Assessment of local climate zones in Tokyo (Japan) and Lyon (France) using satellite and mobile measurements

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According to the IPCC, current climate change is likely to increase the intensity and frequency of extreme events. This is particularly the case for heat waves, the severity of which has increased in Europe in recent decades. In addition, the rise in temperatures due to global climate change is amplified by the urban heat island effect (UHI). This phenomenon is widely analysed and is one of the major themes of urban climatology, especially its impact on human health. A UHI is characterized by a difference in temperature between an urban area and the surrounding rural areas. In general, the temperature in urban areas is higher than in rural areas, especially at night. Solutions must be found through urban planning policies by implementing sustainable adaptation strategies to improve the thermal comfort of the inhabitants. Solutions must start with a better understanding of UHI and urban microclimates.

For this purpose, the use of Local Climate Zones (LCZs) is often used. This concept proposes the use of a common methodology to define the physical characteristics of cities for urban planners, architects and urban climatologists. Therefore, this terminology is transferable to all geographical and cultural areas. The 18 main zones are set up according to the characteristics of the surface structure.

These zones have a theoretical basis and it is necessary to ensure the thermal coherence of this territorial division before its use in development projects. The objective of this study is therefore to compare the LCZs with land surface temperature (LST) data from Landsat measurements and mobile air temperature (AT) measurements carried out in the Tokyo (Japan) and Lyon (France) agglomerations during moving observations, in order to ensure the relevance of the different sectors.

LCZs are obtained by supervised classification of Landsat and Sentinel images. The random tree classifier was used. Results were visually verified using 8 cm resolution orthophotography and edited for classification inaccuracies.

The LSTs were obtained using the single channel algorithm. All images with less than 10% cloud cover were processed from 2000 to mid-2019 (53 for Tokyo and 49 for Lyon). In addition, only pixels with sufficient quality according to the band quality assessment were retained. Air temperature measurements on foot or by bicycle were also carried out at moderate speed (< 8 km/h) at both sites. A Log32 continuous recorder was used under a white ventilated radiation protection shelter. Location was provided by a Garmin 64s GPS. 30 measurement campaigns in Lyon and 23 in Tokyo were carried out during the summer months from 2016 to 2019. LSTs and ATs are studied as a function of LCZs using the Kruskal-Wallis test followed by the Steel-Dwass-Critchlow-Fligner multiple pair comparison procedure.

The results of the LSTs indicate significant differences between areas and thus confirm the value of using LCZs (figure 1: LSTs over Tokyo metropolitan area according to the LCZs, 20th, March 2017). Specifically, the highest surface temperatures are obtained in compact and open low-rise areas, activity zones and heavy industrial zones. The lowest temperatures are found in dense forests and water areas. The results are less significant for ATs, but the overall results are the same. This is due to the fact that ATs have a much lower range than LSTs. Indeed, for the same day, it is very rare to find ATs differences of 3°C when

the differences in LSTs can exceed 30°C. Furthermore, mobile AT measurements are much more dependent on wind and sun exposure than LSTs. In these two agglomerations, LCZs are therefore appropriate planning tools that can be mobilized to tackle UHI and improve urban thermal comfort.

Keywords: Local climate zones, Land surface temperature, Air temperature, Landsat