Abstract

Trees adjust wood anatomical structure to environmental conditions, predisposing time series of quantitative wood anatomical parameters to be valuable source of palaeoenvironmental information. In this doctoral project we analysed the response of vessel parameters of i) floodplain *Quercus robur* to groundwater level fluctuation, hydroclimate variability and extreme events (droughts and floods), and of ii) *Betula pendula* to mechanical damage caused by various disturbances.

Although climatic signal as well as pointer years stored in tree-ring width chronologies of *Quercus robur* largely differ between sites, quantitative vessel parameters contain spatially-homogenous positive signal of previous year summer temperature and current year winter/early spring temperature. The only between-site difference in wood anatomical chronologies is negative effect of moisture on vessel size in floodplain, which does not occur in not-flooded lowland sites. We suggest that while tree productivity benefits from high water availability, the wood anatomical structure of *Quercus robur* is constrained by high soil water saturation in floodplain zone. In addition, the response of tree-ring widths to moisture availability is not uniform inside single stand, but subgroups of trees with completely opposite response coexist (drought limited and moisture limited individuals). The first group of trees significantly reduced their growth after decline of groundwater level, meanwhile the latter group increased productivity. Existence of subgroups with contrasting response to groundwater fluctuations was not observed in case of vessel anatomical series, where individual trees share common climatic signal.

In addition to climate and hydrological conditions, processes causing mechanical damage also alter wood anatomical structure. Vessel size observed in the first tree-ring after stem scarring was by 60 % smaller compared to value expected based on linear age trend. In the following period, vessel size continuously increased, reaching pre-event level in third tree-ring after disturbance. Considering various types of mechanical damage, scarring of bark and cambium, stem tilting and decapitation cause the strongest decrease of vessel size in *Betula pendula*, which significantly outweighs ontogenetic trends and climatic signal. Wood anatomical anomalies spread along and around entire tree stem in case of tilted and decapitated individuals; contrary, xylem compartmentalization through adjustment of vessel size takes place only nearby callus tissue in scarred trees. Root exposure and stem base burial represent disturbances with less apparent response in wood anatomical structure. In case of most serious deformations, it takes more than 3 years to recover pre-disturbance wood anatomical structure. Decline in vessel size is not adequately compensated by increase in vessel number during this period, resulting in significant drop in xylem specific hydraulic conductivity. This indicates that predicted increase in intensity and frequency of disturbances related to climate change may alter transpiration capacity of forest stands.

The results of presented studies indicate that quantitative wood anatomical parameters of broadleaves should be perceived as multi-source driven parameter integrating effects of ontogeny, climate, soil hydrology and disturbances. Vessel size contains different environmental signal than tree-ring widths. Moreover, their signal is less between-site and between-tree variable than signal stored in tree-ring widths. This makes vessel parameters valuable proxy for reconstruction of former fluctuations in hydroclimatic conditions. In addition, abrupt adjustment of vessel size may be used as a tool to date former mass-movements and other types of disturbances. However, proper approaches are required for extraction of desired part of information and filtering out the noise from time series of wood anatomical parameters.

Keywords

Betula pendula, dendrochronology, disturbances, floodplain forest, mass-movement, *Quercus robur*, vessel, wood anatomy