Estimating Population Using Remote Sensing Imagery

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Here are some reflections and references about estimating population using remote sensing imagery. One of the first applications of remote sensing in population estimation can be traced to the 1950s when air photos were utilized in manual counts of dwelling units. A first approach to estimate population from remotely sensed images is called the direct approach. The houses are manually identified and counted. This number of dwelling units is multiplied by the mean density of inhabitants per dwelling to obtain an estimation of the population in this area. While estimated population information is relatively accurate, such a house-counting approach is time consuming and labor intensive, making it difficult to apply to large urban areas. Moreover, in some cities, particularly in developing countries and especially in slums, it?s hard to identify the houses (Porter, 1956; Lo, 1977; Hsu, 1971; Lo and Chan, 1980; Watkins, 1985).

The second major approach is the pixel one. In this approach, the population is directly linked (and estimated) to the information contained in one pixel. The main problem met in this approach is the calibration and the validation processes (at the pixel scale) (Webster, 1996). More recently, Harvest (2002) proposed a pixel-based regression model that can be appears to be effective by using Landsat TM images.

Finally, the third approach consists of subdividing the city into homogeneous areas: this is called the zonal approach. For each type of homogeneous areas a mean density is estimated (field survey, ancillary data ?). Then, the global population can be estimated by extrapolating the sampled areas estimations (surface type multiplied by density) (Kraus and al., 1974; Adeniyi, 1983; Weber, 1994; Wu et al., 2005; 2006). This is not an exhaustive review but it summarized the most used approaches.

The major issue/challenge remains the automatic extraction of homogeneous areas (urban blocks) from available imagery at different spatial and spectral resolutions. A proposed solution is to use simultaneously the available satellite image from medium to high spatial resolution to extract automatically urban blocks. The proposed method detailed in Kurtz et al. (in press 2010) is based on a region based approach: the spatial context of the urban objects and the semantic relationships of these last ones between the available resolutions are used to enhance the simultaneous analysis of both medium spatial resolution and high spatial resolution. First results are encouraging but further research should be continued in this domain.

Validation

An article by Wu and Murray in 2006 (in *Geographical Analysis)* compares a pixel-based and a zonal approach by using Landsat imagery. The both methods are compared by using the impervious surface fraction as an indicator of population. This indicator is also compared with spectral radiance and landcover/use classification for estimating population density. The authors concluded that the pixel-based approach is slightly better than the zonal approach (76% of accuracy). More precisely, for both training and validation areas, the relative error for an entire urban area in pixel-based models is about 1–7% lower than that associated with zonal models. At the zonal level, the accuracy of pixel-based models is about 2–

9% better than zonal models impervious surface fraction, from remotely sensed data. Impervious surface fraction maintains detailed information on urban morphology (Ji and Jensen 1999), so it is well suited for estimating population density.

However with the development of new methodologies as object-oriented image analysis, and the multiplication of high and very high spatial resolution imagery, these methods should be adapted. In fact, on high spatial resolution images (Quickbird, Ikonos) the methods used to differentiate homogeneous type of urban block is even obtained by visual interpretation (Galeon 2008). But object-oriented methods are increasingly used as already explained by others colleagues in this seminar. For instance, the research project POPSATER (Population estimation by remote sensing) is testing these methods on developing countries.

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