

Interactive comment on “The effect of drought and interspecific interactions on the depth of water uptake in deep- and shallow-rooting grassland species as determined by $\delta^{18}\text{O}$ natural abundance” by N. J. Hoekstra et al.

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This paper provides very useful and insightful results into the impact of drought on water uptake, from deep- and shallow-rooting species. Response: We would like to thank you for your interest in the paper and positive feedback and suggestions. Please find below our response to your comments and corresponding changes to the manuscript:

It would be useful if the authors provide details based on the latest IPCC projections of

C2110

which regions will be likely to experience more drought, more severe drought. Although it is commonly argued that drought is occurring in many locations, it is clear that rainfall will increase in some regions, and at some times of year.

Response:

Climate models predict that the climate in Central Europe will be characterised by increasing temperatures and changing precipitation patterns and more frequent occurrence of drought. Projections for Switzerland indicate that in 2070, the mean decrease of summer precipitation ranges from 20 to 40 % compared to 1990 levels, resulting in severe drought stress. However, the aim of this study was not to try and mimic future climate change conditions for this particular location, but instead was designed as a model system to investigate the potential effect of moderate drought stress. We have added the following lines and references to our introduction: “ Climate models predict that the climate in Central Europe will be characterised by increasing temperatures, reduced summer precipitation and increased frequency of extreme events (Christensen, 2003;Schär, 2004). These discrete events include droughts, heat-waves and storms, and can have a large impact on a variety of ecosystem functions and services (Lehner et al., 2006).”#

It would be curious to consider whether this effect of altered depth in water uptake also occurs in trees, which have deeper roots than grasses. Zeppel et al 2008 report this: “(b) water uptake must have occurred from depths of up to 3 m; (c) sap flow was independent of the water content of the top 80 cm of the soil profile; ” Zeppel, M.J.B. et al., 2008. An analysis of the sensitivity of sap flux to soil and plant variables assessed for an Australian woodland using a soil-plant-atmosphere model. Functional Plant Biology, 35(6): 509-520

Response: We are aware of a large body of research depth of water uptake in trees and shrubs and other non-grassland species. Responses in such systems are likely to diverge from the responses we found. For example, as stated above, trees have been

C2111

shown to take up water from depths of up to 3m, and this will have a large effect on the response to drought and plant diversity. Therefore, in order to keep the discussion focussed, we decided to only discuss our results in relation to (comparable) grassland systems (which includes a number of studies including trees and shrubs, e.g. Kulmatisky and Beard, 2013)).#

The paper would also benefit if the authors focus more on the soil water content of each layer, and highlight more clearly their soil water content results.

Response:

We have now extended the results section in a way that addresses this point, as follows “Under control conditions, the soil moisture content ranged from 0.33 and 0.20 g water per g dry soil in the 0-10 cm soil depth interval to 0.28 and 0.18 g water per g dry soil in the 30-40 cm soil depth interval for Tännikon 2011 and Reckenholz 2012, respectively. In both experiments, soil moisture content was significantly lower under drought compared to control conditions ($p < 0.001$). The difference in soil moisture content between control and drought was on average 0.15 and 0.11 g water per g dry soil in the 0-10 cm soil depth interval, but was only 0.03 and 0.06 g water per g dry soil in the 30-40 cm soil depth interval for Tännikon 2011 and Reckenholz 2012, respectively, resulting in a significant water supply \times depth interaction ($p < 0.001$, Fig. 1a, b and Table A1).”#

Also, given future climates are likely to experience more extreme precipitation, it would be useful if the authors consider the framework presented by Knapp et al. 2008 - where changed precipitation leads to water logging in some instances, and drought in others, depending on rooting depth of the species. See Knapp, A.K. et al., 2008. Consequences of more extreme precipitation regimes for terrestrial ecosystems. *BioScience*, 58(9): 811-821.

Response:

As indicated above, our study is based on a model system simulating drought, and

C2112

in order to keep the paper focussed and within word limits, we do not discuss on the wider implications of climate change for different ecosystems and climatic regions (an important topic that is discussed in considerable detail by other authors). #

On behalf of all authors,

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C2113