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Emerging mechanisms of ecosystem functioning in a warmer and drier world

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Ecosystems are expected to face a significantly warmer and drier climate in the coming decades. Experiments have tried to unravel drought responses of ecosystems in mesic and humid biomes, but the structure and functioning of these systems may change when climatic regime shifts occur. Here, we summarize major mechanisms typical of drylands and indicate how these may come into play when current mesic ecosystems face tipping points in a warmer and drier world.

These dryland mechanisms of ecosystem functioning encompass (i) processes of vegetation development, such as self-organization of vegetation patchiness and formation of biological soil crust, (ii) biologically driven biogeochemical and physiological processes, such as drying-wetting cycles and hydraulic redistribution, and (iii) abiotically driven biogeochemical processes, such as photochemical degradation of organic matter and soil hydrophobicity. We present insights from published studies and original model simulations and mapping, and formulate hypotheses on thresholds and spatial locations beyond which dryland mechanisms are expected to operate in non-xeric ecosystems. Notably, for dryland mechanisms to get activated elsewhere there is no need for non-xeric biomes to become actual drylands. With a globally increasing area exposed to gradually rising temperatures, moderate decline in precipitation, and increasing frequency, duration and intensity of extreme heat and drought events, we envision that dryland mechanisms will increasingly control ecosystem functioning in many regions of the world.