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A volumetric approach to population disaggregation using LIDAR remote sensing data.

Abstract

Population downscaling in the European context –generation of the *GEOSTAT* grid or attribution of population to Urban Atlas polygons– has typically used land cover –usually *CORINE* Land Cover (*CLC*) or a refined version of it– and/or different types of Soil Sealing layers –Imperviousness High Resolution Layer or more recently the Global Human Settlement Layer (*GHSL*)–.

As *GEOSTAT 2011* version 2 shows, great advances have been done from the initial European wide grid obtained by the Joint Research Centre (*JRC*) from Census 2001 *LAU2* population data and *CLC*. However a careful reading of this literature shows that these exercises capture well the horizontal dimension of the problem –auxiliary information refers to a 2D world–, but they miss the vertical dimension, the heights of buildings –population density is a 3D concept–.

Using *3D GIS* techniques, we experiment with a volumetric approach to population *gridding*. For this exercise, we use recently released aerial *LIDAR* (*Laser Imaging Detection and Ranging*) remote sensing data. Our study area is the *NUTS2* of Madrid, 179 *LAU2* and around 8.000 km^2. Starting with census tracts population data and *GHSL* at the highest spatial resolution –10 meters pixel– we built population grids at two resolutions: 1ha and 1km^2, using different kinds of auxiliary information. Our base model is pure areal weighting. From this, we explore and quantify how the Total Relative Absolute Errors (*TRAE*) are reduced when:

(*i*) Thematic information, using the Spanish Land Cover and Use Information System (*SIOSE*) for 2011 –with much higher resolution than *CLC*– is used as a mask on *GHSL*.

(*ii*) Building height, at the *GHSL* spatial resolution –10 meters pixel–, is used as auxiliary information in the disaggregation. This is the counterpart of areal weighting in a 3D world, and we name this approach volume weighting.

(*iii*) Both dimensions, thematic information from *SIOSE* and building height from remote sensing data, are used in the spatial disaggregation of population.

Validation is done against fully bottom-up population grids built from a fully geo-referenced (point coordinates) population registry for the region of Madrid. So we know the 'true' population distribution for this region.

As expected, improvements in disaggregation are quite important when building height is taken into consideration. However, our calculations are rough numbers, and can be fine-tuned by the careful selection of land covers where people reside, by experimenting with *LIDAR* parameters in these data sets and by statistical modeling of the underlying systematic relationships between population density, in a 3D world, land use, morphology of the landscape and urban structure. In this sense we consider our calculations as a lower bound of the improvements in incorporating thematic information and building height on *GHSL*. Thematic information has been used previously on this data set, but building height is novelty.

As a byproduct we generate a raster layer of building height at the same resolution of *GHSL*, which constitutes an interesting complement of this product, and may have other remarkable applications, such as adding information on building height to Land Cover databases or Urban Atlas polygons. *LIDAR* data is rapidly becoming publicly and freely available; in fact Spain-wide information on building height at (an almost) any resolution is nowadays a real possibility.