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Satellite-based monitoring urban environmental change and its implications in the coupled human-nature system

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Changes in urban environments play important roles in sustainable urban development. Satellite observations in fine spatial and temporal resolutions, together with new computer technologies, provide the possibility to monitor these changes across large geographic areas and over a long time period. In this study, we developed new algorithms to characterize dynamics of urban extent, urban heat island, and phenology (i.e., onsets of green-up and senescence phases) and successfully implemented them on the advanced Google Earth Engine, a state-of-art platform for planetary-scale data analysis, mapping, and modelling. The evaluation indicates that the proposed algorithms are robust and perform well in deriving changes in urban environments. Finally, we explored the implications of urban environment changes in the coupled human-nature system by investigating the responses of building energy use and pollen season to these changes. The resulted products of annual dynamics of urban extents, urban heat island, and phenology indicators from this study offer new datasets for relevant urban studies such as modeling urban sprawl over large areas and investigating ecosystem responses and human activities to urbanization.