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Modelling the impact of changing climate and forest cultivation on the water balance of a closed lake in North-east Germany

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Over the last 25 years declining water levels are observed in several lakes of forested catchments in North-east-Brandenburg (Germany). This region is located in the transition zone between maritime and continental climate. The annual lake evapotranspiration often exceeds the precipitation which annual average is below 600 mm year-1. So the groundwater recharge mainly controls the water supply of lakes. Changes of climate and forest cultivation can have highly influence on groundwater recharge. To identify and quantify the share of changes in climate and forest management in the decline of the lake water levels, the participating processes are separated and evaluated using water balance modelling in a small lowland catchment. The results and methods were used to predict the development of lake water levels in future.

The lake Redernswalder See (0.5 km^2) was chosen as subject of research. It has a forest dominated catchment (3.5 km^2) and no outlet. Water gauge measurements over the last 25 years show a decline in lake water level by more than 3 m. Changes of climate and forest cultivation are actually observed and will alter the groundwater recharge in the catchment.

Currently, the forest in the Redernswalder See catchment just as throughout North-East Brandenburg is dominated by pine monoculture. Depending on the climate conditions, groundwater recharge may be significantly lower under pine than under broad-leaved trees like beech or oak. Forestry plans to expand the share of beeches and oaks among mixed deciduous forest in future.

The physically based distributed water balance model WaSiM-ETH is used to model groundwater recharge in the catchment and the lake water balance. The horizontal groundwater flow is handled by the built-in 2D groundwater model. This plays an important role as a connector between the lake and its catchment. To verify the hydrogeological conditions, a separate 3D groundwater model of this Late Pleistocene lowland catchment was built up.

With an application of regionalised climate scenarios the lake water level will decrease further in future. This is affected mainly by an increasing lake evapotranspiration. Forest conversation can although increase the water supply and slow the water level decrease, but the influence of climate change can finally not be compensated.