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Identification of urbanization in Rio de Janeiro based on land-surface temperature using the Rio de Janeiro Petrochemical Complex (COMPERJ) as pilot area

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Urbanization studies are extremely important for both socioeconomic and environmental sectors as the impacts caused by anthropogenic activities have been growing and damaging many areas. For instance, Rio de Janeiro Petrochemical Complex (COMPERJ) is scheduled to begin operation in 2020. The facility is located on a 45 square kilometers land in Itaborai, Rio de Janeiro. It is expected that COMPERJ construction increases the pressure on local infrastructure conditions and the environmental system. Accordingly, this manuscript aims to analyze the impact of COMPERJ on land-surface temperature (LST) based on remotely sensed data from Landsat satellites and uses this interesting region as a pilot area to analyze the LST behavior over time. Images were grouped in two periods with the same number of years, 2002 to 2007 and 2008 to 2013, with the aim of representing environmental conditions prior to construction and after the COMPERJ construction, respectively. Post-construction results show a ring of LST concentric values coming from the colder outer part toward the warmer core with spatial characteristics similar to an urban heat island (UHI). However, our results show that a comparison using LST between different time periods to assess the urban increase or the UHI intensification must be carefully conducted as the spatial and temporal variations of LST are related not only to surface characteristics, but also to weather and season. Our results show that although LST is closely related to surface characteristics, the weather and climate conditions may have a greater influence on LST. In fact, results for individual images indicate that the LST values before the construction of the COMPERJ can be both larger and smaller than the values referring to the period after the construction and vice versa, indicating in some situations an overlap of the weather and/or climatic conditions to the surface conditions. This fact is observed in both winter and summer. Accordingly, we have used the COMPERJ region as a pilot area to test LST data normalization/standardization methods to reduce the influence of background weather and climate conditions from different temporal times. The LST temporal evolution was verified by the Students's t statistical test conducted at the 5% level and it was not possible to confirm based on the Student's test that LST values increased after COMPERJ construction. On the other hand, obtained results based on the LST normalization/standardization confirm, within the significance level assumed, its increase just inside the construction area of COMPERJ. Based on the results found in the pilot area, the LST normalization/standardization was used to analyze the urbanization on Metropolitan Area of Rio de Janeiro (MARJ). The temporal analysis was carried out based on the division of data in three decades 80, 90 and 2000. Results have confirmed the difficulty to move from a limited area to a great territorial extension, due to the different land covers, but despite this difficult, it is possible to identify urban areas and observe temporal changes using the LST normalization/standardization.