Urbanization at risk: urban growth, flood risk and climate variability

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Motivation

Climate migration and urbanization is a rising concern

- Limited knowledge about the link between global warming and migration (IPCC, 2018)
- Empirical evidence is mixed (Henderson et al., 2017; Castells-Quintana et al., 2021)

Cities are expanding into flood prone areas (Rentschler et al., 2022; Andreadis et al., 2022)

- We know less about mechanisms

Migration as an adaptation mechanism

- Population pressure may induce urban growth into vulnerable areas

Research question

How does climate variability shape urbanization?

- Do drought shocks affect the expansion of cities?
- Are cities responding by expanding into floodplains?

Data

Create panel tracking city growth for 6,554 cities in lower and lower-middle income countries between 1992 and 2015

- Urban area expansion - WSF-Evolution (30m resolution)
- Global floodplains (Nardi et al., 2019) (250m resolution)
- Standardised Precipitation-Evapotranspiration Index (SPEI) calculated using ERA5 EWCMF reanalysis data
- Estimated commuting zones around cities - Functional Urban Area data (Schiavina et al., 2019)

Data - Example

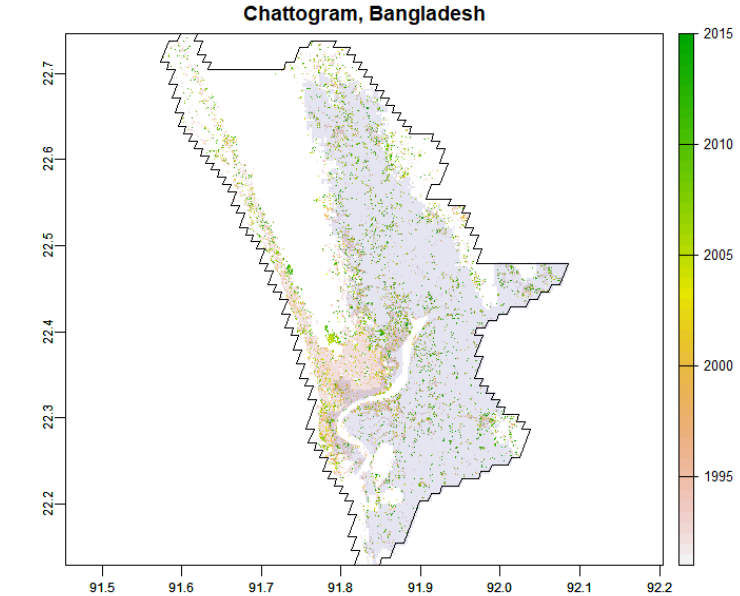


Figure: Growth of urban area, and floodplain delineation.

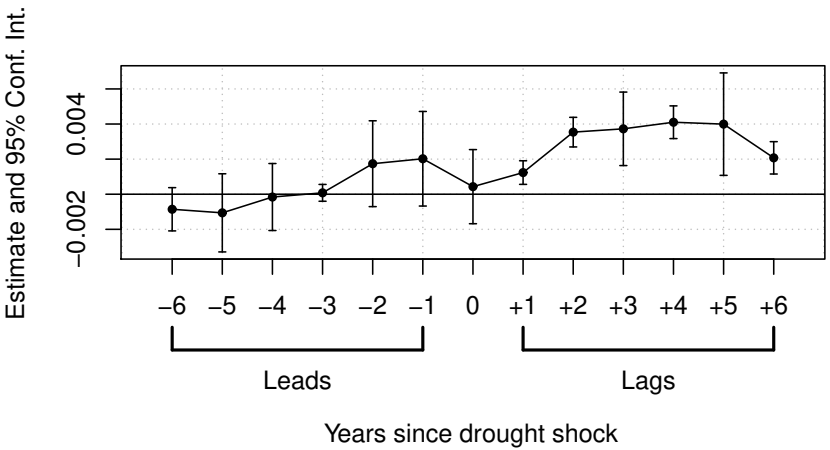
Empirical approach

- I estimate the following distributed lag model:

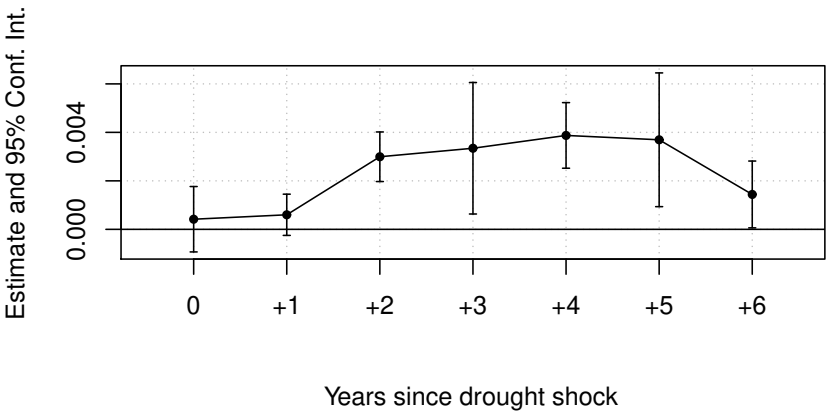
$$ln(Y_{c,t}) - ln(Y_{c,t-1}) = \sum_{k=0}^{L} \beta_{1k} Drought_{c,t-k} + \gamma_t + \delta_c + \psi_{1c} t + \psi_{2c} t^2 + \varepsilon_{d,t} \quad (1)$$

- $Y_{c,t}$ is urban or flood area (pixels) in city c, and year t
- $Drought_c$, for 90th percentile $SPEI_{100km}$ event
- δ_c and γ_t: city and year fixed effects
- ψ: city-specific linear, and quadratic time trends
- Standard errors account for serial correlation up to 10 years and spatial correlation over 300 km (Conley, 1999)

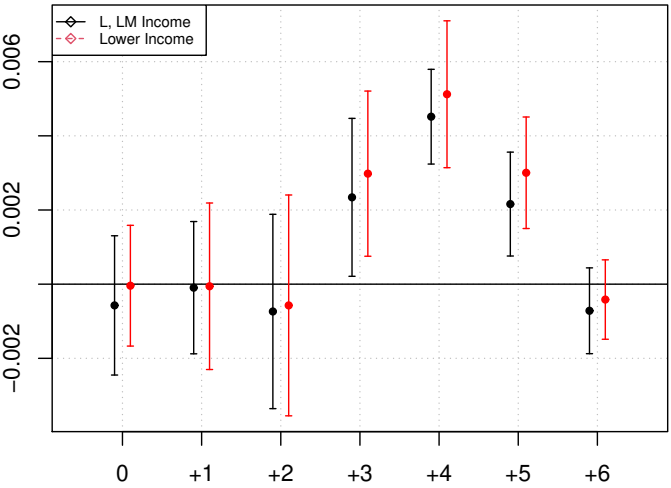
Drought effects on city growth - full sample



Drought effects on city growth - cities with floodplains



Drought effects on city floodplain growth



Discussion

- Drought shocks increases urban area in a global sample of cities
  - Contrast with previous evidence
- Drought shocks also lead to increase in urban area in floodplains
- Potential mechanisms
  - drought shocks reduce agricultural productivity
  - large influx of migrants increase pressure to build
- Accumulated effect of between 1 and 1.5%
  - Defined as $\hat{\Omega}_j = \sum_{L=0}^{j} \beta_L$ (Hsiang & Jina, 2014)
  - suggests growth effects rather than level effects (Burke et al., 2015), no temporal displacement (Hsiang, 2016)

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