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Modelling leaf area carrying capacity for site adapted sustainable forest management in the Northern Limestone Alps

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While the Limestone Alps cover 16% of Austria, they are the source for 30-50% of the population's drinking water. Soils in this region are typically very shallow, often consisting of just organic layers overlaying the bedrock. Maintaining vegetation (forests) to protect such vulnerable sites from soil erosion is necessary to ensure future water supplies, as well as to prevent flooding; since re-establishment of vegetation is difficult once erosion occurs. Water supply is a determinant of both species composition and leaf area. Changing climate or altered soil water storage capacity after disturbance can enhance the risk of drought stress. Adaptive forest management may account for changing environmental conditions by regenerating tolerant tree species and keeping stand density below critical thresholds.

A hydrological model has been used to determine leaf area carrying capacities under climate change scenarios for representative species on a hydrotope basis for sites in the Northern Limestone Alps. In-situ field measurements were combined with laboratory analysis of soil properties to parameterize BROOK90 for this task. To obtain accurate input parameters for the properties of forest soils, which are distinguished by humus layers and high organic contents, soil water retention curves were determined in the laboratory for dominating soil types of the Northern Limestone Alps. For scaling purposes, pedo-transfer functions were developed using information on texture, structure and humus content. To test the hydrological model, a drought stress experiment was set up in a mature European beech (Fagus sylvatica) forest by reducing stand precipitation with roofs underneath the crown of selected trees. The experiment started in spring 2010. Climate records including precipitation, global radiation, air temperature, vapour pressure and wind speed have been measured since summer 2010. Soil moisture, matrix potential and sap flow were compared for stressed and untreated control trees.

This modelling approach can be used to better understand hydrological processes in forested mountain areas. The model output can aid sustainable forest management decisions that are adapted to the carrying capacity of any given site of interest.