The role of climate change and human pressure on forest decline in the early Holocene on Qinghai-Tibetan Plateau – an ecohydrological modelling approach

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The contemporary alpine ecosystem of the entire Tibetan Plateau (TiP) is mainly covered by grasslands. However, palynological studies have revealed that these grasslands were largely forested throughout the early to mid-Holocene period. Pollen records suggest a dramatic and extensive forest decline beginning around 6000 years BP. It is widely accepted that this significant change in vegetation cover was caused by a change in regional climate conditions. Many studies have however questioned whether or not climate alone was the main controlling factor for this decline. It still remains unclear, if and to what extent human activities were also involved. Given this fundamental change it is relevant to note that currently anthropogenic impacts (overgrazing, land management) as well as climate change and their interaction cause a high degradation of alpine grasslands. Consequences comprise significant changes in vegetation composition, less productivity, loss in soil nutrients and water conservation capacity up to severe desertification effects.

A suitable way to understand the nature of tree decline on alpine meadows in the north-eastern TiP during the Holocene is the application of simulation models. We studied the vegetation dynamics with a spatial explicit process-based ecohydrological model which has been recently developed for drylands. In a first step, we successfully adapted the existing grid-based vegetation model to an alpine meadow in the north-eastern TiP. Simulated time series data for soil moisture and vegetation coverage fit empirical recorded data rather well. By comparing pollen patterns with simulated vegetation pattern based on pollen independent climate data, we were able to test to what extent past climate change affected the forest decline. Interestingly, simulation results show that climate change alone was not able to explain the decrease in the proportion of woody pollen over the last 6000 years.

Key words: Tibetan Plateau, forest decline, climate change, alpine meadow, human activity, grazing, anthropogenic land use, Holocene, mid-Holocene