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Consequences of secondary succession on water availability in Mediterranean areas: a study case in northeastern Spain

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Water availability during summer periods in Mediterranean regions is low and depends on reservoirs that have stored the runoff from upstream catchments. River discharges in these regions have decreased during the last century, leading to less inflow into reservoirs. One of the main factors explaining the decrease in river discharge is land use change. Mountainous areas in Europe, especially in Southern regions such as the Spanish Pyrenees, have undergone major depopulation during the past century, which has lead to the abandonment of agricultural fields. These abandoned fields have been colonized by natural species which has changed the hydrological characteristics of the area. Studying the hydrological effect of secondary succession in abandoned fields on water yield can be helpful to determine future reservoir management strategies.

This work uses a modelling approach to investigate the effects of secondary succession on monthly inflow into the Yesa reservoir (central Spanish Pyrenees). The study focuses on two major elements. First the change in hydrological relevant parameters of the vegetation and soil due to secondary succession is simulated from 1950 until 2050. This is done by simulating the change in aboveground carbon density and organic matter fraction with a logistic Markov-chain model. This Markov-chain model has spatially distributed transition probabilities that depend on terrain characteristics in order to simulate different transition rates depending on the suitability of the terrain. Vegetation and soil parameters are related to carbon and organic matter with equations from literature. Secondly, a hydrological model is used to calculate the discharge flowing into the Yesa reservoir during different stages of the succession. These modeled discharges will be compared with present monthly reservoir inflow measurements to search for trends in water yield on both monthly and decadal scale. Finally, the calculated future reservoir inflow will be compared with estimated future water demand. Analysis of present and future monthly residuals of reservoir in an outflow will allow for a simple way of assessing changes in water stress.