Extraction of different urban area categories from satellite images using Window Independent Context Segmentation

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1. INTRODUCTION

Per-pixel based methods for spectral classification of remote-sensed images in urban areas are problematic because of the heterogeneity of spectral signatures which leads to land-cover classification problems. Furthermore it is not the urban areas spectral characteristics that are of interest for most researchers. Instead information about the spatial and structural properties and different indicators of social and economic functions is of more importance for the understanding of urban areas. The problem, thus, is to turn the purely spectral information from remotely sensed images into a meaningful information source using methods that go beyond the per pixel based methods. In this abstract a novel method for image segmentation is presented called Window Independent Context Segmentation (WICS, patent pending). The method is used in a case study covering the central parts of Stockholm, Sweden. The case study tries to resolve two research problems found in urban analysis with remote sensing image data and propose WICS as a possible method that; "…examines the spatial and structural properties of urban areas represented in the digital image, not just their spectral characteristics."[1] and which "…move beyond simply mapping the physical form of urban areas, to provide indicators of their social and economic functioning."[1]. Examples of methods that also try to go beyond the per pixel based methods can be found in the emerging Object Based Image Analysis (OBIA) field. Hay and Castilla (2006) propose that OBIA; "…is a sub discipline of GISicence devoted to partitioning remote sensing (RS) imagery into meaningful image-objects…"[2]. In this light WICS can bee seen as an unsupervised OBIA method that uses contextual information to find natural groupings in the image while not being constrained by a kernel window. The main theoretical idea behind the use of WICS in urban analysis is that the local configuration of different matter with different spectral signatures (asphalt, grass, concrete etc.) could be seen as a visual fingerprint of function, planning and use. To extract these fingerprints it is necessary to go beyond the individual building and grass field and aggregate them into more generalized concepts such as different types of "urban areas".

2. CASE STUDY

The study area is the central parts of Stockholm, Sweden. A 7x6km subset of a-per pixel based classified SPOT5 satellite scene from 2008 with a resolution of 10x10meters was used as data input for the WICS analysis. The per-pixel based classification was a standard iso clustering routine resulting in 20 spectral classes. The verification is based on independently produced planning data dividing the central parts of Stockholm into different categories based on architectural styles, planning ideologies and function on an aggregated city block scale presented on a map belonging to the 1998 exhibition proposal [3] for the 1999 "overview" plan for Stockholm [4]. The verification data was scanned and digitized and some of the urban categories selected as the most commonly found to use for the verification. Because of the names for the categories might not make sense out of a Swedish planning context they are coded as letters and a short description exemplified by figure 1-5.

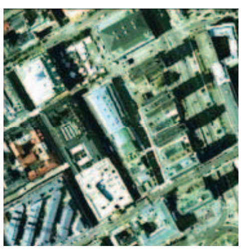

Fig.1 **A** Inner city

Fig.2 **B** Industry

Fig.3 **C** Narrow-block housing

Fig.4 **D** Single family housing

Fig.5 **E** Single family housing, less "planned" than D

The distribution of the different urban categories in the central parts of Stockholm is presented in figure 6. The categories are overlaid on a 1x1metres aerial photo. Figure 7 below show the final WICS result alongside the urban categories. Only the five WICS classes covering the urban categories of interest are presented in black to grey. White indicates all other classes. A neighborhood majority filter (20 pixel radius) has been used to smooth out the result according to the scale of the objects of interest.

Fig.6 Urban categories in the central parts of Stockholm overlaid on a 1x1meters aerial photo.

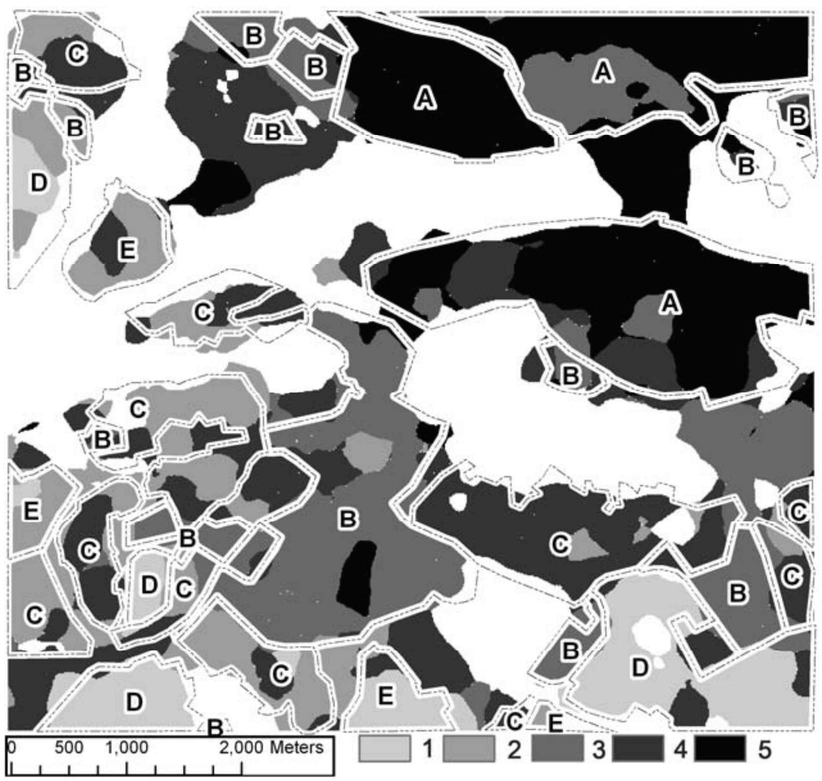

Fig.7 Smoothed WICS classes

The extracted WICS areas inside all the different urban categories area presented in figure 8.

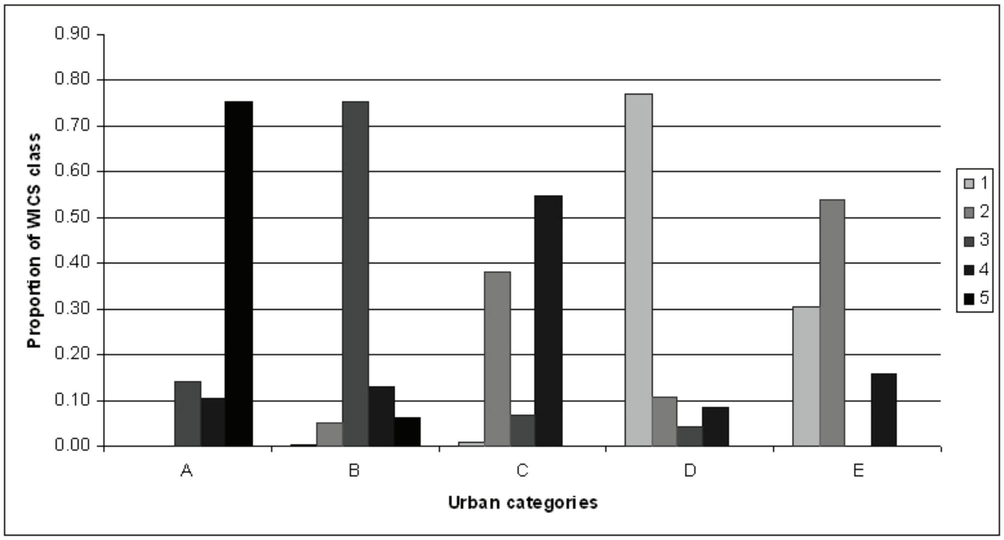

Fig.8 Proportion of WICS classes in each urban category

Figure 8 shows that the urban categories A, B and D are dominated by one WICS class, 5, 3 and 1. Urban categories C and D on the other hand do not have any dominating WICS class.

3. CONCLUSIONS

The results show promising possibilities to extract categories of urban areas that differ both in function and underlying planning ideologies. As it stands now further work with parameters seems necessary to get a more clear separation between the different categories. It is also possible that higher resolution is needed for an effective separation as some of the difference in characteristics might get lost in the 10x10meter resolution.

4. REFERENCES

[1] Donnay, J.-P., Barnsley, M. J. and P.A. Longeley, *Remote Sensing and Urban Analysis*, Taylor & Francis, Suffolk, 2001.

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