Geophysical Research Abstracts
Vol. 20, EGU2018-18978, 2018
EGU General Assembly 2018

Size-related scaling of crown structure and principles of space equivalence influence structure and dynamics of natural forests

Sudip Pandey, Marco Carrer, and Giai Petit

University of Padova, Department of Land, Environment, Agriculture and Forestry, Italy (sudip.pandey@phd.unipd.it)

Natural and uneven-aged forest ecosystems are commonly characterized by a typical reversed j-shaped frequency distribution of tree sizes. The allometric scaling of crown architecture with tree size has been proposed to determine the structure and dynamics of these forest ecosystems, according to principles of optimal use of resources (energy equivalence). However, while the crown volume (V_{CRO}) theoretically expresses the potential of total leaf transpiration and thus refers to the use of soil water resources, on the contrary the crown area (A_{CRO}) indicates how much an individual is exposed to solar radiation.

Here we tested two alternative hypotheses, that is whether the scaling of V_{CRO} or A_{CRO} with tree height (H) is the main driver of the structure of natural forest according to a principle of equal availability of soil resources or space for a light interception, respectively.

We collected dendrometric data from 17,385 trees in 8 permanent plots (1 to 4 hectares in area) from different geographical locations (2 in Himalaya Nepal; 2 in Carpathian mountain in Romania; 4 plots at different elevation in the Eastern Alps, Italy). We assessed the allometric scaling of A_{CRO} and V_{CRO} with H and calculated the frequency distribution of trees in H-classes. We then applied an allometric model based on these scaling relationships and predicted the theoretical distribution of trees.

We found a highly significant scaling relationship of both A_{CRO} and V_{CRO} with H in all the plots. The frequency distribution in H-classes was the typically reversed j-shape in unmanaged forests, and the best model prediction was always the one based on the scaling of A_{CRO}.

Our results suggest that natural forests are oriented towards a condition of space equivalence between tree-size classes, and crown enlargement with increasing tree size determines the distribution of tree sizes and ultimately the overall ecosystem dynamics.

Keywords: allometry, crown, optimality principles, forest dynamics, forest structure, tree size distribution, tree height