Legacy Effects of Climate Extremes in Alpine Grassland

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 4492931
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Year 2018
Title Legacy Effects of Climate Extremes in Alpine Grassland
Journal FRONTIERS IN PLANT SCIENCE
Volume 9
Number 9
Pages / **Article-Number** 1586
Keywords biomass; drought; heat wave; mountain; recovery; resistance; stress; warming
Climate change is particularly apparent in many mountainous regions, with warming rates of more than twice the global average being reported for the European Alps. As a result, the probability of climate extremes has increased and is expected to rise further. In an earlier study, we looked into immediate impacts of experimentally imposed heat waves in alpine grassland, and found that these systems were able to cope with heat as long as enough water was available. However, concomitant drought led to increased stress, and reduced aboveground biomass production and green plant cover. Here, we studied the legacy effects (lag-effects) of the imposed climate extreme to see whether delayed responses occurred and how fast the alpine grassland could rebound from the initial changes. Green cover continued to be suppressed the two following years in communities that had been exposed to the most intense hot drought, while aboveground biomass production had returned to control levels by year 2. The initial lower resistance of the forb fraction in the communities was not compensated by faster recovery later on. This resulted in alpine communities that became (and remained) relatively enriched with graminoids, which resisted the original extreme better. The responses of alpine grassland to heat extremes with or without drought observed in this study resemble those typically found in lowland grassland in the short term. However, alpine grassland exhibited longer legacy effects from an annual perspective, with delayed recovery of aboveground production and persistent changes in community composition. This suggests that once initial resistance thresholds are exceeded, impacts may be longer-lasting in alpine grassland, where recovery is constrained by both the short growing season and difficult seedling establishment.
Publisher FRONTIERS MEDIA SA
ISSN/ISBN 1664-462X
edoc-URL https://edoc.unibas.ch/67898/
Full Text on edoc No;
Digital Object Identifier DOI 10.3389/fpls.2018.01586
PubMed ID http://www.ncbi.nlm.nih.gov/pubmed/30425726
ISI-Number 000448641800001
Document type (ISI) Journal Article