Sub-District Level Zoning by Building Spatial Pattern: Fethiye City Center Case

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The study

The recognition of building pattern and the definition of zones with similar building pattern are new in cartography and urban modeling. In this study, two different approaches are tested to find the resultant maps and their conformity for the needed urban zones. These approaches are;

- Self-organizing Maps (SOM) (Kohonen, 1995)
- Mean-shift Image segmentation (Derpanis, 2005)

At the beginning of the application of the zonation approaches, some data conversion operations are required in the data preparation stage. There are certain reasons for this requirement. First, in both zonation approaches, while some of the attributes used are measured by using polygon data model functions (e.g. Polygon-based measurements, area and perimeter), some are measured by using point data model functions (e.g. Point-based measurements, density and distance related measurements). Another important reason is that the resultant of these applications should be in a zone form that does not have spaces in between.

The first step of these conversions is given in figure 1., and figure 2, where a point data layer is created by converting the building polygons to the point data (as illustrated by figure 1). Then, point to polygon conversion (as illustrated by figure 2) is applied via voronoi/thiessen polygons to come up with the desired polygon based zone outputs. The created voronoi layer, which contains the computed spatial attributes, constitutes the main input of the tested zonation approaches.

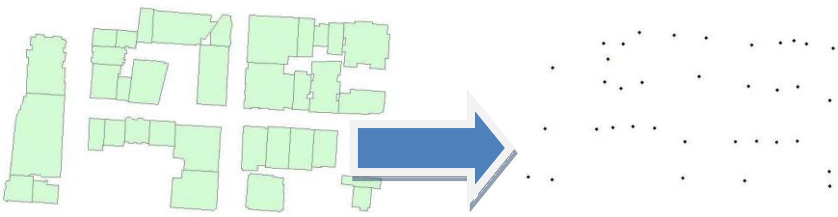

Figure 1. Polygon to point conversion

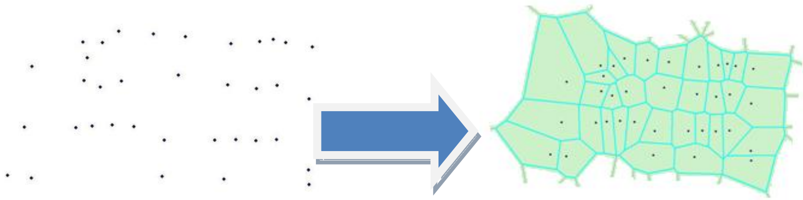

Figure 2. Point to polygon (voronoi/thiessen) conversion

In the literature, these zonation approaches could be appraised in the multivariate cluster analysis. In spite of the variety of the application areas and its convenience, cluster analysis is new technique. The definition of the cluster analysis could be done as an analysis, which looks for the information organization between the introduced attributes to obtain homogeneous zones or clusters. Spatial clustering is the task of grouping the objects of a database into meaningful subclasses (Azimi and Delavar, 2007). The difference of spatial clustering from traditional clustering algorithms is that spatial information is taken into account as a component in the spatial clustering methods.

Apart from the positional information of the input entities, the employed approaches are applied by using three different attribute groups. These attribute groups characterize three different aspects of the studied urban pattern, which are building geometry, density with derived spatial attributes, and density with kernel density function. Attribute groups with contained attributes are;

- Building geometry;
  - The perimeter of the polygon building object
  - The area of the polygon building object

- Building density;
  - Distance from the nearest building
  - The number of neighbors within the distance of 100m
  - The area of the voronoi/thiessen polygon

- Kernel density raster is created by using the kernel function of ArcGIS software. Moreover, the raster result of the function is used to generate building weight attribute, which is used as a non-spatial component.

In addition to these three zonation alternatives, a fourth zoning alternative is configured by using the districting module of ArcGIS software. In this alternative, expert opinion via visual interpretation is performed by using the same software tool. Figure 3 represents the visual interpretation environment created by voronoi polygons, which are formed by using point entities created at the point of building object centres.

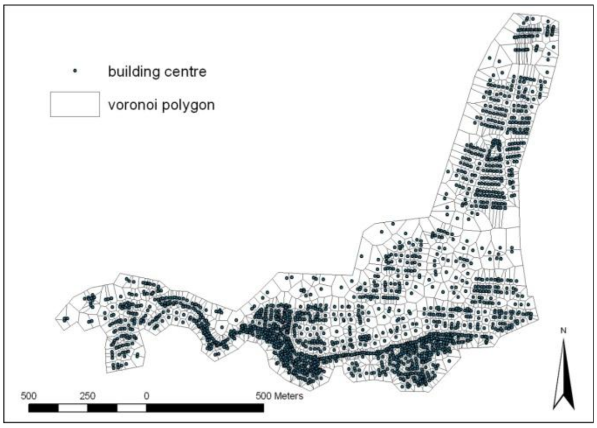

Figure 3. Building centre points and voronoi polygons produced by these points

The methods tested in the study for Sub-district zonation, that is, clustering, are used to automate the zonation process. In an urban environment, the formation of building texture is effected from social, physical and economical factors, so that even the clustering algorithms can automate the process of small statistical area (SSA) generation, and replacement with manual approaches based on expert opinion seems difficult. Consequently, the result of the zonation based on expert opinion (as illustrated by figure 4) is used as a reference zonation to assess the results of two tested zonation methods for three different approaches.

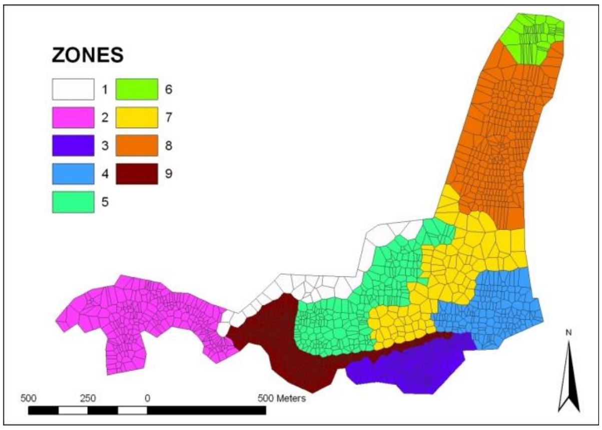

Figure *Fout! Geen tekst met opgegeven opmaakprofiel in document.*. The result of the zonation based on expert opinion, used to assess clustering results.

The SOM method is a very robust method for the clustering of the multi-dimensional data. Nevertheless, the applied tests showed that the spatial information used in the GeoSOM step of the utilized software causes highly correlated results. The zonation results of all three SOM approaches give approximately the same zone borders.

The method of image segmentation with building density index gives the most appropriate Sub-district zone results. This comparison is made by considering the similarity between the application outputs and the zonation based on expert opinion result.

References

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