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Trees susceptibility to wind damages: the effect of slope

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The interaction of forests and wind disturbances is a topical issue in scientific research, especially considering that the ongoing climate change will lead to a probable increase in the frequency of natural disturbances of high severity (e.g., storms).

The study of wind-tree interaction has led to the development of various models for predicting wind risk damage to forest stands. Of these models, ForestGALES is the most widely adopted across forest species and geographical locations. Initially developed in the UK as a management tool to assess the susceptibility of plantations to windstorm damage, this semi-empirical, process-based wind risk model has since been expanded and used in other contexts, both European and non-European. Recently ForestGALES has been updated and developed in the R framework (fgr package), in order to be easily applicable to different scenarios. However, the original ForestGALES reference database used to derive empirical coefficients of tree anchorage is limited to a relatively flat area and small size trees (Diameter at Breast Height -DBH- less than 30 cm).

In this context, the first objective of this research was to investigate the anchorage of standing trees with large diameters by means of pulling tests. Therefore, 44 spruce trees (*Picea abies* (L.) Karst.), an important species for alpine silviculture and particularly susceptible to wind damage, were subjected to destructive pulling tests.

Using a load cell, inclinometers and strain gauges the tree felling was monitored in all its phases. Of the 44 plants tested (DBH> 40 cm), 13 were selected in sloped terrain in order to test if slope may affect stability, in a comparison with trees with similar characteristics on flat terrain. The first results showed that trees on a slope have a higher overturning coefficient and are therefore more resistant to uprooting.

The data obtained from the field were translated into input parameters for ForestGALES model, allowing to differentiate the parameters for spruce according to the slope of the terrain. The parametrisation was further complemented with physical parameters (MOE and MOR) typical of spruce trees grown in the mountain/dolomitic environment. Using these new parametrisations, wind risk assessment maps were created for a case study area located in the north-eastern Italian Alps. This area was strongly affected by storm Vaia in October 2018, the mapping, therefore, aims to observe the susceptibility of stands before and after the disturbance event.