The evaluation of roof greening priority and benefits in Hong Kong

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Urbanization is a global megatrend of the 21st century. Although continuous urbanization can facilitate economic development, urban expansion and population growth put enormous pressure on the ecological environment and climate change. Greenspaces are pieces of urban nature designed to reduce the adverse effects of urbanization and protect people's health, particularly providing universal access to greenspaces has become one of the targets of Sustainable Development Goal 11 "Sustainable cities and communities". Green roofs have the potential to provide additional greenspaces and have been regarded as an effective strategy to mitigate the adverse impacts of urbanization. Thus, it warrants evaluating which roofs should be prioritized for greening and what benefits can be brought. However, there are few studies assessing the priority of roof greening from the perspective of urban sustainability, especially since the assessment on the urban scale is blank. To encourage green roofs, thus, a full understanding is necessary.

Hong Kong is a thoroughly urbanized city with a dense population and uneven greenspaces in built-up areas. It is located in the subtropical region, where high-density buildings and impervious surfaces lead to distinct urban heat island effects and intensive anthropogenic activities have increased carbon emissions. As a result, urban sustainability faces serious challenges in Hong Kong. To address the challenge, we used geospatial big data to comprehensively assess the priority and benefits of green roofs from the perspective of urban sustainability at the urban scale and overcome the limitation of separate evaluation of small-scale green roofs based on limited data and indicators, so as to enhance the cognition of green roofs. Specifically, building geometry and attribute information were used to identify the potential roofs; different from the indicators based on only attributes, we focused on several indicators closely related to urban sustainability and quantified them to determine the urgency of roof greening under different conditions, then combined all indicators to assess the greening priority and benefits of all potential roofs.

Through a multifaceted assessment, we found the area of potential roofs that can be greened reaches about 90% in Hong Kong and most potential roofs show the urgent need for greening, where the average greening priority was 0.74 and the greening priority of ~81% of the potential roofs up to 0.7, especially in urban cores. Additionally, we estimated that green roofs could increase the greenspace coverage rate around buildings from 0.35 to 0.58 and human exposure to greenspace from 35.3% to 56.7%, which could reach a high level globally; temperature simulation results showed that green roofs could reduce the air temperature by 0-0.4°C; we also estimated that green roofs could provide 820,000 metric tons of additional carbon storage and have the potential to offset ~3% of annual carbon emissions in Hong Kong, and at the same time, bring hundreds of millions (HK$) in economic performance a year. Our explicit insights can support greening policies and sustainable development in Hong Kong and other cities across the globe.

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