

通过遥感监测不同城市栖息地的城市树冠动态*

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摘要:【目的】城市树木作为应对人类社会面临的各种挑战的绿色处方,越来越受到学者和政策制定者的关注。城市树木的树冠状态是其生理健康的一个指标。利用遥感技术对树冠动态进行充分监测,有助于检测不同城市栖息地的植物生长情况,从而为管理措施提供依据,以最大限度地发挥城市树木的效益。

【方法】本研究以香港九龙半岛为案例研究地点,并根据来自政府和公开的数据,将研究区域中的树划分为路边、住宅用地、公园三种城市生境和自然生境。研究比较了四种利用亚米级空间精度的 WorldView-2 遥感数据分割单个树冠的方法。然后,将单个树冠与多光谱且高时间分辨率的 Sentinel-2 卫星数据相结合,以获得 2016 年至 2020 年每个季节的树冠生长动态。并应用基于不同树冠成分的光谱特征构建的叶片叶绿素密度、木质枝条密度和树冠含水量三个指标来反映树冠状况。【结果】在四种应用于城市区域树木冠层分割的方法中,VDVI 与决策树组合方法的所有三个性能指标都大于所有其他方法,表明使用 VDVI 与决策树组合方法的树冠分割质量明显优于本研究中测试的其他方法。基于此方法在整个研究区域内共识别出 47,428 个树冠。然后我们进一步探索了在五年尺度的超级台风影响下,亚热带城市中分布最广泛的细叶榕 (*Ficus microcarpa*) 在不同城市生境下的动态。【结论】研究发现,城市树木呈现出不同的树冠生长趋势,三种城市栖息地的树木状况相对于生长在自然地型的树木要差,这表明城市环境抑制了树木的自然生长。此外,研究期间的两次超强台风也为城市树木在不同栖息地的恢复能力提供了证据。在台风来临之前,生长在自然区域的树木的指标表现最好。而在台风期间,自然区域的树木收到了最严重的损失。在台风之后的恢复期,自然区域的树木相比于其他三个城市生境的树木恢复的更快,这说明自然树木的恢复能力最强。同时在三种城市生境中,生长在路边树木的恢复能力最弱。这项研究展示了如何利用遥感数据更好地了解不同城市栖息地树冠的长期动态,这对于监测城市树木的动态和采取管理措施以保持城市树木的健康和生长至关重要。

关键词: 城市树木监测; 树冠生长动态; 遥感; 城市生境

Remote sensing for monitoring urban canopy dynamics across heterogeneous urban habitats*

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Abstract: 【Objective】Urban trees have attracted increasing attention to serve as a green prescription for addressing various challenges facing human society like climate change and environmental deterioration. However, without healthy growth of urban trees, they cannot service any environmental, social, and economic benefits in a sustainable manner. By monitoring the canopy development, the tree growth dynamics in different urban habitats can be detected and appropriate management approaches can be executed.

【Method】Using the Kowloon Peninsula, Hong Kong, as a case, this study divided the trees in the study area into three urban habitats: roadsides, residential neighbourhood, and parks, and natural habitats based on government and public data. The study compared four methods for segmenting individual tree canopy.

pies using WorldView-2 remote sensing data with sub-meter spatial resolution. Then, the individual canopies were combined with multispectral and high-temporal resolution Sentinel-2 satellite data to obtain the canopy growth dynamics for each season from 2016 to 2020. Three indicators, leaf chlorophyll density, woody branch density, and canopy water content, constructed based on the spectral characteristics of different components, were used to reflect the canopy condition. **【Result】** Among the four methods applied to tree canopy segmentation in urban areas, all three performance indicators of the combined VDVI and decision tree method were greater than all other methods, indicating that the quality of tree canopy segmentation using the combined VDVI and decision tree method was significantly better than the other methods tested in this study. A total of 47,428 tree canopies were identified in the entire study area based on this method. We then further explored the dynamics of *Ficus microcarpa*, the most widely distributed tree in subtropical cities, in different urban habitats under the influence of super typhoons at a five-year scale. **【Conclusion】** The study found that urban trees showed different canopy growth trends, and the condition of trees in the three urban habitats was worse than that of trees growing in natural terrain, indicating that the urban environment inhibited the natural growth of trees. In addition, the two super typhoons during the study period also provided evidence for the resilience of urban trees in different habitats. Before the typhoon, the indicators of trees growing in natural areas performed best. During the typhoon, the trees in natural areas suffered the most serious losses. In the recovery period after the typhoon, the trees in natural areas recovered faster than the trees in the other three urban habitats, indicating that natural trees have the strongest recovery capacity. At the same time, among the three urban habitats, the recovery capacity of trees growing on the roadside was the weakest. This study shows how remote sensing data can be used to better understand the long-term dynamics of tree canopies in different urban habitats, which is crucial for monitoring the dynamics of urban trees and taking management measures to maintain the health and growth of urban trees.

Key words: urban tree monitoring; canopy growth dynamics; remote sensing; urban habitat.