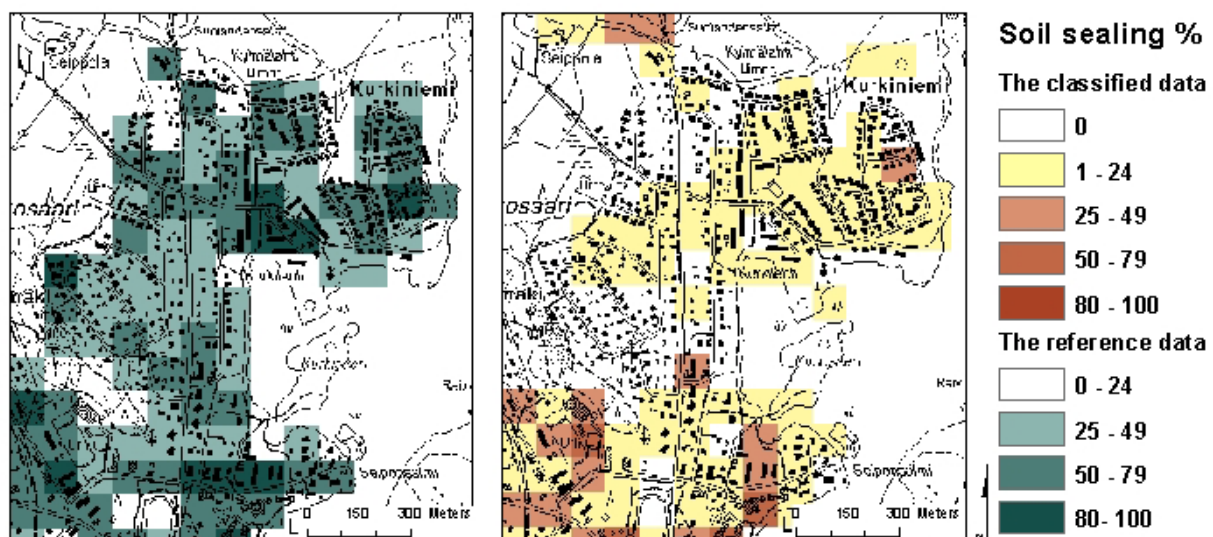


Figure 2. Classification results of the classified soil sealing layer and the reference data compared to topographic base map (resolution 1m). An example is from Keuruu (coordinates in Finnish uniform coordinate system (YKJ): 6908718, 3380620) Three different threshold values are shown for both layers. From the classified data, the values between 1-25% are also shown as yellow to demonstrate underestimation of urban areas.

While non-urban areas are dominating in Finnish database, the overall accuracy of the database is very high even though built-areas are not captured correctly. Because the whole dataset is been used for the validation, the precision of validation is high. As a comparison, same method was carried out also for smaller samples (500 – 500000 cells) taken from the reference data. It was noticed that when using over 500 samples from Stratum 1 and 2000 samples from Stratum 2, the number of samples did not have significant impact on results and omission and commission errors of sample-data were ranging about $\pm 2\%$ compared to those of whole data set.

In this evaluation not all of the reference cells were evaluated visually, but visual analysis was carried out for several different areas to confirm accuracy of evaluation results. Visual interpretation of the reference data showed that in most cases it was able to describe urban areas well and that the accuracy of the classified dataset was very much lower than required 85%.

As shown previously, using 80% threshold is not very suitable in Finnish areas. As a comparison the evaluation was also done by using thresholds 25% and 50% to separate urban and urban areas. Results of the validation are displayed in tables 2 and 3

Table 2 The error-matrix of evaluation carried out for the whole dataset, threshold = 50%

		Reference data		Sum	User's accuracy
		B	O		
Classified data	B	75149	52008	127157	59,10
	O	174530	33393638	33568168	99,48
	Sum	249679	33445646	33695325	
	Producer's accuracy	30,10	99,84		
Overall accuracy %		99,33			
Pclass		0,0075			
commission %		40,90			
omission %		69,13			

Table 3 The error-matrix of evaluation carried out for the whole dataset, threshold = 25

		Reference data		Sum	User's accuracy
		B	O		
Classified data	B	196621	50882	247503	79,44
	O	545443	32902379	33447822	98,37
	Sum	742064	32953261	33695325	
	Producer's accuracy	26,50	99,85		
Overall accuracy %		98,23			
Pclass		0,0225			
commission %		20,56			
omission %		70,79			

By using threshold 50% both commission and omission errors decreased a little. Still the omission error was almost 70%, which means that only third of real urban areas were captured. Threshold of 25% seemed to correspond best to the reality of Finnish urban areas. This can be seen well in the value of commission error which is remarkable lower than in other two cases. However the omission error is still high, which is mostly due to differences between data composition. The reference data based on actual databases is able to take into the consideration large single houses, even those under the canopy, while soil sealing data can not capture those.

Finnish settlement structure is very scattered and large covered areas are rare. Vegetation is common even in most urban areas (trees at the yard etc.). Due to this, urban areas are very difficult to identify based on satellite images and commonly used threshold values and definitions are not suitable. Some part of the high value of omission error can be explained by uncertainties in reference data and differences between methods used to create reference and soil sealing data, but both qualitative, quantitative and visual analysis showed that classification accuracy of the non-built up areas is reaching the required 85% accuracy but that built-up areas are strongly underestimated and the required accuracy is not been reached.