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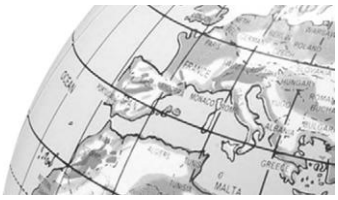

# Comparison of indicator 11.3.1 estimates provided by distinct assumptions on the urban population distribution

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This work compares estimates of the indicator 11.3.1 provided by different assumptions concerning the urban population distribution. The comparison is based on results obtained for Mainland Portugal, at the municipality level. The indicator 11.3.1 was assessed using the Land Use Efficiency (LUE) formula proposed by Corbane et al. (2017). The LUE can be faced as a proxy of the "ratio of Land Consumption Rate to Population Growth Rate", which is also known as indicator 11.3.1, because it is associated with the SDG 11 ("Make cities inclusive, safe, resilient and sustainable") and more specifically with the target 11.3 that aims a more sustainable growth of cities, among other aspects (UN-Habitat, 2018).

The LUE indicator aims at monitoring and measuring urban development. Its assessment requires the quantification of the surface occupied by urban areas and its inhabitants, at different temporal instants. The LUE formula proposed by Corbane et al. (2017) measures the change rate of the built-up area per capita. Negative values of LUE indicate that urban soil consumption was faster than urban population growth in the period under review. Values of LUE around zero indicate that the soil consumption per capita was stable over the period under review (i.e. the urban surface and the urban population increased or decreased both at the same rate). Positive values of LUE indicate that urban soil consumption was slower than urban population growth in the period under review.

Assuming that the surface occupied by built-up areas is equivalent to the surface occupied by urban areas, we estimated such surface using data extracted from the Portuguese Land Cover Land Use maps for 2010 and 2015 (known as COS 2010 and COS 2015). The land cover classes chosen to represent the urban areas were the Artificial areas (1) excluding Construction sites (311). To ensure the comparability of the indicator at different moments, the measurement of the surface of each municipality occupied by urban areas at different years was carried out using the same administrative limits, which correspond to the municipalities boundaries in 2013 (Nicolau et al., 2019).

To determine the inhabitants in urban areas, we used estimates of the resident population by municipality produced by Statistics Portugal, for 2010 and 2015. We tested two assumptions concerning the distribution of the urban population in Mainland:

a) A simplified (S) assumption, which admits that the urban inhabitants may be represented by the residents in administrative units, to which the urban areas pertain. This means that the entire population lives in urban areas.
b) A more pragmatic (P) assumption, which admits that although most of the population is concentrated in urban areas, there is a small share living outside urban areas.

The assessment of the urban population by assumption P was accomplished by the allocation of inhabitants to the areas where people are most likely to reside, followed by an overlay of the urban areas with the population distribution produced by the allocation. Such requires the identification of the land cover classes that can represent residential areas. In a former work (Nicolau et al., 2019), we choose three classes that are typically urban and one non-urban class: Continuous urban fabric (111), Discontinuous urban fabric (112), Sports, leisure and cultural facilities, and historic zones (142) and Complex cultivation patterns (242).Therefore the residents per municipality were distributed by these four classes using a dasymetric mapping technique.

The results presented herein correspond to estimates of the LUE indicator that only differ in the evaluation of the urban population per municipality. To distinguish the LUE estimates provided by each assumption, the obtained by S are

designated LUE-S and the obtained by P are designated LUE-P.

In the period 2010-2015, the surface occupied by urban areas increased in almost all the municipalities (97%) and in the Mainland. The average soil consumption rate per municipality was about 3.5%. In the same period, the Mainland and the majority of the municipalities (90%) lost inhabitants. The urban population (assessed by assumption P) also declined in 90% of the municipalities.

In the period 2010-2015, the LUE-S and LUE-P estimates were negative both in the Mainland and in most municipalities (94.6%). These negative values of the LUE are explained by the expansion of urban areas, while the decrease of their residents. Most municipalities with positive estimates of LUE belong to the fringe of Lisbon Metropolitan Area, where urban soil consumption was slower than urban population growth. Table 1 compares LUE estimates for the period 2010-2015 based on assumptions S and P. Presented results show that the estimates of LUE produced by S do not differ from those produced by P. Therefore, the spatial distribution of LUE-S and LUE-P (Figure 1) is similar.

**Table 1** – Comparison of LUE-S and LUE-P estimates for the period 2010-2015

| | LUE-S | LUE-P |
|---|---|---|
| Mainland Portugal | -0,10 | -0,10 |
| Minimum per municipality | -1,30 | -1,30 |
| Municipality Median | -0,13 | -0,13 |
| Municipality Mean | -0,16 | -0,16 |
| Maximum per municipality | 0,12 | 0,12 |
| % of Municipalities with LUE > 0 | 5,4 | 5,4 |
| % of Municipalities with LUE = 0 | 0 | 0 |
| % of Municipalities with LUE < 0 | 94,6 | 94,6 |

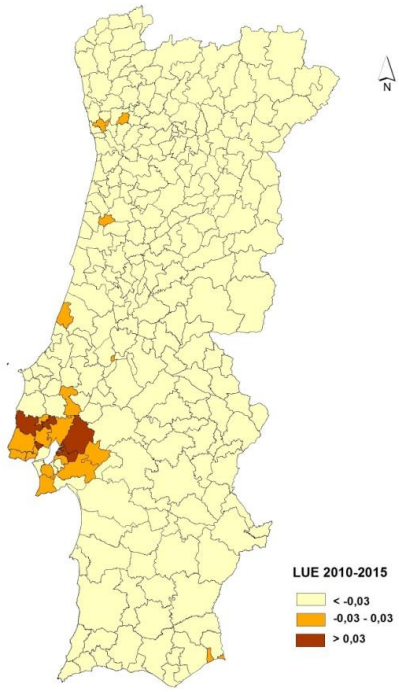


**Figure 1** - LUE-S and LUE-P estimates per municipality for 2010–2015

The differences between the LUE-S and LUE-P estimates for the period 2010–2015 are not significant because the assumption P just enabled the allocation of a very small number of inhabitants to non-urban areas. In fact, the proportion of the Mainland population allocated, in 2010 and 2015, to non-urban areas was only 0.03%. The differences between the LUE-S and LUE-P estimates can however become significant if a larger number of inhabitants is allocated to non-urban areas.

Admitting that the criterion imposed for this allocation has been too strict (a population density equal to 1.6 inhabitants per square kilometer), we are planning to develop a sensitivity analysis to clarify how the differences between LUE-S and LUE-P estimates may vary with different allocation criteria.

## References

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