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Predicting and comparing canopy biomass by satellite-extracted vegetation indices and a temperature-driven phenological modelling approach

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Urban forest provides several important ecosystem services to cite residents and city environment, by which most functions were related to trees' canopy biomass. To understand the dynamics of canopy biomass affecting the ecosystem services, this study applied and compared two approaches in predicting canopy biomass of *Koelreuteria elegans* street trees in the city of Taipei in Taiwan. The first approach extracted vegetation indices (VI) from time series data of the 2018 Sentinel-2 satellite images, to represent signals of tree canopy variation, including Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI), image classification based on VI time series data was processed to extract pixels with high canopy covers, and examined the associated phenological activities. In contrast, the other approach applied a system dynamic model to capture changes of canopy phenological activities in different seasons by factors of canopy size, leaf duration, and phenology events, all controlled by an accumulated temperature function to characterize green up and defoliation mechanisms. The growth temperature and growth rate of new leaves were calibrated with the phenological records. Results found good correlations between satellite-extracted vegetation indices approach and a temperature-driven phenological modelling. Reconstructed by NDVI and EVI, both indices caught the start of spring growth of *Koelreuteria elegans* in March to a full-sized canopy in April, with the whole growing season extended to the end of September, and a beginning of main defoliation from October to the lowest canopy size in January and February next year. Built from the image classification results for pure canopy cover, the maximum value of NDVI and EVI was 0.443 and 0.486, while the minimum was 0.08 and 0.163, respectively. In comparison, results from the canopy phenological modelling showed similar trends that canopy biomass reached its lowest point in February, entered to a rapid growth phase in March and reached full canopy size in April. Although the canopy phenological model also predicted a main growing season lasted until October, during the defoliation period, the leaves of the *Koelreuteria elegans* never completely fell off, due to the actual monthly minimum average temperature in the city of Taipei was higher than 10^{o}C as the threshold of the controlled temperature. Based on these results, we suggest that when ground tree survey and inventory data are available, both satellite-extracted vegetation indices and modelling approach can provide useful predictions for landscape planning and urban forestry management.