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Fragile States and Where to Find Them: Precipitation and State Fragility

Introduction

Precipitation variability and incidence of extreme rainfall events are likely to increase with climate change (IPCC 2018, Diffenbaugh 2020). A growing body of literature has tied such deviations from normal precipitation to higher incidence of civil or armed conflict (Hsiang, Burke, Miguel 2013). However, many of these studies are limited to narrow measures such as incidence of ethnic violence (Guasiro and Rogall 2017), inter-group riots (Bolhken and Sargenti 2010), armed conflict (Raleigh and Kniveton (2012), or militarized interstate disputes (Devlin and Hendrix 2014). Broader measures of fragility may be more important factors for international development through their impact on international aid flows: more fragile states received 58% less bilateral aid and experienced twice as much aid volatility as other countries, after controlling for poverty and acute conflicts (McGillivray 2011).

Here, we investigate globally whether the relationship between precipitation and conflict extends to a broader measure of state fragility that incorporates social, economic, political, and cohesion indicators. We estimate on-year and lagged effects of variation in annual precipitation on a nation's Fragile State Index across the globe between 2006 to 2020. Our model includes linear and quadratic precipitation terms to account for potential fragility changes at extreme precipitation levels. We also account for both time-invariant unobservables at the national level and time-varying unobservables at the global level. Additionally, we consider heterogeneity in effects across high-income and low-income nations to explore whether wealth may cushion countries from increased fragility following precipitation shocks.

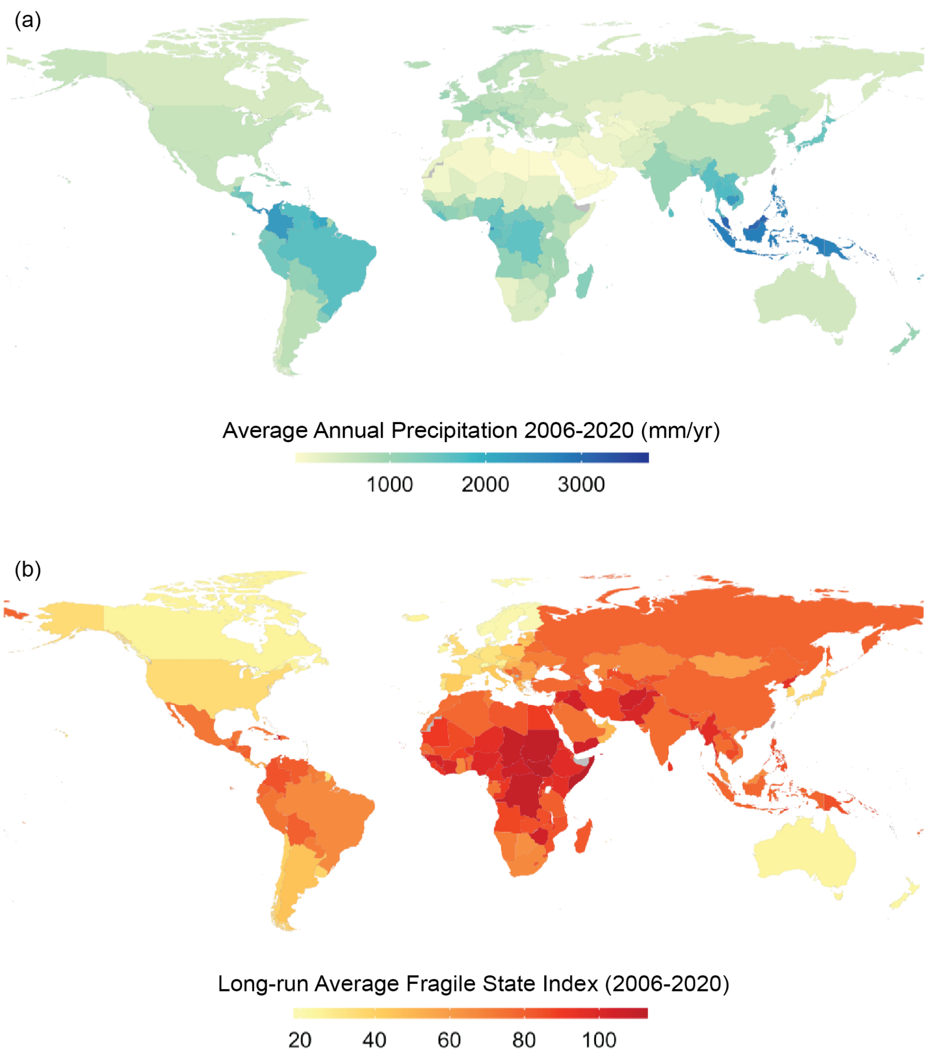
Methods

To estimate the effect of annual precipitation on state fragility, we run the following regression:

$$Y_{it} = \sum_{\tau=0}^{2} \left(\beta_{1,\tau} X_{i,t-\tau} + \beta_{2,\tau} X_{i,t-\tau}^2\right) + \alpha_i + \delta_t + \varepsilon_{i,t}$$

Where Y is state fragility, X is the cumulative precipitation in country i during year t, τ is the time lag in years, α are country fixed effects, δ are year fixed-effects and ε is the error term. In essence, the regression compares countries to themselves over time and uses year-to-year changes in annual precipitation to estimate the effect of precipitation on state fragility. For a given τ, if $\beta_{1,\tau}$ is positive, this suggests more rain leads to greater fragility; if $\beta_{2,\tau}$ is positive, this suggests both decreases and increases in precipitation relative to the country-specific mean lead to greater fragility. If we assume changes are random, and precipitation trends over time don't vary between countries,[1] the combined estimates of βs can be interpreted as the causal effect of precipitation on state fragility.

[1] Our approach doesn't control for time-varying unobservables at the regional/continental level. Research suggests that precipitation is trending differently in different parts of the world (IPCC 2018).



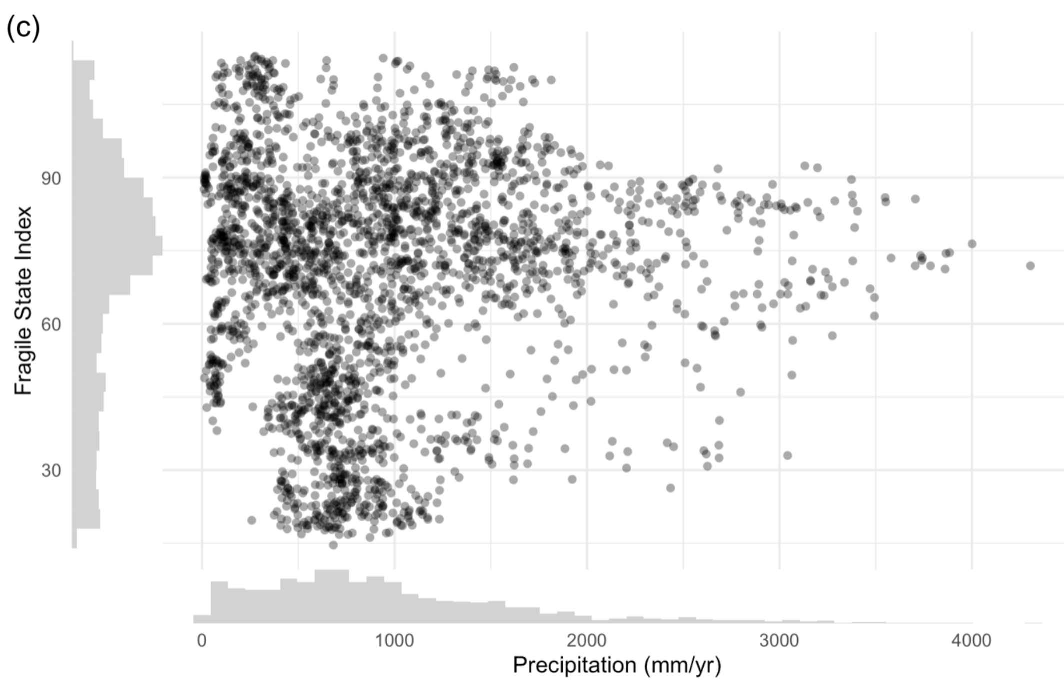
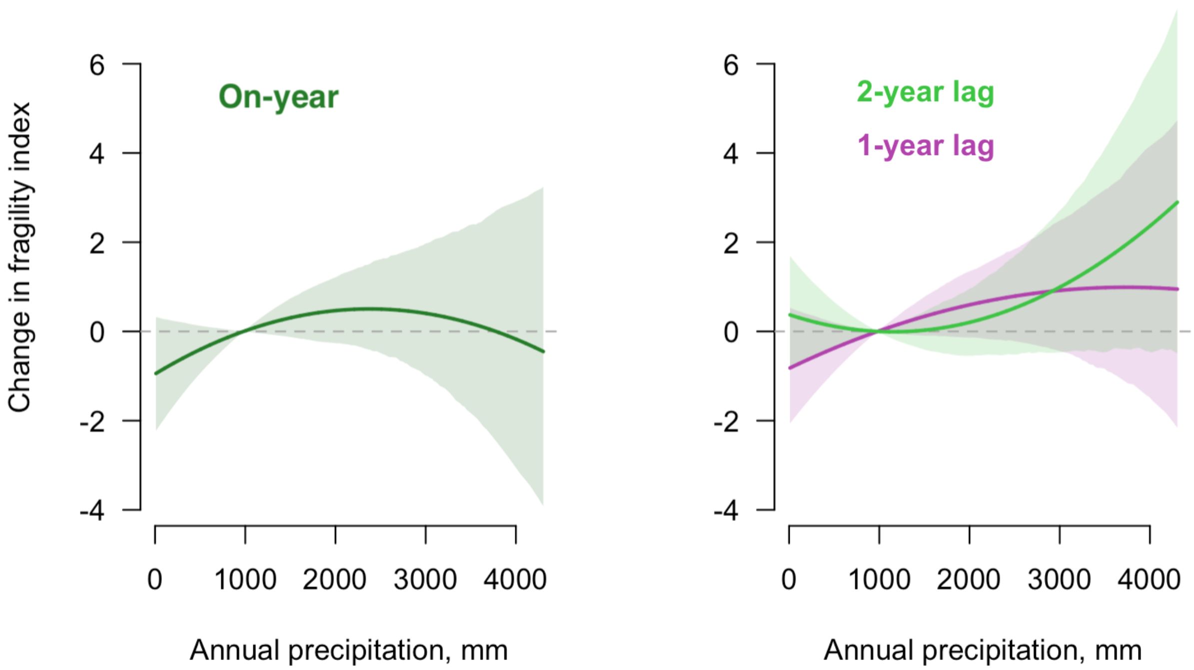


Figure 1: Cross-sectional relationship between precipitation and fragility. All plots show country-level data over the time period 2006-2020. (a) displays mean CMAP cumulative annual precipitation, (b) displays mean state fragility as measured by the Fragile State Index. (c) shows lack of clear cross-sectional correlation between the two variables; each point is a country-year (n=2670); histograms reflect marginal distributions.



Marginal Effect Point Estimates

	at 500mm	*at 1500mm*	*at 4000mm*
On-year	0.000968	0.000452	-0.000838
One-year lag	0.000843	0.000583	-0.000067
Two-year lag	-0.000379	0.000205	0.001665

Figure 2: High and low precipitation are associated with lower same-year fragility (a), but higher fragility after two years (b). (not significant at $p<0.05$)
Effect of annual cumulative precipitation on state fragility index (n=2097 country-years) relative to predicted fragility index value, centered at mean cumulative annual precipitation (967mm). (a) displays predicted index value for year t and precipitation in year t, (b) displays predicted index value for years t+1 and t+2 and precipitation in year t. Two figures are from the same regression. Shaded regions represent 95% confidence intervals constructed from 1000 bootstrap samples. (c) Lists marginal effects of an additional millimeter of rain on fragility index value at three arbitrary values of annual precipitation (confidence intervals not calculated).

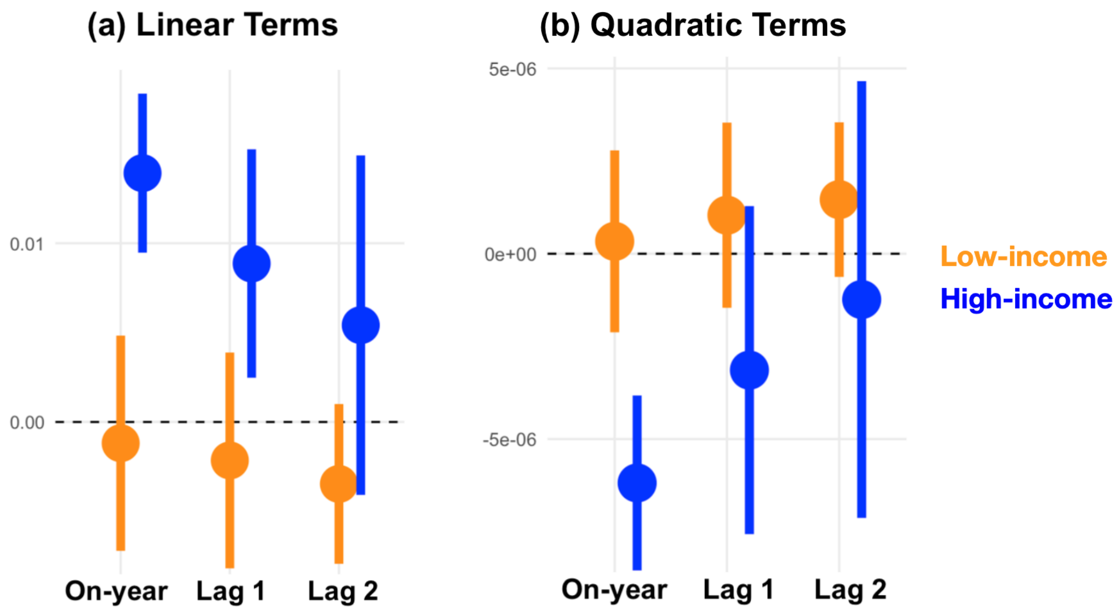


Figure 3. Heterogeneity in effects by per-capita income

Estimates and 95% confidence intervals for on-year, 1-year lag, and 2-year lag coefficients on annual cumulative precipitation. 3(a) contains linear precipitation terms, 3(b) displays quadratic precipitation terms. “Low-income” and “High-income” refer to the lowest and highest GNI per capita country groupings according to the [World Bank](). No significant differences in effects were found when subsetting countries by mean precipitation, mean fragility, or continent instead of income.