International Symposium "Root Research and Applications"
RootRAP, 2–4 September 2009, Boku – Vienna, Austria

Belowground allometric relations in Norway spruce growing in soils with contrasting skeleton and water content

Martin Lukac[1], Jozef Pajtík[2], Bohdan Konôpka[2]

[1]*NERC Centre for Population Biology, Division of Biology, Imperial College London, Silwood Park Campus, Ascot, SL5 7PY, UK*

[2]*National Forest Centre, Forest Research Institute Zvolen, T.G. Masaryka 22, 960 92 Zvolen, Slovak Republic*

Key words: belowground biomass, *Picea abies*, soil skeleton, water-logging, allometric relation

An increasing importance is assigned to the estimation and verification of carbon stocks in forests. Forestry practice applies several long-established and reliable methods to assess the aboveground biomass; however we still lack accurate predictors of belowground biomass. The root system is important for tree anchorage, water and nutrients absorption from the soil, as a location for storing carbohydrate reserves and for synthesizing growth hormones. To provide all there functions, trees must transfer a considerable proportion of assimilated carbohydrates into the root systems. Estimation and modelling of below-ground structures of trees and forests is also important for the calculation of carbon stock and its changes, as well as for understanding and predicting ecosystem functioning.

To address the lack of information in this area, we utilized a major windthrow event which took place in the Tatra Mountains (Slovakia) on 19th November 2004, exposing a large amount of Norway spruce coarse root systems. In particular, the objectives of this study were: (1) to construct allometric relationships between stem parameters and below-ground compartments of Norway spruce and (2) to evaluate the effects of soil conditions, particularly soil skeleton content and water-logging, on the relative size of stem, stump and root system.

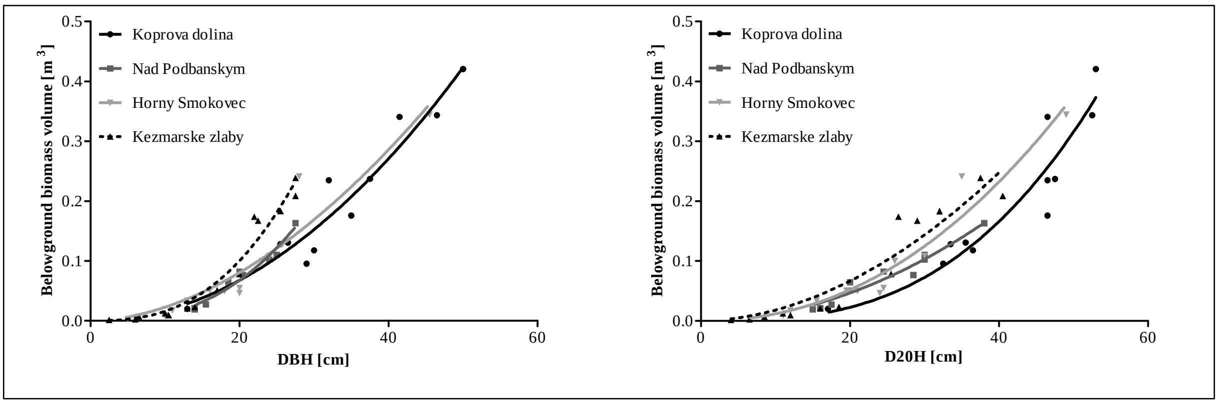
Four sites representing a gradient of skeleton content (from 25% to 65%), as well as water-logging, were selected within the windthrown area (Table 1). During the summer of 2005, a total of 47 wind-uprooted spruce trees were randomly selected for stem and below-ground parts measurements. The volume of all coarse roots and belowground stumps of selected spruce trees was established and linked to aboveground stem parameters. Based on volume data, we have constructed separate models for belowground biomass prediction in each stand.

Table 1. Soil characteristics of the experimental plots

Stand name	Soil type	Type of skeleton	Proportion of skeleton	Water regime
Koprova dolina	humic podzol	Boulder	65%	well drained
Nad Podbanskym	cambic podzol	Stony	45%	well drained
Horny Smokovec	haplic cambisol	moderate stony	25%	well drained
Kezmarske zlaby	stagnic pseudogley	Stony	40%	water-logged

Increasing soil skeleton content had negative impact on root/shoot ratio, while soil water-logging led to an increase in this ratio. When we constructed allometric relationships for belowground biomass prediction, we were able to show that boulder content does not alter the allometric relations (Figure 1). Perhaps surprisingly, given the response of biomass allocation ratios to increasing soil skeleton content, there was no significant difference between the models fitted to the data from the sites with well-draining soil. Waterlogging, on the other hand, had a strong impact on the model parameters, suggesting that it is this soil condition that has to be considered when constructing generalized belowground biomass allometric relations.

Figure 1. Belowground biomass volume prediction based on diameter at 20cm (D20H) and 130cm (DBH) from ground level.



We have shown that it is possible to construct reliable models predicting belowground biomass and that soil skeleton content does not change calculated model parameters. Stem diameters measured 20 cm and 130 cm from the ground level proved to be a stable and accurate predictor variable. However allometric model parameters have to be site specific, especially if they are to be applied to sites with contrasting soil water conditions.