Municipal Climate Risks and Policy Opportunities

World Bank / GWU / IGC Annual Urbanization and Poverty Reduction Conference

“Climate Change and Sustainable Organization”

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Key Points

1. **Climate change poses a myriad of physical risks to cities**
   - Risks are exacerbated by population and development trends

2. **Climate change can put fiscal pressure on local public finances**
   - Fiscal feedback effects may exacerbate direct impacts

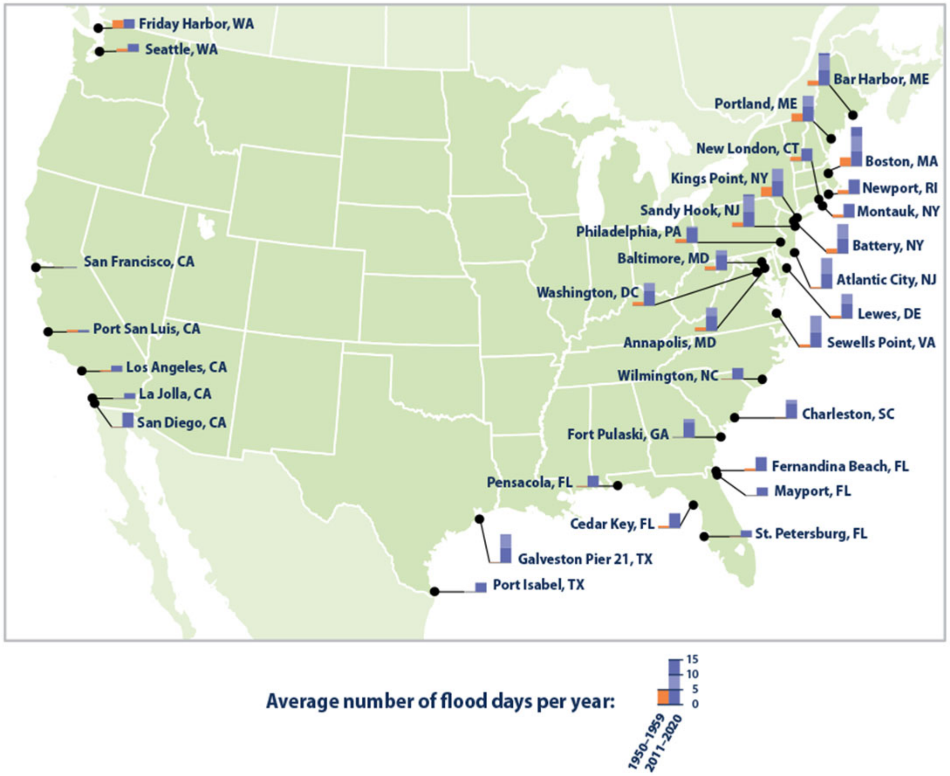
3. **Local regulations can improve resilience**
   - Building codes, information can be (cost)effective

1. Cities and Climate Risks: Flooding

- **Flooding incidence has increased significantly across many U.S. cities**
- Boston, MA: 3 floods[†]/year in 1950s vs. 13 floods/year in 2010s on average
- Charleston, SC: 0.1 floods/year in 1950s vs. 6 floods/year in 2010s on average

[†]Defined as coastal water level exceedance above local flooding threshold

Frequency of Flooding Along U.S. Coasts, 2011–2020 Versus 1950–1959

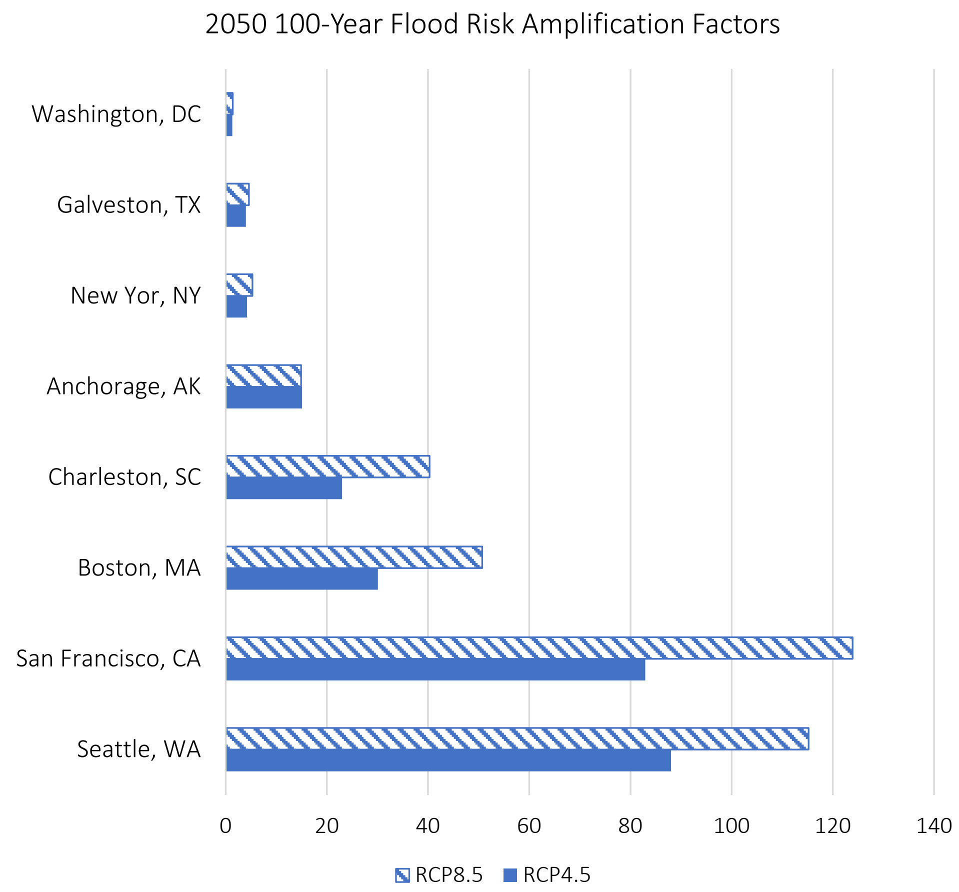


Source: US EPA (2021)

1. Cities and Climate Risks: Flooding

- **Flooding incidence predicted to increase dramatically as a result of climate change in many cities**
- New York, NY: Flood risk amplification factor of 4.2 (5.3) in moderate (very high) emissions scenario
- Boston, MA: Flood risk amplification factor of 30 (50) in moderate (very high) emissions scenario

Increase in annual likelihood of exceeding tidal gauge level of historical 100-year flooding threshold in RCP 4.5 (8.5) scenario (Buchanan et al. 2017)

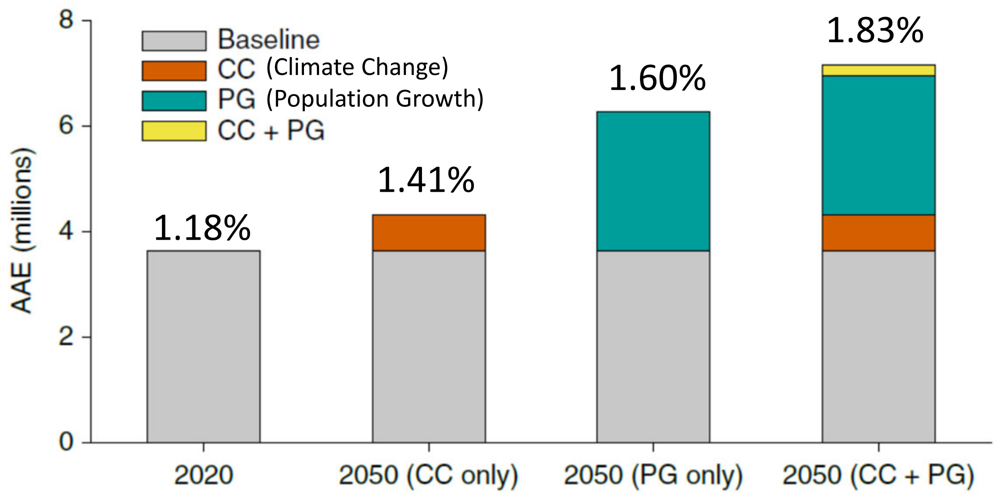


Data Source: Buchanan et al. (2017)

1. Cities and Climate Risks: Flooding

- **Population projected to growth relatively *more* in riskier areas**

- Population growth alone projected to increase fraction of U.S. population affected by flooding each year from 1.18% to 1.60%



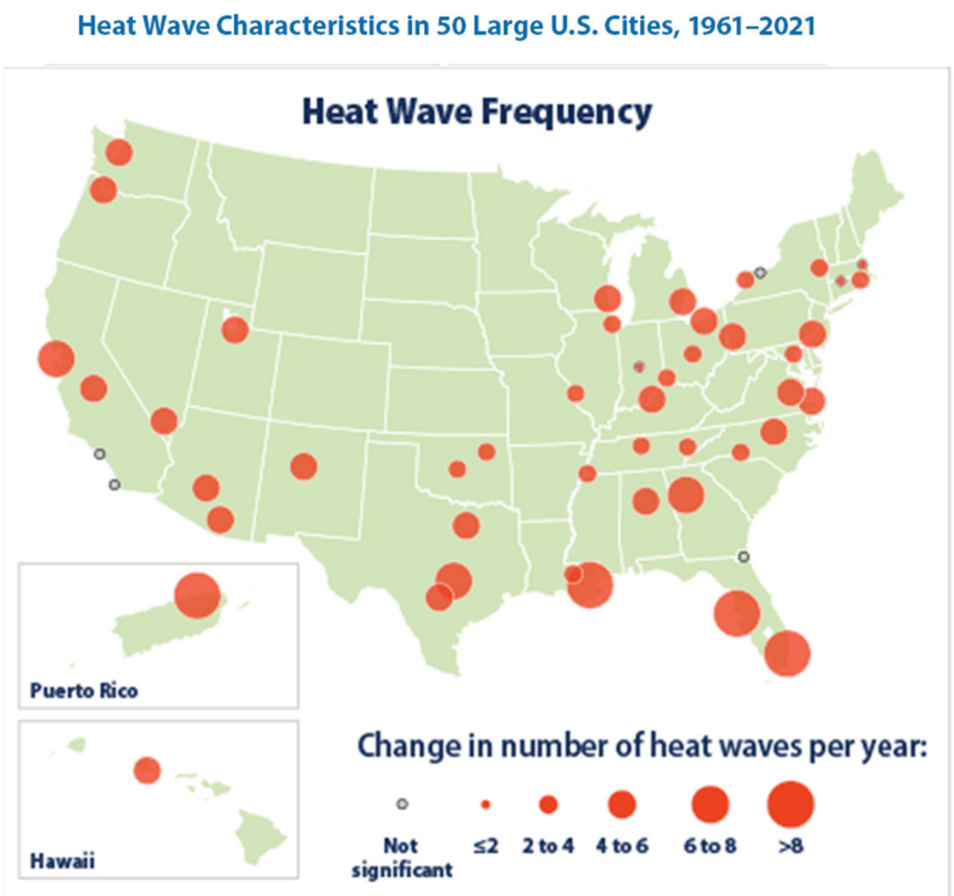
Average annual exposure (AAE) to flooding in the United States

Source: Wing et al. (2022)

1. Cities and Climate Risks: Extreme Heat

- **Heat wave incidence has increased significantly across many U.S. cities**
- Tampa, FL: +9.6 additional heat waves† per year on average 1961-2021
- Seattle, WA: +4.5 additional heat waves per year on average 1961-2021

†Defined as period of two or more consecutive days where daily minimum apparent temperature exceeds 85th percentile of historical July-August temperature (1981-2010) in a given city

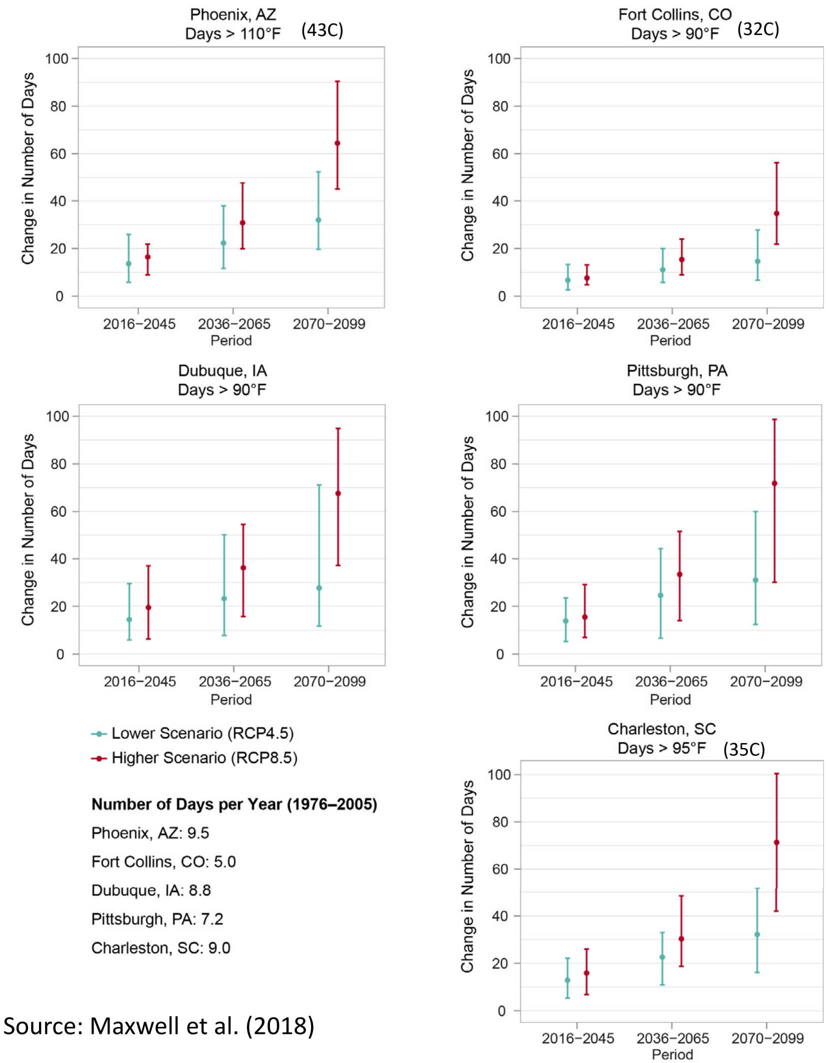


Source: US EPA (2021)

1. Cities and Climate Risks: Extreme Heat

- **Extreme heat incidence predicted to increase dramatically as a result of climate change in many cities**
- Phoenix, AZ: +30 (+60) additional days with temperatures above 43C in moderate (very high) emissions scenario
- Charleston, SC: +30 (+70) additional days with temperatures above 35C in moderate (very high) emissions scenario

Moderate (very high) emissions scenarios correspond to RCP 4.5 (8.5) scenarios, respectively (Maxwell et al., 2018)

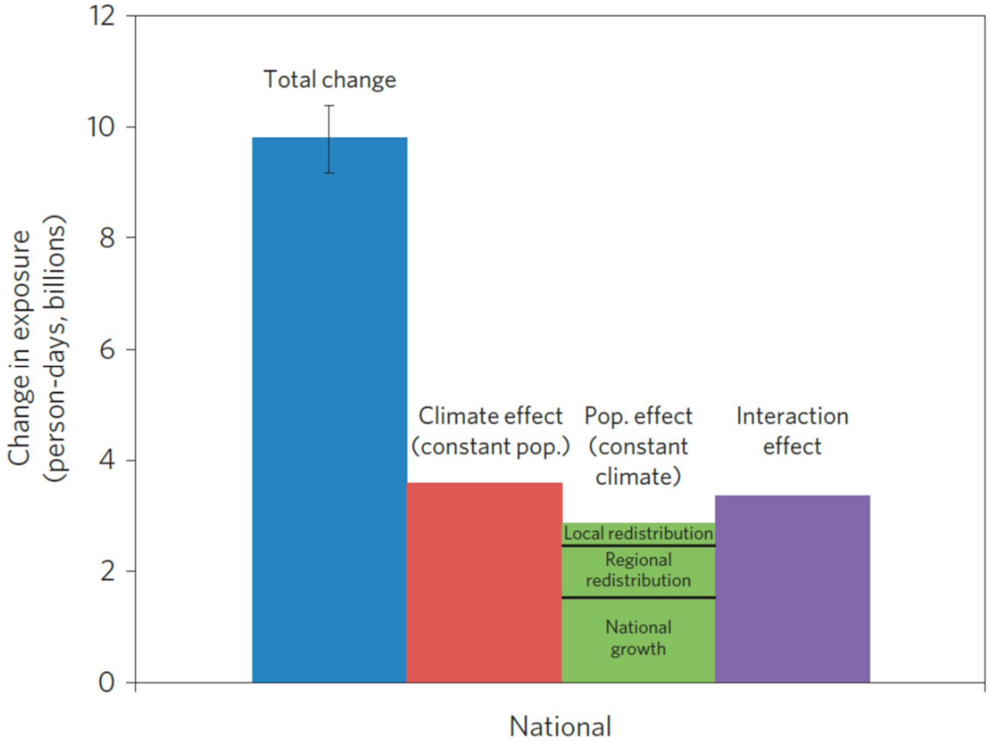


Source: Maxwell et al. (2018)

1. Cities and Climate Risks: Extreme Heat

- **Population projected to growth relatively *more* in riskier areas**

- Climate change, population change, and their interaction contribute roughly equally to projected aggregate increase in heat exposure (Jones et al., 2015)



Projected increase in heat exposure (person-days exposed to daytime temperatures>35C) in SRES A2 scenario, 2041-2070 vs. 1971-2000

Source: Jones et al., 2015

2. Fiscal Impacts: Evidence

- Growing awareness of potential climate pressure on local public finances

- Hurricane (cyclone) strikes in the U.S.:
  - Decrease local economic growth (e.g., Strobl, 2011)
  - Decrease local property values (e.g., Ortega and Taspinar, 2018; Gibson and Mullins, 2020)
  - Decrease local tax revenues (Jerch et al., 2021)
  - Increase municipal borrowing costs (Jerch et al., 2021)
  - Decrease some local public good expenditures (e.g., public works, Jerch et al., 2021)
  - Increase some higher gov't expenditures (e.g., income transfers, Deryugina, 2017; Miao et al., 2018)

2. Fiscal Impacts: Evidence

- Growing awareness of potential climate pressure on local public finances

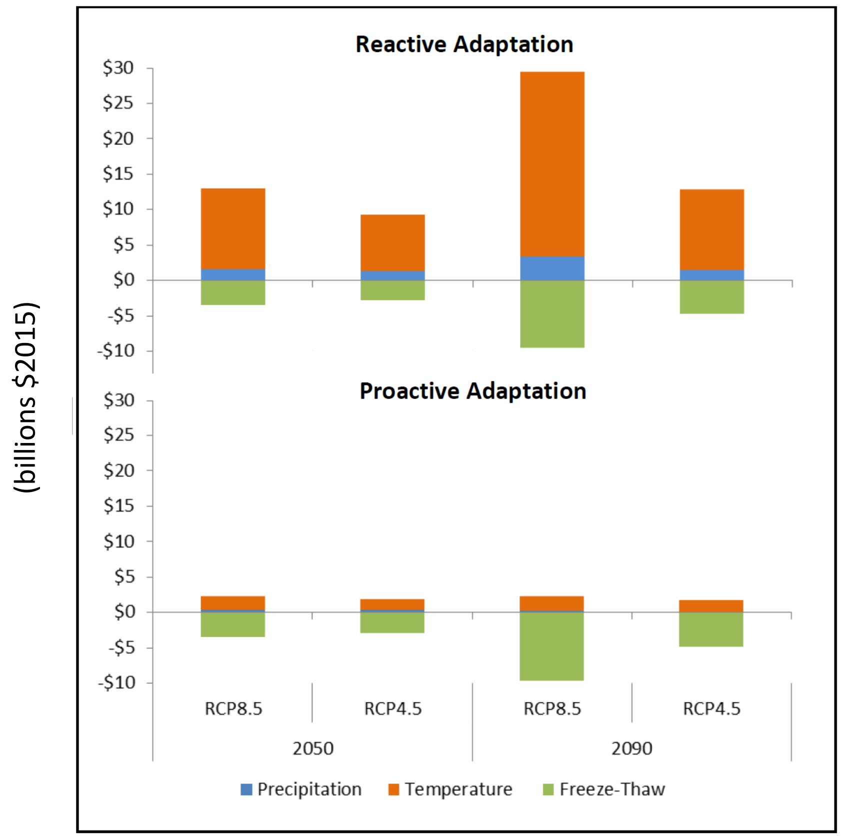
- Wildfire events in California (Liao and Kousky, 2022):
  - +25 pp increase in probability of municipal budget deficit
    - Increase municipal tax revenues (due to CA property tax rules)
    - Increase municipal expenditures (e.g., public safety)

- Wildfire events in the U.S.:
  - Increase public healthcare costs (Barrage, 2021)

2. Fiscal Impacts: Evidence

- Climate change may also alter cost of providing existing local gov't services
- E.g.: Across 100 US cities, annual cost of maintaining urban drainage system resilience to 50-year storm projected to increase $4-5.6 billion by 2090 (EPA, 2017)
- Some cost savings as well, e.g., declines in road maintenance cost due to reduced freeze-thaw (EPA, 2017)

Change in Annual Costs for U.S. Roads across 100 US Cities



Change in annual costs for reactive/proactive adaptation in 2050 (2040-59) and 2090 (2080-2099) relative to reference period (1950-2013), undiscounted

Source: EPA (2017)

2. Fiscal Impacts: Evidence

- Municipal borrowing costs already increasing in expected future risk changes
- Sea level rise:
  - 1% increase in expected sea level rise costs → +23.4 basis points increase in annualized issuance cost for long-term municipal bonds (Painter, 2020)
  - Bond market impact consistent with increased volatility in local government cash flows supporting debt payment (Goldsmith-Pinkham et al., 2021)
- Wildfire risk changes:
  - Preliminary results suggesting increased municipal bond spreads in areas with higher predicted 2050 wildfire risk increases (Barrage, Jeon, and Walsh, 2023)

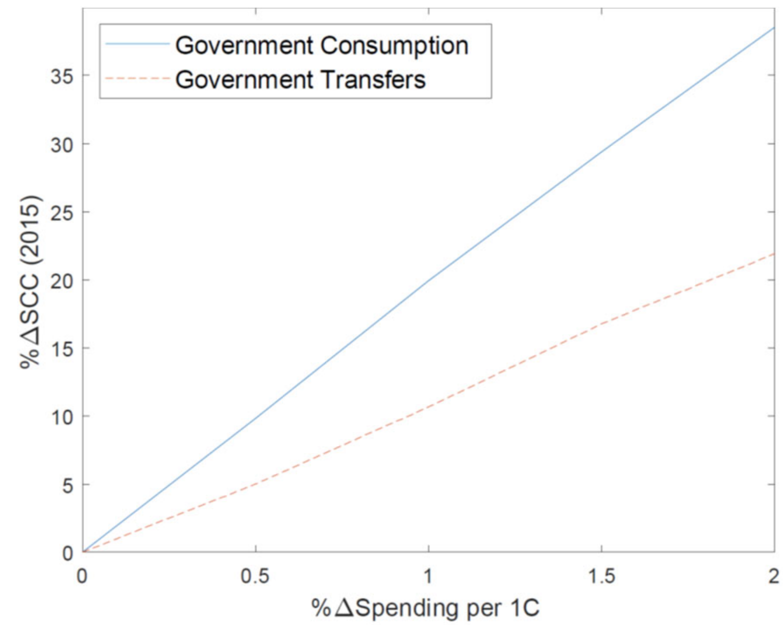
2. Fiscal Impacts: Implications

- Fiscal costs necessitate tax increases and/or spending cuts (at some level of gov't)

→ **Fiscal feedback effects can exacerbate the economic burdens of climate change**

- At US national level, high sensitivity of the social cost of carbon (SCC) to climate impacts on public expenditure / transfer obligations (Barrage, 2021)

Sensitivity of US SCC to Climate Impacts on Public Expenditure Obligations



- US SCC increases +20% per +1% increase in gov't consumption requirements per 1C warming
- US SCC increases +10% per +1% increase in gov't transfer obligations per 1C warming

Source: Barrage (2022)

3. Risk Reduction: Local Policies

- How can local jurisdictions foster resilience to climate risks?
  - Options location-specific, cost-effectiveness often unknown

- Some examples from the U.S.:
  - Building codes
  - Information

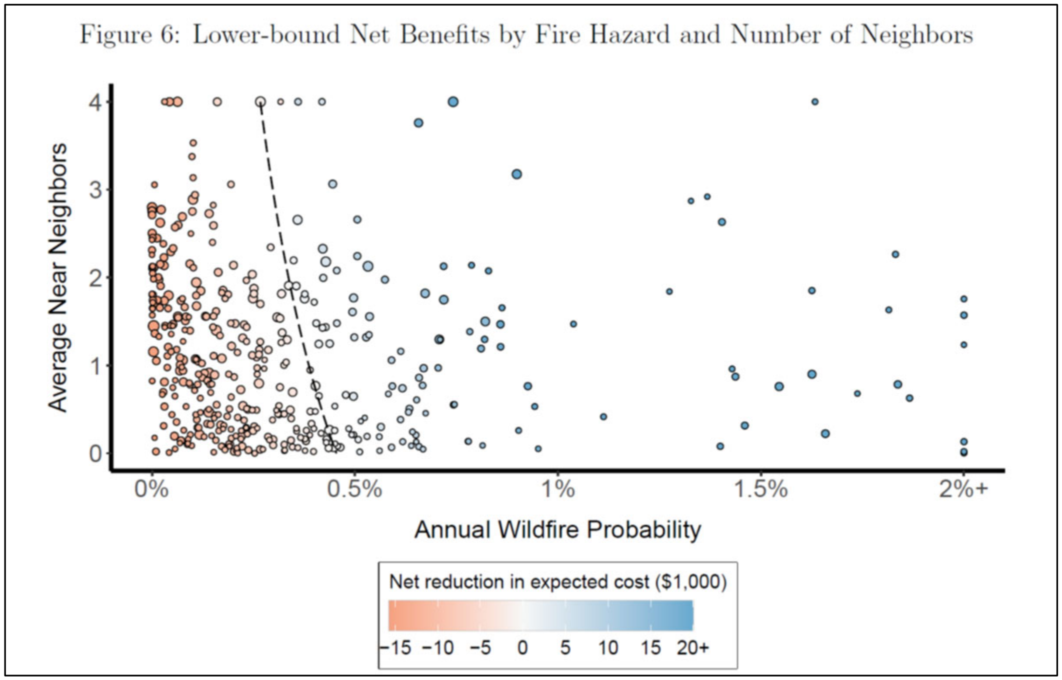
3. Local Policies: Building Codes

California wildfire building codes (Baylis and Boomhower, 2022):

- **Reduce probability of home destruction in case of wildfire by 40%**
- **Reduce *neighboring* homes' probability of destruction by 6%**

- Costly for both new construction (~$16k) and retrofits (~$63k)

→ Cost-effective depending on annual wildfire probability and number of near neighbors



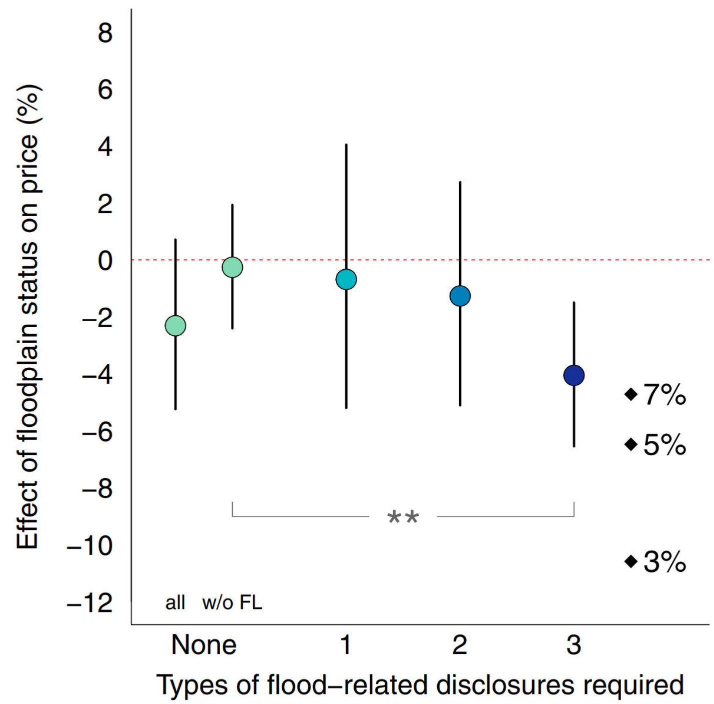
Cost-effectiveness of California wildfire building codes across zip codes

Source: Baylis and Boomhower (2022)

3. Local Policies: Information

- We know that housing *prices* respond to climatic risk information, e.g.:
  - Flood risk maps (e.g., Hino and Burke, 2021; Gibson et al. 2021; Harrison et al. 2001; Bin et al. 2008, Beltran et al., 2018, etc.)
  - Disclosure laws (Pope, 2008)
  - Local wildfire risk website (Donovan et al. 2007)
- However, home price capitalization often appears too small relative to expected damages (e.g., Hino and Burke, 2021; Bakkensen and Barrage, 2021)
- Whether *damages* decrease as a result of better risk information also remains an open question
- Flood *insurance* uptake also increases after risk signals (Gallagher, 2014)

Effect of Flood Zone Status and Disclosure Laws on Housing Prices



Source: Hino and Burke (2021)

Summary

- Climate change poses many direct physical and indirect (incl. fiscal) risks to cities

- In theory, adaptation can reduce damages significantly
  - Optimizing migration/investment lowers sea level rise costs from 4.5% to 0.11% of GDP (Desmet et al., 2021)

- In practice, many potential obstacles requiring further research and policy efforts
  - Misinformation may inhibit adaptation (Bakkensen and Barrage, 2021; Long et al., 2020 Barrage and Furst, 2019, etc.)
  - Benchmark population projections imply large increases in climate risk exposure
  - Seemingly beneficial policies not yet widely adopted (e.g., risk disclosure, building codes, etc.)