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Assessing the protection function of Alpine forest ecosystems using BGC modelling theory

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The purpose of this study was to assess the protection function of forests in Alpine areas by modelling the flux dynamics (water, carbon, nutrients) within a watershed as they may depend on the vegetation pattern and forest management impacts. The application case for this study was the catchment Schmittenbach, located in the province of Salzburg. Data available covered the hydrology (rainfall measurements from 1981 to 1998 and runoff measurements at the river Schmittenbach from 1981 to 2005), vegetation dynamics (currently 69% forest, predominantly Norway Spruce). The method of simulating the forest growth and water outflow was validated. For simulations of the key ecosystem processes (e.g. photosynthesis, carbon and nitrogen allocation in the different plant parts, litter fall, mineralisation, tree water uptake, transpiration, rainfall interception, evaporation, snow accumulation and snow melt, outflow of spare water) the biogeochemical ecosystem model Biome-BGC was applied. Relevant model extensions were the tree species specific parameter sets and the improved thinning regime. The model is sensitive to site characteristics and needs daily weather data and information on the atmospheric composition, which makes it sensitive to higher CO2-levels and climate change. For model validation 53 plots were selected covering the full range of site quality and stand age. Tree volume and soil was measured and compared with the respective model results. The outflow for the watershed was predicted by combining the simulated forest-outflow (derived from plot-outflow) with the outflow from the non-forest area (calculated with a fixed outflow/rainfall coefficient (OC)). The analysis of production and water related model outputs indicated that mechanistic modelling can be used as a tool to assess the performance of Alpine protection forests. The Water Use Efficiency (WUE), the ratio of Net primary production (NPP) and Transpiration, was found the highest for juvenile stands ($\leq$20yr). The WUE was also found directly proportional to the elevation. A positive correlation between annual outflow and the WUE could be shown. Yearly outflow predictions for the whole catchment for the years 1981-2005 showed no significant difference from the measurements.

Key words: protection forests, outflow, flux dynamics, BGC-Modelling