2.4 Fundamentals of GHSL

The GHSL consists of three main information components hierarchically placed at three different levels of abstraction: Global Human Settlement built-up areas (GHS-BU), the GHS population grids (GHS-POP) and the GHS urban/rural classification model (GHS-SMOD).

At the base of the hierarchy - including the most spatially accurate and the least abstract information level - we have a layer collecting concrete evidences about the human presence on the planetary surface as seen from global Earth Observation systems. In the GHSL paradigm, the fundamental link between Earth Observation sensor data and the human presence is the observable presence of built-up structures or buildings. From the GHSL perspective, the "building" makes the physical part of the human settlement fabric or spatial extension that is observable and measurable using the available global sensors. At this basic level the GHSL reports about *built-up areas (GHS-BU)*, as *areas (spatial units) where buildings can be found* {Pesaresi_al_2013}. The concept of "buildings" formalized by the GHSL are *enclosed constructions above ground which are intended or used for the shelter of humans, animals, things or for the production of economic goods and that refer to any structure constructed or erected on its site {ref:* Pesaresi_al_2013}. This abstraction is very similar to the standard topographic definition of the "building" class as compiled in the INSPIRE directive[13], except for the fact that the condition of the *permanency of the structure* it is not in the GHSL definition. This fact allows to include also refugee camps, informal settlements, slums and other temporary settlements and shelters in the notion of *built-up area* in the GHSL concept.

The intermediate abstraction information layer of the GHSL is the population grid or GHS-POP that is produced in an in-between spatial resolution. This information layer is derived from the combination of global collections of national population census data and global built-up areas as extracted from Earth Observation data analytics (GHS-BU). In the approach taken by the GHSL, the population data collected by national censuses with heterogeneous criteria and heterogeneous update time are harmonized in the space and time domains in to the GHS-POP grids, by systematic and consistent application of the same set of data interpolation and spatial disaggregation methods to the best available global spatial baseline data {Freire_al_2016}.

The top abstraction information layer of the GHSL it is the urban/rural classification model (GHS-SMOD). It is provided with the least spatial detail (1 km) by combining the two less-abstract and more-spatially-detailed built-up and population grids, GHS-BU and GHS-POP, respectively. The GHS-SMOD model implemented by the GHSL it is consistent with the "Degree of urbanisation" (DEGURBA) model adopted by EUROSTAT[14]. It discriminates 3 settlement class abstractions: 1) Cities, 2) Towns and suburbs and 3) Rural areas. The discrimination is based on the population density in the square kilometre grid[15], total settlement population and other spatial generalization parameters.

In the GHSL paradigm, the base layer GHS-BU it is designed to be the most stable against different visions and approaches, while GHS-SMOD is the most abstract and as such exposed to conceptual changes and alternative problem settings proposed by the different stakeholders involved in the post-2015 international framework processes. The modular hierarchical abstraction schema used in the GHSL design allows to protect the investment made in the global, fine-scale information gathering from perturbations on the abstract classification schema that may be introduced by different decision-makers involved in the process and potentially producing different problem setting and abstractions. On the other side, the modular hierarchical abstraction schema facilitates the test of alternative abstract

[13] INSPIRE Infrastructure for Spatial Information in Europe D2.8.III.2 Data Specification on Buildings – Draft Technical Guidelines http://inspire.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_BU_v3.0rc3.pdf

[14] http://ec.europa.eu/eurostat/web/degree-of-urbanisation/overview

[15] densely, intermediate density and thinly populated areas

models on the same agreed information baseline, facilitating the discussion and the comparison of the results also between international stakeholders not necessary sharing the same high abstraction definitions.

The following section helps the reader to understand fundamental concepts of GHSL and its data. The first subparagraph deals with extraction of information from satellite imagery (2.4.1) and built-up definition.

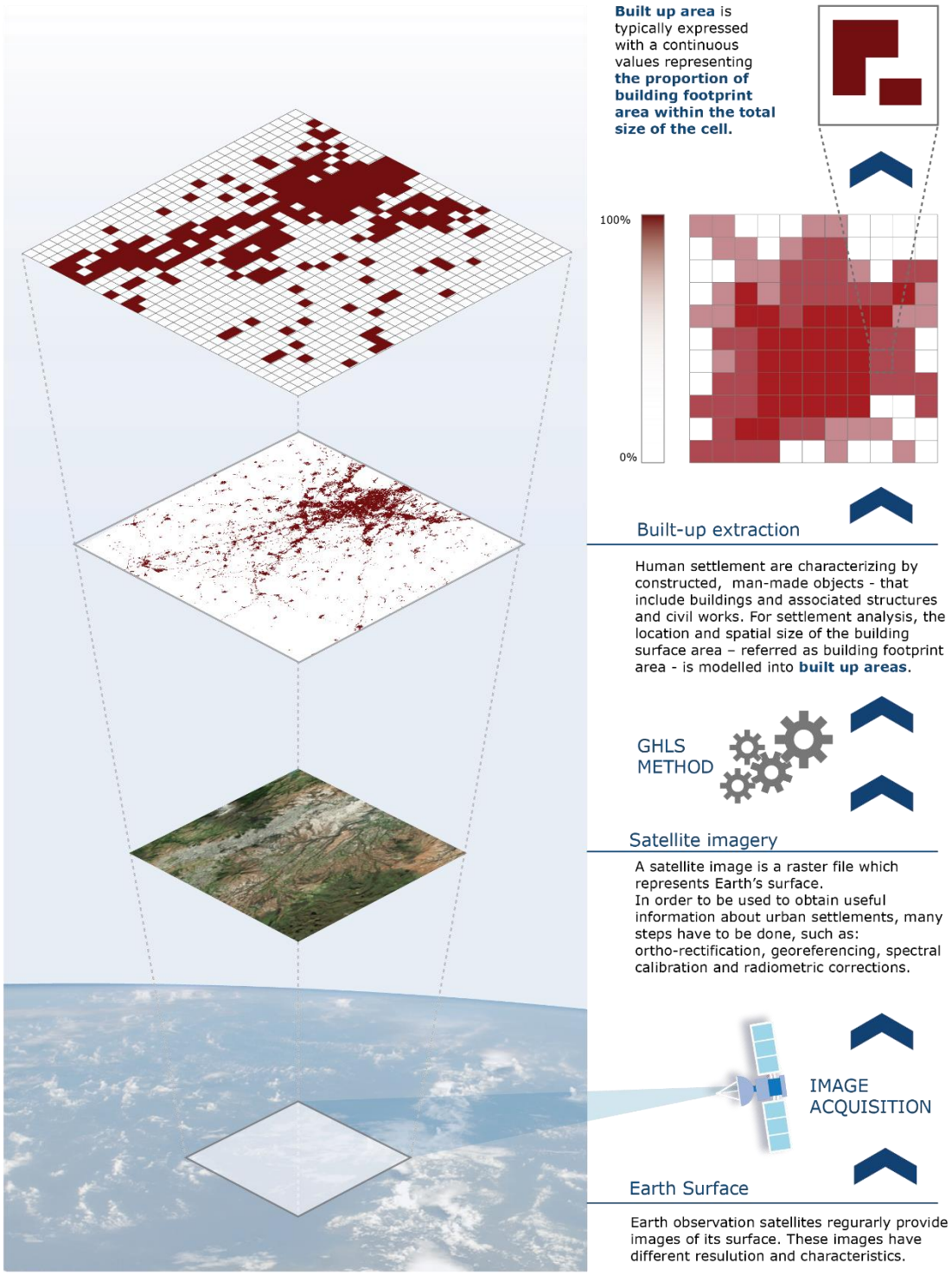
The second paragraph explore the process allows to combine built-up grids with census data to produce the population grids (2.4.2).

The third paragraph (2.4.3) illustrates the key elements and rules of the settlement model, derived from the New Degree of Urbanization (Lewis Dijkstra and Hugo Poelman 2014): specifically, the rules for defining *Urban Centres*, *Urban Clusters* and rural settlements are illustrated.

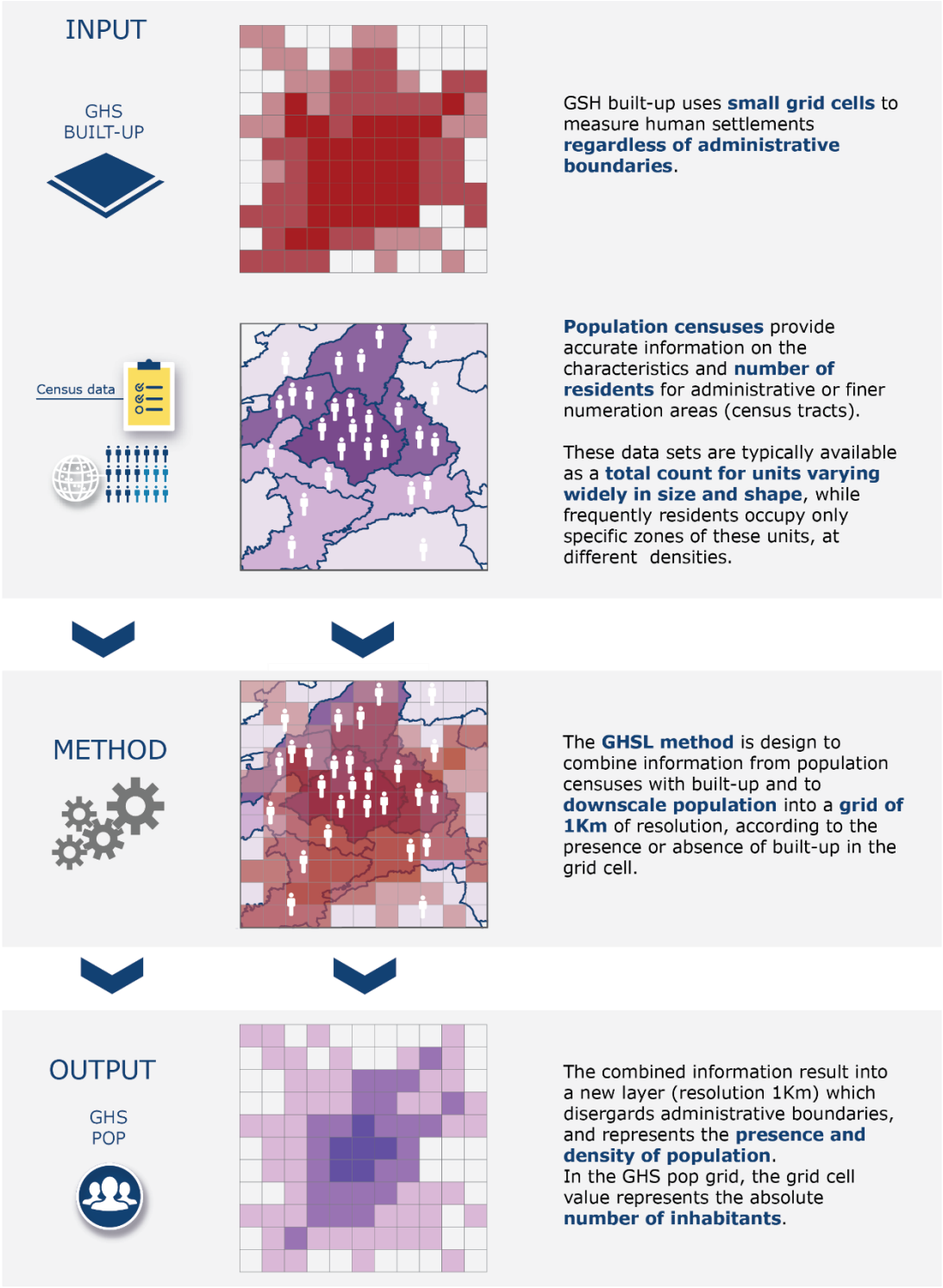
The forth paragraphs show with simple images, and example of three GHSL datasets (GHS Built-up, GHS POP and S-MOD) for the city of Madrid, Spain (2.4.4).

Image 2 © artefacti, Fotolia.com

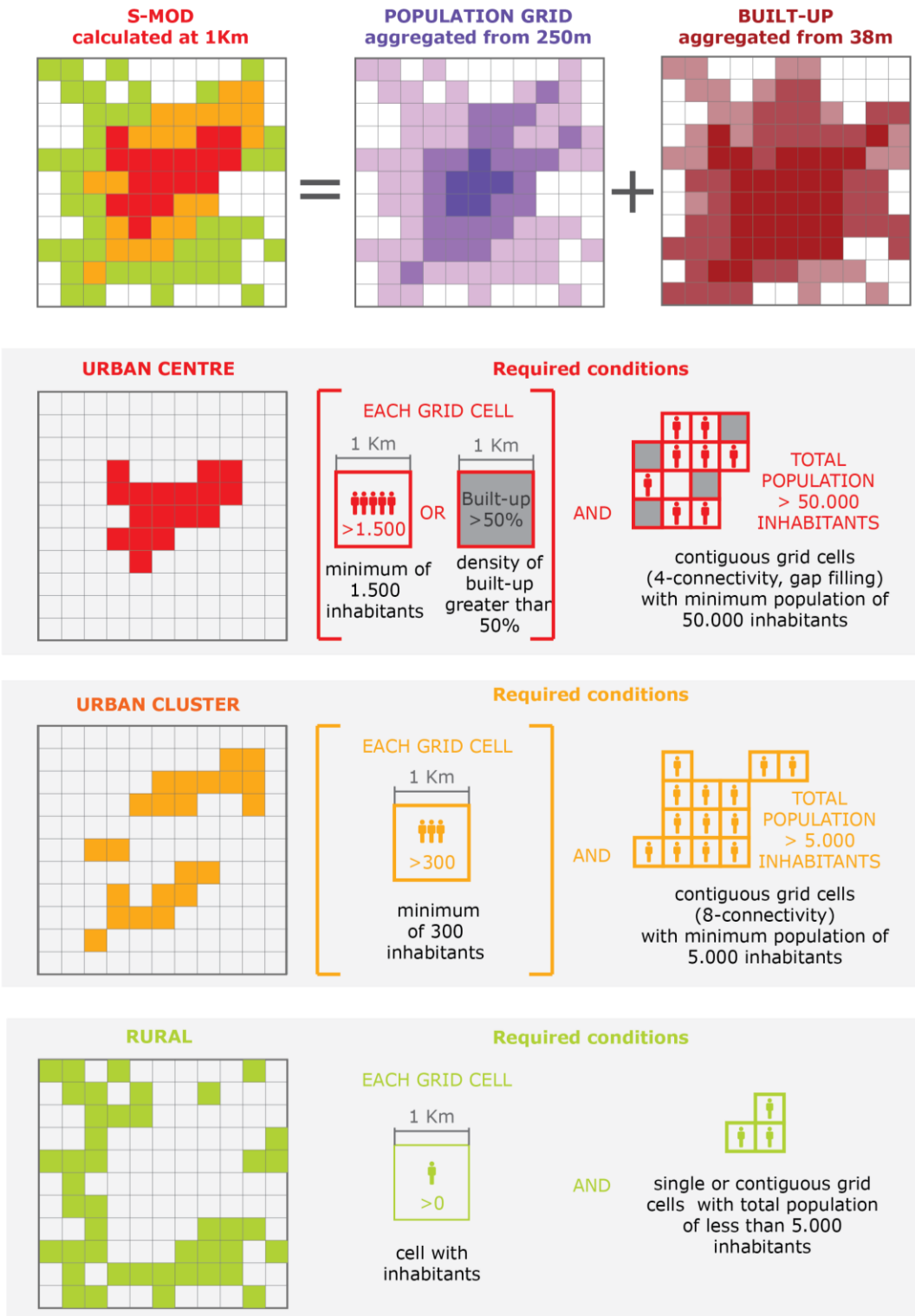
2.4.1 From Earth's surface to built-up area



2.4.2 From Built-up area to population grid



2.4.3 The GHSL Settlement Model



2.4.4 An example from the city of Madrid, Spain