

Book Reviews

Wind and Trees

Edited by Coutts, M.P. and Grace, J. 1995. Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, UK. ISBN 0 521 46037 9. 485 pages. Hardback. £65.00.

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Wind and Trees is a sample collection of papers presented at the conference on Wind and Wind-Related Damage to Trees, held at Heriot-Watt University, Edinburgh in July 1993. This IUFRO-conference, initiated by Chris Quine of the UK Forestry Commission, attracted approximately 100 delegates from 17 countries. The publication claims to be the first to combine the various disciplines of meteorology, mechanics and physiology in an attempt to understand how and why trees are damaged by wind. To say that *Wind and Trees* brings those topics together to provide a better understanding of the problem of wind damage to trees and forests, is, however, somewhat misleading. The above areas are certainly included, but only as separate papers, and no real effort is made to combine results from the various disciplines. The book includes 27 papers from 52 contributors from all over the world. The papers are divided into five different sections dealing with (i) airflow over topography and in forests, (ii) mechanics of trees under wind loading, (iii) tree physiological responses, (iv) impacts of wind on forests and ecology, and (v) risk assessment and management response.

The first section, which deals with airflow over open and forested areas, includes six papers discussing the influence of topography, roughness of the surface, edges, etc., on the turbulence and movements of wind. From a forester's perspective, the papers are technical in nature and understanding them requires both time and a reasonable knowledge of climatology and meteorology. Some points are, however, worth mentioning. Having studied the effects of coherent gusts on trees and stand canopies, Gardiner suggests that an irregular forest structure may have stability benefits over more uniform stands. Based on a wind tunnel experiment, Chen *et al.* identify three separate zones (quiet, wake and readjustment) at certain distances (in tree lengths) from the forest edge, and speculate what the effects of those zones would be on the overall seedling microclimate on a clear-cut. Inglis *et al.* test a linear airflow model called Flowstar against data from a complex terrain. According to the authors, the model requires further development in order to become robust enough for use in practicable forest planning operations. To predict wind speed, Hannah *et al.* have developed some multiple regression equations based on altitude, topex (exposure), roughness length, position and distance to the coast, which have shown encouraging results in independent tests.

The mechanics of trees when exposed to wind loading are dealt with in the publication's second section. In an overview chapter, Wood discusses the "adaptive growth hypothesis" which postulates that a tree will grow sufficiently strong to resist the forces exerted upon it, and that this optimisation of strength by nature is invariably more elegant than that achieved by the human design process. The author states, however, that this leaves the tree vulnerable to events unprecedented in its growth history (such as a storm blowing from a

non-prevalent direction) and even if the tree and roots grow adaptively, the soil itself does not adapt. This then leads to the overturning of trees rather than the snapping of stems, especially after a thinning operation. The now widely-accepted idea that thinning increases the risk of wind damage of trees is also described in a modelling experiment by Milne. Working with Sitka spruce (*Picea sitchensis* (Bong.) Carr.) in Ireland, Rodgers *et al.* found an increase in soil pore water pressure, when studying dynamic *in situ* loading of mature trees, and state that this led to hydraulic fracturing of the soil/root plate. They stress the importance of using site preparation methods which encourage deeper and more symmetrical root growth. Two separate papers deal with different modes/types of failure. Mattheck *et al.* describe criteria for failure after studying damaged trees, while Guitard and Castera attempt to understand and predict them with a tree sway mechanical model. The two concluding papers in the second section describe new instruments for measuring stress (Watson) and for assessing the wood quality of standing trees (Bethge and Mattheck).

In the third section of *Wind and Trees*, four papers discuss how trees react or respond when exposed to external stress and the resulting physiological processes of the trees. Telewski describes the influence of wind on tree growth and development, in terms of stress and strain relationships, and distinguishes between primary and secondary forms of stress. The primary stress is the force of the wind which leads to a number of viable and mechanical strains, with actual windthrow representing the ultimate phase. Secondary stresses, such as changes in atmospheric conditions around leaves and the influence of gravity due to displacement, also lead to physiological strain responses. Those strains can be seen as changes in transpiration and photosynthesis, reduced translocation, callose formation and more long term structural changes in canopy, leaf, stem and root morphology, in addition to modifications to the actual cell structure. Based on the results of two wind tunnel experiments, Stokes *et al.* describe how exposed seedlings have more roots and greater root cross sectional area on the windward side than on sides perpendicular to the wind. They suggest that this is an adaptive growth response, where trees allocate more assimilates to those roots necessary for anchorage. A similar finding, with more root biomass allocated on the leeward side of trees compared to those perpendicular to the wind, is reported by Nicholl *et al.*, based on studies into the breeding and selection of trees for improved wind stability. They also found differences in the allocation of biomass between above and below ground parts of the trees (root/shoot ratios) across different clones. They suggest that improved stability might be achieved by clonal selection, but state that more research is required.

Of the three papers in the publication's fourth section, which deals with impacts of wind on forest ecosystems, two describe the effect of more catastrophic events such as hurricanes in the Caribbean. Foster and Boose suggest that predictable pathways and characteristics could be found on regional and landscape levels, using models based on historical data after major storms. At stand level, they noticed the remarkable rates of recovery of the forest vegetation after major storms, which were mainly due to the very high rates of survival and resprouting. For better understanding and prediction, however, more studies of additional forest types are needed, particularly in the areas of hydrology, nutrient cycling and soil/organic dynamics. After reviewing papers reporting on 26 wind events in 27 different forests, Everham asks for a standard method for measuring damage to forests caused by storms. To facilitate comparisons, the author suggests that such a method should at least include both mortality and structural losses (described in terms of a decrease in basal area). When looking at the directions in which conifer trees blew over in a sub-alpine forest, Woolridge *et al.* found a distinct relationship between airflow and features of the local terrain.

Of the seven papers in the final section of *Wind and Trees*, two deal with the risk assessment for wind damage, while the remaining five are more oriented towards the management of the forest to avoid or prevent wind damage. In the introductory paper, Quine compares the British Windthrow Hazard Classification System with a new and more conceptual wind risk model, and suggests that a risk-based system, rather than a hazard-based system, is now required. Whatever the difference between risk and hazard, Quine suggests that the new model must be based on the interaction between variable wind climate and changing tree vulnerability. He concludes, however, that more understanding is urgently required, particularly in terms of the latter, where a change in management practice can significantly alter the vulnerability of the tree in different development stages. In the second paper dealing with risk assessment, Wollenweber and Wollenweber describe a method which includes a hierarchy of models in order to simulate the effect of the wind after a modification of the landscape. The authors claim that the method is both fast and efficient, and offers cost-effective assessments of environmental problems.

Nielsen offers a clear explanation as to why traditional thinning models with constant thinning intensities cause stability problems in Norway spruce (*Picea abies* (L.) Karst.) stands in Denmark. He suggests an alternative management practice for those stands, commencing with an initial wide spacing, followed by decreased thinning intensities and a no-thin regime during the final third of the rotation. Based on long term experiments with Norway spruce in the Czech Republic, Slodick suggests a similar management approach, where the initial wide spacing also minimizes the risk of snow damage. As 4% of the annual allowable cut in British Columbia, Canada comprises windthrow damaged trees, Mitchell discusses topping and pruning as ways of reducing the risk of damage in partial cuttings. Finally, in two separate papers, Somerville and Studholme describe the problems with windthrow in Monterey pine (*Pinus radiata* D. Don) plantations in New Zealand. In some areas of the country, where windthrow can be as high as 90%, harvesting usually takes place after the trees have blown down. Site preparation is therefore deliberately avoided, as the resulting increased stability leads to broken, as opposed to fallen, trees!

Even if *Wind and Trees* does not give the full answers to many of the very costly problems that wind and storms can cause to trees and forests, it focuses on some important aspects. Anyone interested in this field should at least attempt to see a copy. As a proceedings publication from a scientific conference, it can certainly defend its place on the bookshelf as a useful reference to much of the most recent research.