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Understory biomass measurement based on SfM data by a manual low-flying drone under the canopy

Yupan Zhang[1], Yuichi Onda[1], Hiroaki Kato[1], Xinchao Sun[2], and Takashi Gomi[3]
[1]Center for Research in Isotopes and Environmental Dynamics, University of Tsukuba, Ibaraki, Japan (s1930233@s.tsukuba.ac.jp)
[2]Institute of Surface-Earth System Science, Tianjin University, Tianjin , PR China (xinchao.sun@tju.edu.cn)
[3]Department of International Environmental and Agricultural Science, Tokyo University of Agriculture and Technology, Tokyo , Japan (gomit@cc.tuat.ac.jp)

Understory vegetation has the important effect that cannot be ignored on Evapotranspiration. In previous studies, laser scanner was used to measure small-scale biomass and airborne LiDAR was used to assess light availability to understory vegetation, which in turn was converted to understory biomass production. However, it is difficult to measure watershed-scale understory biomass with high resolution. In this study, Structure from Motion (SfM) was used to reconstruct understory vegetation structure by a manual low-flying drone under the canopy with radial paths in a line thinning plantation and a spot thinning plantation made by Japanese cedar and cypress. By generating Orthomosaic image and dense point cloud data, we then extracted Excess Green Index (ExG) and Canopy Height Model (CHM), combining with understory biomass data from field harvesting to establish a quantitative relationship between the CHM and biomass, which was then used to map biomass and vegetation coverage in the study area. The results indicated that (1) a flight height of 7-10 meters is more conducive to understory vegetation reconstruction, with a photo quality greater than 0.8 and a point cloud density of more than 20 points/cm^2. (2) a regression cubic model based on the CHM has acceptable accuracy and biomass estimate capability ($P<0.01$), with a coefficient of determination of 0.75. (3) compared with the spot thinning, the understory biomass under the line thinning scenario was higher(average biomass 3.03kg/m^2). (4) vegetation coverage based on the ExG index of visible light analysis was affected by ambient light(strong sunlight on a sunny day), and it cannot reflect the seasonal changes of understory vegetation biomass. These results disclosed the potential of the dense point cloud from drone SfM for estimating understory biomass. With this method, we will measure more than 5000m^2 of headwater catchment and output a understory biomass map.