

Three-dimensional aerodynamic structure estimation and wind field simulation for wide tree shelterbelts

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Abstract : The structural parameters of tree shelterbelts have traditionally focused on overall density, inadvertently overlooking potential heterogeneity within the forest structure. This oversight has led to considerable errors in wind field numerical simulations. In this study, aerodynamic parameters (A3D) were calculated for *Metasequoia glyptostroboides* and *Populus euramevicana* shelterbelts with two rows, based on the method reported by Zhou *et al.*. The wind field was simulated using the governing equations in FLUENT software, allowing for the derivation of shelter effects. The A3D ranged from 0.04 to 1.94 and from 0.06 to 2.10 for *M.glyptostroboides* and *P.euramevicana* shelterbelts, respectively. The relative horizontal wind speed at 0.2H (tree height H) was derived from the wind field simulation. Leeward of the shelterbelts, the wind speed initially decreased and then accelerated briefly over a short distance. Subsequently, the wind speed decreased again, with a minimum relative speed (U_m/U_0) of 43% at 3.7H and of 37% at 6.1H for both shelterbelts. Finally, the wind speed began to recover, yielding relative shelter distances (D70) of 14.4H and 26.2H for both shelterbelts. Moreover, wind fields were simulated for shelterbelts with planted shrubs, which markedly improved the shelter effect owing to the optimized A3D. These findings introduce new methods and practices for the design, construction, and management of tree shelterbelts.