

## **Last-century changes of alpine meadows water-use efficiency – assessment by time-series analysis of the carbon isotope composition of horns of an alpine grazer *Capra ibex***

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### Abstract

The water-use response of alpine meadows to recent climate change was investigated with a new strategy to go back in time: using a time-series of *Capra ibex* horns as archives of the alpine meadows carbon isotope discrimination ( $^{13}\Delta$ ). From the collection of the Natural History Museum of Bern, horns of 24 animals from the population of Augsmatthorn-Brienzer Rothorn, Switzerland, were sampled covering the period from 1938 to 2006. Samples were taken from the beginning of each year-ring of horns, which represent horn growth in the spring. Alpine meadows  $^{13}\Delta$  increased slightly (+0.3 ‰), though significantly ( $p < 0.05$ ), over the observation period. Estimated intercellular CO<sub>2</sub> concentration increased (+60  $\mu\text{mol mol}^{-1}$ ) less than the atmospheric CO<sub>2</sub> concentration (+80  $\mu\text{mol mol}^{-1}$ ), so that intrinsic water-use efficiency increased by 18.4% during the 70-years period. However, atmospheric evaporative increased by approx. 0.1 kPa between 1955 and 2006. In consequence, the instantaneous water-use efficiency did not change during the same period. The observed changes in intrinsic water-use efficiency were in the same range as those of trees (as reported by others), indicating that there is no fundamental difference between forests and grassland in the response to increasing ambient CO<sub>2</sub>. This is the first reconstruction of the water-use efficiency response of a natural grassland ecosystem to last century CO<sub>2</sub> and climatic changes.