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When water runs dry — peatland C dynamic under extreme droughts

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Ecosystems are increasingly exposed to climatic extremes, such as drought and extreme rainfall patterns. Recent studies evidenced the strong variability in ecosystem's response to droughts, raising the issue of non-linear responses in ecosystem's carbon (C) dynamic. The conundrum is what causes C fluxes to shift in response to drought, and most importantly, does such extreme events have lasting effects? Here, we will synthesize the results from three different studies testing the effect of droughts and/or extreme rainfall patterns on peatland CO_2 fluxes.

In a first experiment, we tested the resistance and resilience effects of extreme rainfall patterns on peatland C fluxes in a mesocosm experiment. We found that increasingly intense but less frequent rainfall, with longer intermediate dry periods, destabilises water table dynamic, with cascading effects on peatland C fluxes. Yet, peatland C dynamics might be more resilient than expected as vascular plants may fulfil a compensatory role by taking up more C. Moreover, CO_2 fluxes displayed lasting influence of extreme rainfall after restoration of the water table dynamics.

In a second experiment, we manipulated the water table depth in the field and generated a gradient spanning from -5 to -60 cm. We found that substantial changes in peatland CO_2 respiration occurred when the water level fell below a critical point of -24 cm. Around that apparently critical water level, we showed that plant and fungal communities were suddenly altered and raised CO_2 respiration rates.

In the last experiment, we tested the combined effect of prolonged drought and warming on the C uptake of two *Sphagnum* species. We found that the effect of climate warming on *Sphagnum* community photosynthesis toggles from positive to negative as the peatland goes from rainy to dry periods during summer. We further found that mechanisms of compensation among the dominant *Sphagnum* species stabilized the average C uptake of the *Sphagnum* community over the growing season.

As a corollary, our results show that extreme climatic events induce functional transitions in peatland C dynamics. These functional transitions further depends on the phenotypic plasticity among plant and microbial species as well as on the evenness of specific functional groups that modulate the effects of droughts on peatland C dynamic.