Leveraging Enhanced Built-up Area Characteristics to Improve Spatial Population Distribution Modelling

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Up-to-date and spatially detailed information on human population distribution is increasingly demanded for a broad range of applications such as risk analysis, disease modelling, poverty reduction, human health, sustainable urban development or security-related issues. Population grids such as WorldPop, GWPv4 and GHS-POP represent the state-of-the art in terms of open- and free population distribution datasets available at a global or continental scale; each of them employing different input data sources and different top-down disaggregation methods to assign population counts to a regular grid of fixed spatial resolution. In current population gridding approaches, there are, however, main constrains that arise from the spatial resolution and quality of the two major input data sources: specifically, the accuracy of the derived population grid is largely determined by the quality of the areal census-based population count data and the quality of the spatially explicit human settlements data. Therefore, the improvement of data describing the pattern and properties of human settlements offers a means to enhance human population disaggregation methods.
Within this context, the German Aerospace Center (DLR) has developed a new suite of global layers and related analysis tools that accurately describe the built-up environment and its characteristics at a high spatial resolution (<30 m cell size) with an extended thematic and semantic depth. These layers include i) the World Settlement Footprint 2015 (WSF-2015) - a binary settlement mask, ii) the WSF-2015 Imperviousness/Greenness representing the percent of impervious/green surface within areas assigned as settlements by the WSF-2015, and iii) experimental data describing the average volume of buildings in a certain area . The WSF products are generated on the basis of a joint analysis of Sentinel-1 radar and Landsat multispectral imagery, whereas the prototypic data on the average building volume is derived from digital surface models (DSM) such as the one provided globally by TanDEM-X or alternatively from more detailed locally available DSM’s produced from very high resolution optical data.
This study introduces a new methodology to i) derive enhanced key parameters on the built-up environment based on a joint analysis of the WSF data in combination with additional sources such as Open Street Map and DSM data, and ii) use these enhanced features for a more detailed modelling, with an increased accuracy of the population counts and an improved spatial representation. With the results obtained from this research, we expect to overcome the limitations of current input layers, where settlements in rural areas are underrepresented and both the morphological properties e.g. built-up density and use-related aspects e.g. residential, industrial within the built-up area are only roughly approximated. The resulting human population distribution maps are compared against fine resolution census data and already available grid-based population distribution products to estimate their accuracy.