Supporting Information for "Multi-actor, multi-impact scenario discovery of consequential narrative storylines in human-natural systems"

Antonia Hadjimichael[1,2], Patrick M. Reed[3], Julianne D. Quinn[4], Chris R. Vernon[5], Travis Thurber[5]

[1]Department of Geosciences, The Pennsylvania State University, State College, PA, USA

[2]Earth and Environmental Systems Institute (EESI), The Pennsylvania State University, State College, PA, USA

[3]School of Civil and Environmental Engineering, Cornell University, Ithaca, NY, USA

[4]Department of Engineering Systems and Environment, University of Virginia, Charlottesville, VA, USA

[5]Atmospheric Sciences & Global Change, Pacific Northwest National Laboratory, Richland, WA, USA

Contents of this file

1. Figures S1 to S3: Drought year classification by historical 60-year rolling windows; distribution of streamflows in exploratory ensemble, as created by Quinn, Hadjimichael, Reed, and Steinschneider (2020); thresholds used to classify the states of the world as within the historical context

References

Ault, T. R., Cole, J. E., Overpeck, J. T., Pederson, G. T., & Meko, D. M. (2014, January). Assessing the Risk of Persistent Drought Using Climate Model Simulations and Paleoclimate Data. *Journal of Climate*, *27*(20), 7529–7549. Retrieved 2020-04-28, from https://journals.ametsoc.org/doi/full/10.1175/JCLI-D-12-00282.1 (Publisher: American Meteorological Society) doi: 10.1175/JCLI-D-12-00282.1

Quinn, J. D., Hadjimichael, A., Reed, P. M., & Steinschneider, S. (2020). Can Exploratory Modeling of Water Scarcity Vulnerabilities and Robustness Be Scenario Neutral? *Earth's Future*, *8*(11), e2020EF001650. Retrieved 2023-01-04, from https://onlinelibrary.wiley.com/doi/abs/10.1029/2020EF001650 (_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1029/2020EF001650) doi: 10.1029/2020EF001650

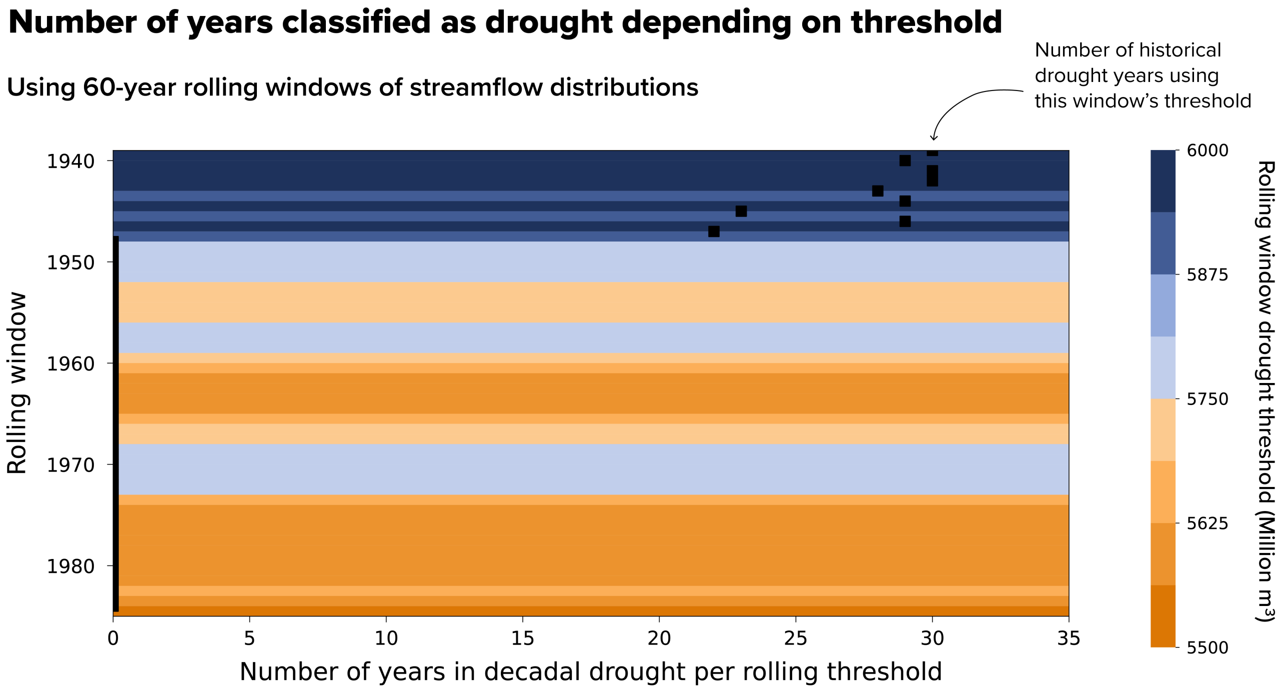

Figure S1. Number of years classified as drought depending on each rolling-window threshold.

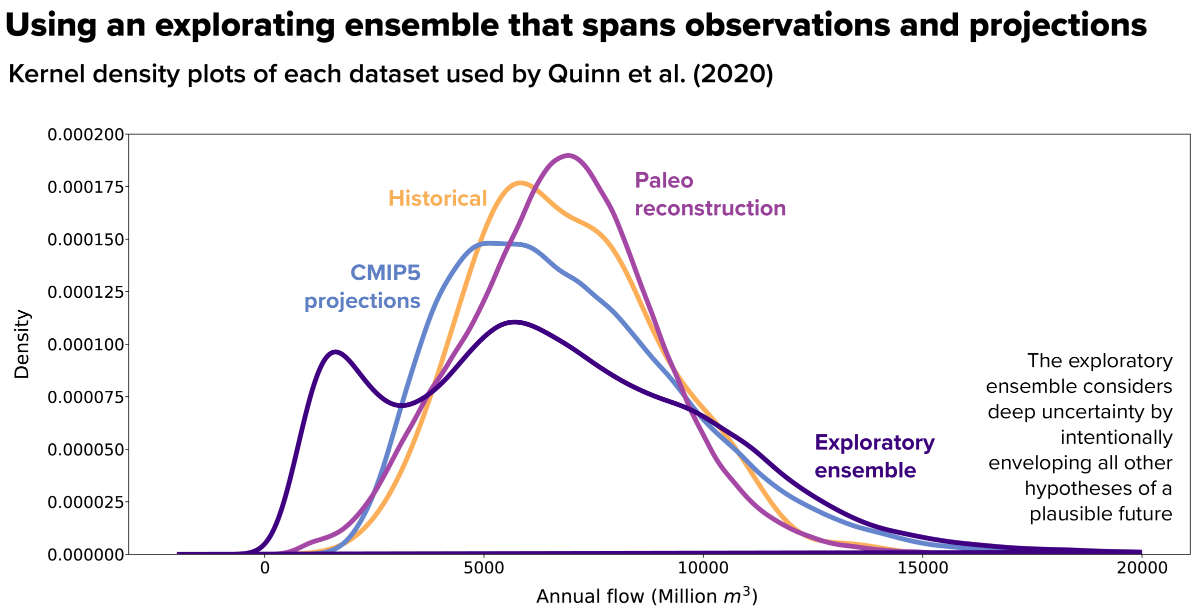

Figure S2. Distribution of streamflows in the exploratory ensemble used by this experiment, as it relates to other 'rival framings' of plausible future streamflow. The ensemble used is created by Quinn et al. (2020) and all the data are provided by that paper and accompanying online repository (`https://github.com/julianneq/UCRB_analysis`).

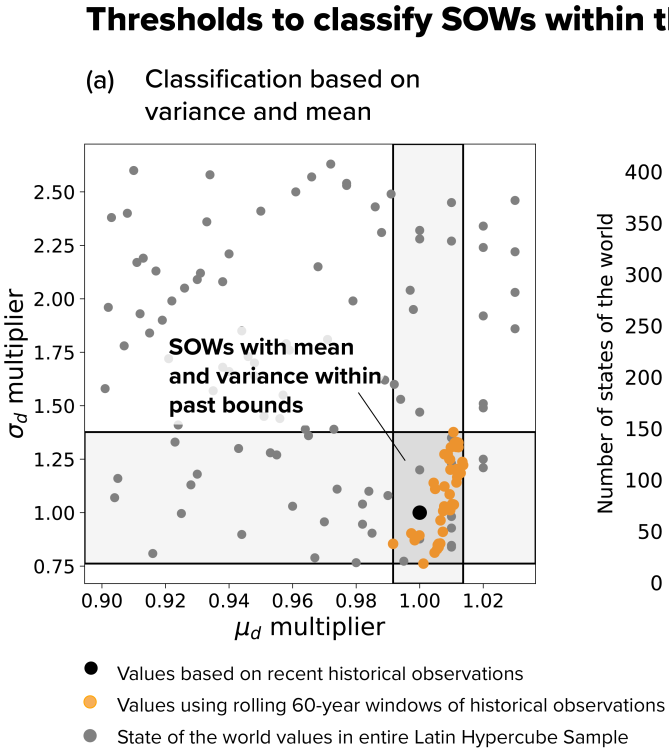

Figure S3. Identification of states of the world (SOWs) within the bounds of the past. (a) Variability (σ_d) and persistence (p_{dd}) properties of each SOW in the ensemble. These properties are determined by fitting the Gaussian Hidden Markov Model to the historical observations (resulting in the black point) and then sampling changes to these properties to represent alternative SOWs for the basin, as elaborated in Quinn et al. (2020). Each orange point represents 10 realizations of streamflow that exhibit the same sampled statistical properties, for a total of 1000 SOWs. Each grey point represents the variability and persistence properties of one of the 100 reconstructions of paleo streamflow with added noise, following the same procedure as Quinn et al. (2020). The mean values of both the variability and persistence properties are used to select SOWs that fall within the bounds of the past (recent history and paleo reconstructions). (b) Histogram of drought years occurring in each sampled SOW. The black vertical line represents the number of droughts that have occurred per century in both the historic and paleo record, using the threshold-based classification of Ault et al. (2014) and others.