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Climate Change Impacts on the Growth of Hybrid Poplar Trees in an Agroforestry System in Brandenburg, NE Germany

Diana-Maria Seserman (1), Ina Pohle (2,3), Dirk Freese (1), Maik Veste (1,4)

(1) Chair of Soil Protection and Recultivation, Brandenburg University of Technology Cottbus–Senftenberg, Cottbus, Germany (seserman@b-tu.de), (2) Chair of Hydrology and Water Resources Management, Brandenburg University of Technology Cottbus–Senftenberg, Cottbus, Germany, (3) Environmental and Biochemical Sciences, The James Hutton Institute, Aberdeen, United Kingdom, (4) Institute of Botany, University of Hohenheim, Stuttgart-Hohenheim, Germany

Climate change is expected in Brandenburg, eastern Germany, in terms of increasing annual temperature and changes in climate variability, as well as the number of extreme weather events. Since agroforestry systems have a planning horizon of several decades, long-term yield assessments are required in order to evaluate the economic profitability and environmental sustainability of such systems. Accordingly, our aim was to simulate the tree growth of poplar trees (Populus nigra x P. maximowiczii) in an agroforestry system in Brandenburg for the next forty years. For this purpose, we used the process-oriented Yield-SAFE model, a parameter-sparse, biophysical model developed for the simulation of plant growth in agroforestry systems. For the investigated period from 2011 to 2014, the validation simulations showed clear correlations with the observed values for woody tree biomass. For the unfolding period from 2015 to 2055, a variety of possible climate changes (including higher evaporation requirements and reduced water availability) and their uncertainties were incorporated into our assessment. The tree yield sensitivity to future climatic conditions was evaluated using 100 realizations of a scenario of the statistical regional climate model Statistical Analogue Resampling Scheme (STAR), which assumes an increase in annual temperature of 2K, as well as decreasing annual precipitation by 30–40 mm. The Yield-SAFE model responded sensitively to changes in the meteorological input data, showing that (1) shifts in temperature and/or precipitation would have a directly proportional influence on tree growth and (2) the impact of potential climate changes on tree growth must be assessed in terms of the complex interaction of various influencing factors. This was evidenced, for example, by the fact that higher average annual temperatures could either increase the tree growth due to a prolonged vegetation period or, on the contrary, decrease the tree growth due to higher potential evapotranspiration. The model results are important for the sustainable planning and management of agroforestry systems, upcoming risk assessments, and example analysis of adaptation scenarios in the near and distant future.