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Human land-use change impacts rainfall seasonality

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Anthropogenic land-use change has profoundly changed the Earth's terrestrial water cycle. Studies of how land-use change induced modifications in terrestrial evaporation alters atmospheric moisture content and subsequent precipitation (i.e.; moisture recycling) have primarily focussed on the annual mean impacts. However, the functioning of agriculture and ecosystems are often dependent on the onset, length, and magnitude of the growing season rainfall. Hence, rainfall seasonality is of crucial importance. Here, we (1) analyse how humans have altered rainfall seasonality through land-use change induced modification of moisture recycling, (2) investigate the mechanisms for the rainfall seasonality changes, and (3) discuss how downwind regions may be affected by rainfall seasonality changes. We model human land-use change effects (including irrigation) on evaporation using the global hydrological model STEAM and trace precipitation changes using the atmospheric moisture tracking scheme WAM-2layers. We find that changes in rainfall seasonality is considerably stronger than changes to mean annual precipitation, and is accentuated in locations downwind to significant land-use changes. In particular, we associate sustained rainfall season downwind with land-use types that favour transpiration. This effect is explained by the long residence time of transpiration in both the unsaturated zone and the atmosphere, in contrast to interception and soil evaporation. Our results shed light on the human influence of hydrological systems both locally and at large distances, and which may have crucial implications for agricultural production and ecosystem functioning. These insights are important in a time of both rapid land-use and climate change.