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A new method for automatic identification and ranking the urban heat island hotspots

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Urban Heat Islands (UHIs) are increasingly posing critical challenges to urban environments and human well-being. In response, we propose a novel methodology to identify Urban Heat Island Hotspots (UHIHs) to address the urgent need for effective management and mitigation strategies. Our research introduces the innovative concept of direct UHIHs detection and ranking, providing a framework for urban planning stakeholders to prioritise areas for regeneration based on UHIH severity.

A new concept is proposed, and it consists of: hotspot ranking in a given urban area, a new algorithm for hotspot detection, and a new tool for automatic detection and ranking hotspots. This approach greatly improves the effectiveness of interventions to mitigate the adverse impacts of UHIs on urban environments and public health.

This methodology addresses the critical importance of incorporating threshold percentiles and considering the spatial coverage of the study area. It relies on percentile-based thresholds, establishing the minimum acceptable values for individual cells and the mean values of the entire UHIH area. Through extensive experimentation with various threshold pairs, we identified the most suitable thresholds for further application, considering both LST values and non-climatic factors (e.g., urban fabric and imperviousness). The new hotspot identification algorithm calculates minimum acceptable values for individual cells and hotspot means, which plays a pivotal role in pinpointing UHI hotspots effectively. Each hotspot is identified on a step-by-step basis, starting with the identification of the highest temperature cell, which hasn't been assigned to any other hotspot in previous steps. Further on, the algorithm searches among all surrounding cells and checks if they meet the two threshold conditions or not. In case of a positive result, the identified cell is assigned to the current hotspot and placed in a stack for its neighbours to be further considered. In addition to the detection process, this research introduces the concept of hotspot ranking based on their intensity. This innovative feature enhances the utility of our algorithm by prioritising the severity of UHI hotspots, facilitating data-driven decision-making for urban planning and climate mitigation strategies.

The practical implementation of the proposed algorithm is sustained by the use of the versatile R programming language, providing researchers and practitioners with a flexible and user-friendly tool.

This research addresses the complex challenges urban heat islands induce, offering a comprehensive approach readily adoptable by researchers and urban planners. It underscores the urgency of UHI management and its potential to enhance the well-being of urban populations.

In summary, this new approach and tool could become very useful in the urban planning process as they:

- Enhance the effectiveness by prioritising the assessment of UHIHs based on their severity in a given location;
- Provide a valuable tool for data-informed decision-making in urban planning and climate mitigation;
- Enables urban planners and stakeholders to allocate resources and interventions more strategically, focusing on the critical areas from the UHI perspective;
- Maximise the impact of the urban planners/stakeholders' efforts in enhancing urban resilience and sustainability.