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A revised view on the sensitivity of global freshwater availability to changes in precipitation, potential evaporation, and other factors

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Precipitation (P) and potential evaporation (Ep) are commonly studied drivers of changing freshwater availability, as aridity (Ep/P) explains ∼90% of the spatial differences in mean runoff across the globe. However, it is unclear if changes in aridity over time are also the most important cause for temporal changes in mean runoff and how this varies across regions. Here, we resolve shortcomings of previous Budyko-based global assessments on the relative role of aridity for changes in water availability. We argue that previous assessments do not properly account for precipitation effects. To resolve this issue, the effects of changes in Ep and P need to be considered separately. We present a new global assessment of the elasticity of runoff to changes in precipitation, potential evaporation, and other factors. The global pattern suggests that for 83% of the land surface runoff is most sensitive to precipitation changes, while other factors dominate for the remaining 17%. Runoff elasticity to changes in potential evaporation is always lower than elasticity to precipitation, and in many arid regions this difference can reach an order of magnitude. Although surface water resources in dryland regions are highly sensitive to precipitation changes, their sensitivity to changes in other factors (e.g. changing climatic variability, CO_2 – vegetation feedbacks and anthropogenic modifications to the landscape) is often far higher. Nonetheless, at the global scale we find precipitation changes have the greatest impact on water availability, which contrasts markedly with recent assessments.