A proposed method for disaggregating census data Using object-oriented image classification and GIS

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ABSTRACT:

Monitoring and modeling urbanization require reliable analytical techniques and suitable methods of visualization. However, aggregated demographic data from the population census are associated with analytical and cartographic problems due to the arbitrary nature of areal unit partitioning (Mennis, 2003). To remedy these problems of census data, dasymetric mapping with remote sensing can be employed. This method uses land use/land cover information extracted from remotely sensed images to obtain an improved estimation of where people actually live (Liu, 2004). An areal interpolation technique is then applied to disaggregate the census population data into spatial units with homogenous land use (Mennis, 2003). The advent of IKONOS imagery opened an opportunity for dasymetric mapping at detailed map scales (Liu, 2004). Within the above context, this paper examines the possibilities of generating more heterogeneous population density maps using dasymetric mapping with object-oriented classification in urban areas.

1. Introduction

Management of the urban environment involves procedures of monitoring and modeling which require reliable analytical techniques and methods of visualization. Conventional surveying and mapping methods cannot deliver the necessary information in a timely and cost-effective mode. Human land use decisions on the environment are influenced by socioeconomic factors which can be represented by spatially distributed data. However, aggregated demographic datasets from census are associated with analytical and cartographic problems due to the arbitrary nature of areal unit partitioning (Mennis, 2003). Graphical representation of population data and socioeconomic information is commenly undertaken using the choropleth mapping technique (Klinkenberg, 1998).

To remedy these problems of census data, dasymetric mapping with remote sensing can be employed. This method uses land use/land cover information extracted from remotely sensed images to obtain an improved estimation of where people actually live (Liu, 2004). An areal interpolation technique is then applied to disaggregate census population data into spatial units with homogenous land use (Mennis, 2003). In the past, various images have been examined for dasymetric mapping, such as aerial photographs, Landsat TM, and SPOT. Although the successes of these studies vary, the most basic technique is known as binary classification, wherein all classes are designated as either inhabitable or non-habitable, and the population is distributed by areal weighting into the inhabitable areas of each enumeration district.

As pixels only do not hold enough information to detect the different phenomena, more advanced and most knowledge based methods seem to be more promising. Definiens' eCognition, with its object-oriented approach offers new possibilities to face these problems (Hofmann, 2001). Therefore, Socio-economic attributes of ground objects (e.g. building, transportation infrastructure) can be sufficiently identified with the increasing availability of higher resolution images and smaller census districts.

Within the above context, this paper examines the possibilities of generating more homogeneous maps using dasymetric mapping with object-oriented classification in urban areas.

2. Approach

This paper aims at disaggregating census data using dasymetric mapping with object-oriented classifications in urban areas. In this context, two multi-temporal studies will be conducted. The first one explores the use of object-oriented classification in mapping urban land cover and land use and the second study concerns data transformation from arbitrary aggregations units to more consistent spatial units. For the first study, principal strategies of object-oriented analysis will be reviewed along with IKONOS data covering Santa Barbara city, CA region. Then, we can produce an accurate land use map by making rules for accurate information detection. Urban areas as centers of economic and social development are an important objective in the application of remote sensing technology. Common problems in detailed and accurate urban area remote sensing results from the spatial and spectral heterogeneity of the urban environment typically consisting of built up structures (buildings, transportation areas), various vegetation covers (e.g. parks, gardens, agricultural areas), bare soil zones and water bodies (Herold et al, 2002). Considering the spatial heterogeneity of urban areas and building 'meaningful' objects which coincide with patterns of reality, urban land use characterization from such data should apply an object-oriented rather than a pixel based image analysis. Object-oriented analysis is based on a two-step workflow including segmentation and segment-based classification. An essential characteristic of an object oriented approach is the definition of appropriate class parameters or rules for a best description of the desired output classes. For reliable classification results the most typical and best describing class parameters have to be tested for each class (Matthias et al, 2004). This work can build sets of rules for urban land use feature detection.

For the second study, dasymetric mapping with land use maps from satellite imagery for disaggregating census data will be examined. A dasymetric map depicts quantitative areal data using boundaries that divide the mapped area into zones of relative homogeneity with the purpose of best portraying the underlying statistical surface. Dasymetric mapping differs from choropleth mapping in that the boundaries of cartographic representation are not arbitrary but reflect the spatial distribution of the variable being mapped (Eicher et al, 2001). Wright demonstrated dasymetric mapping by first redistributing population from a set of areal units into inhabited and uninhabited regions as indicated on USGS topographic maps. He then subdivided the inhabited regions into smaller portions, using settlement pattern data also gathered from USGS topographic maps. Population density values are derived subjectively for the different types of

settlement patterns, and this information is used to estimate population density for the portions of the inhabited regions according to the fraction of inhabited region area each portion occupies (Mennis, 2003). Eicher and Brewer note that while improving the accuracy of population distribution, this method suffers from two weaknesses: first, like Wright's (1936), approach, the percentages are subjectively determined, and second, the method does not account for differences in area among the three land use classes within a county (Mennis, 2003). To remedy these problems, dasymetric mapping using the land use map with high resolution imagery at object-level will be introduced. This research can allow more detailed population mapping.

3. Discussion and conclusion

The paper discusses the potential of object-oriented classification for dasymetric mapping within remote sensing and census geography. Areal census data and high resolution remotely sensed images will probably become more important data sources for geography. Easily accessible data sets provide opportunities and impetuses to bridge the gap between disciplines with compatible data structures and related attributional and spatial analyses. Disaggregated census data could meet the needs of a wide range of integrated socio-economic and environmental applications (Chen, 2002). Dasymetric mapping could derive its value from the ability to overcome the weakness of the choropleth mapping method. It allows the data to be independent from the arbitrary enumeration areas and limits therefore the extent of the ecological fallacy and of the modifiable area unit problem (Jose, 1998). We still have challenges to make target zones more consistent.

4. References

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