Forest structure and disturbance dynamics detected with high-resolution airborne LIDAR

(高解像度航空機 LIDAR によって検出した森林構造と撹乱ダイナミクス)

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Forest ecosystems are a significant fraction of the earth's surface, and accurate estimates of forest structure and dynamics in relation to disturbance are essential for understanding how forest ecosystems respond to climate change. Unfortunately, conventional field-based approaches can not provide a clear picture of how topography controls forest structure and how forest landscapes respond to catastrophic natural events of a large spatial scale. With the advancement in remote sensing techniques along with a greater data availability from airborne laser scanning (ALS), it is now possible to obtain simultaneous high-resolution information of the three-dimensional structure of forests and the underlying terrain with extensive spatial coverage. This thesis examines the potential application of ALS in describing the variability of forest structure in relation to topographic heterogeneity and neighborhood crowd (Chapter 2), stand biomass and biomass loss due to typhoon (Chapter 3), the vulnerability of forest landscape to typhoon wind, and explanatory factors of the spatial pattern of damage (Chapter 4). Chapter 2 concludes that for a regional scale (230 km^2), canopy height is shaped mainly by the neighboring tree density, distance from nearby gaps, and topographic curvature. Taller trees are most likely located in concave positions with greater water availability, in the middle of a contiguous forest stand, and at an intermediate elevation. In Chapter 3, high-resolution satellite images were used to detect the damage caused by typhoon '*Jebi*' (which travelled over the Kyoto area on September 4, 2018). After that, inventory plots were used to estimate living biomass and biomass loss of the study area using ALS metrics. The results of Chapter 3 indicated that typhoon 'Jebi' affected 247 ha of forest land (1.07% of the total area) and removed 92.3 Gg above-ground biomass (AGB) from the study area (1.44% of the total AGB of the site). In Chapter 4, simulated mesoscale meteorological data were used in addition to ALS and machine learning techniques to estimate the present vulnerability of forests to typhoon wind. The results found that the interaction of local topography and wind profile during typhoons drove the major damage pattern. In addition to that, the vulnerability increased consistently with the increase of canopy height and wind speed. I hope the findings of this study will help forest managers to make proper management decisions and contribute to the formulation of adaptive policies to be prepared for future catastrophic storm events in forested lands.