

# Drought Effects in Swiss Grassland Systems under Changing Climate

## Background information on NCCR publications



Clearly visible drought effect under a rain shelter at Chamau, one of the three sites studied in the PLANT/SOIL project.

The recent CH2011 report highlights that future summers in Switzerland are expected to be considerably drier than at present. However, to date, only a limited number of experiments on drought effects exist, especially in the more humid regions of Central Europe, including Switzerland. Thus, a drought manipulation experiment was initiated as part of the NCCR Climate at three Swiss grassland sites in 2005 (Project *Drought Effects on Plant Water Uptake and Water Use as well as Soil Carbon Dynamics in Swiss Grassland Systems under Changing Climate*). Experimental plots were established in three grasslands at different elevations (393, 982 and 1978 m a.s.l.) differing in management intensities. Half of the plots were equipped with rain shelters during spring/summer while the other half received ambient precipitation. Over the past seven years, process- and system-oriented data on plant and community C and H<sub>2</sub>O relations were collected, which also served as the basis for an economic assessment of drought effects in Swiss grasslands. Aboveground biomass production was reduced by drought at the lowland and the sub-alpine sites, while no or rather a positive effect was found at the wettest site in the pre-Alps. This was consistent throughout the years. Although the reduction of forage yield was highest at the sub-alpine site, the economic loss was highest for the lowland, most intensively managed site, due to lowest direct payments and strongest dependence on actual costs.

Using a stable isotope approach, shifts in plant water niches in response to drought were studied.

Surprisingly, plants shifted their water uptake to more shallow soil layers under drought, at least in lowland grasslands. Supporting this finding, the majority of new roots was found in the top soil under drought. Moreover, root responses to changing soil moisture were highly dynamic (e.g., in the recovery phase after the imposed drought), thus, no drought effect on belowground production was observed at an annual time scale.

Leaf gas exchange was reduced under drier conditions, but plants tended to use the available water more efficiently, thus increased their water use efficiency. This response was less pronounced in grasses than in forbs. Grasses were more vulnerable to drought. Chronic damage to the photosystem II was detected only at the high elevation site, indicating non-stomatal drought effects.

Despite fast and significant responses to drought, no major memory effects were seen in plant ecophysiology or soil physical and chemical properties after six years of treatment, indicating a high resilience of Swiss grassland systems to summer drought.

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Project website: [www.botany.unibe.ch/nccr/index.php](http://www.botany.unibe.ch/nccr/index.php)

### Publications referred to in this article:

- Gilgen, A. K., and Buchmann, N. 2009: Response of temperate grasslands at different altitudes to simulated summer drought differed but scaled with annual precipitation. *Biogeosciences* 6:2525–2539.
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- Signarbieux, C., and Feller, U. 2011: Non-stomatal limitations of photosynthesis in grassland species under artificial drought in the field. *Environ. Exp. Bot.* 71:192–197.

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