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Effects of simulated drought and warming on microbial responses to drying and rewetting in contrasting land-uses

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Climate change will increase temperatures and the frequency and intensity of extreme drought and rainfall events. When a drought period is followed by a rainfall event, there is a big CO_2 pulse from soil to the atmosphere which is regulated by soil microorganisms. In the present study, we set out to investigate how simulated drought and warming affects the soil microbial responses to drying and rewetting (DRW), and how those responses will interact with the level of land degradation. Previous work has shown that exposure DRW cycles in the laboratory and in the field can induce changes in the microbial community such that it resumes growth rates faster after a DRW cycle. In addition, it has been observed that a history of drought in both a humid heathland ecosystem in Northern Europe and in semi-arid grasslands in Texas can select for microorganisms with a higher carbon use efficiency (CUE) during DRW. In this study we tested if these observations could be extended to subtropical environments.

Rain shelters and open top chambers (OTC) were installed in Northwestern Ethiopia in two contrasting land-uses; a degraded cropland and a pristine forest. Soils were sampled (>1-year field treatments) and exposed to a DRW cycle in the laboratory. Microbial growth and respiration responses were followed with high temporal resolution over 3 weeks. We hypothesized that (i) simulated drought would result in more resilient and efficient microbial communities to DRW, while (ii) simulated warming should leave microbial community traits linked to moisture unchanged. In addition, (iii) we hypothesized that microbial communities would recover growth rates faster in the cropland since that ecosystem is more prone to DRW events.

Microbial responses in both land-uses and treatments universally showed a highly resilient type of community response with both bacterial growth and fungal growth increasing immediately upon rewetting, linked with the expected respiration pulse. The field treatments simulating drought and warming did not affect the already high resilience of soil microbial communities to DRW cycles. However, differences between the rates of recovery between fungi and bacteria were observed. Fungal growth recovered faster than bacterial growth, peaking c. 15 h in comparison to bacteria that peaked at c.20h after rewetting. Simulated drought reduced the microbial CUE during rewetting in croplands without affecting the forest soils. The CUE was also elevated in the warming

treatments in both land-uses, and generally higher in croplands than in forest soils. Taken together, the responses in microbial CUE during the rewetting of dry soils were likely linked to either (i) differences in resource availability which were higher in warming treatments and in croplands compared to forests, or (ii) selection of more efficient microbial communities due to a higher exposure to DRW events driven by the higher temperatures in the cropland, and increased evapotranspiration in the warming treatments.