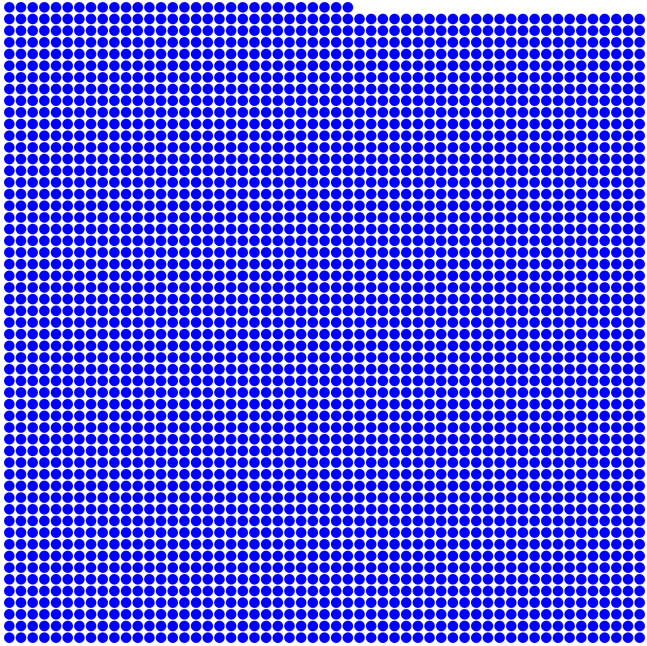
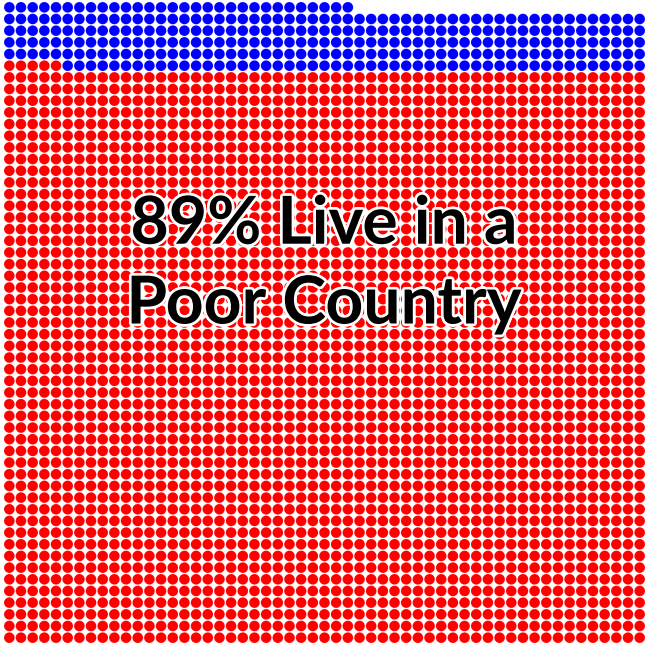
Floods

Dev Patel


1 in 4 People Face Severe Flood Risk




89% Live in a
Poor Country

Existing data on floods is severely biased

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Next Seven Minutes:

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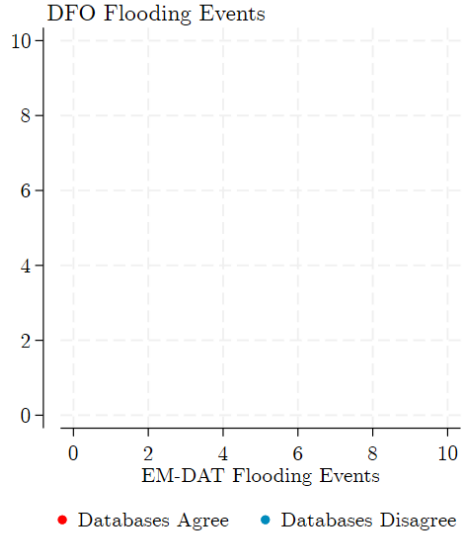
Next Seven Minutes:

1. Limitations of current data sources
2. New methodology to detect floods anywhere on earth for $\approx$ 25 years
3. Applications to understand and mitigate flood damages


DFO Flooding Events
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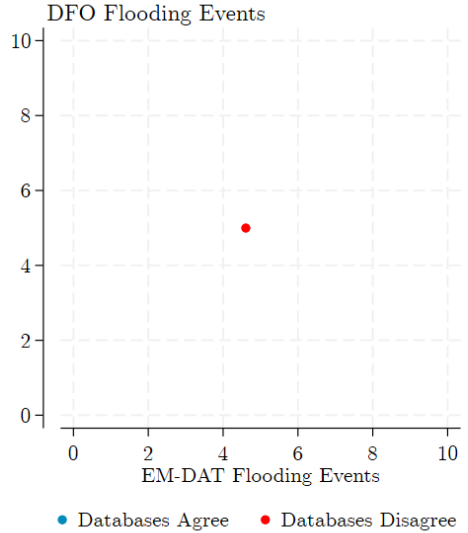
EM-DAT Flooding Events
Databases Agree
Databases Disagree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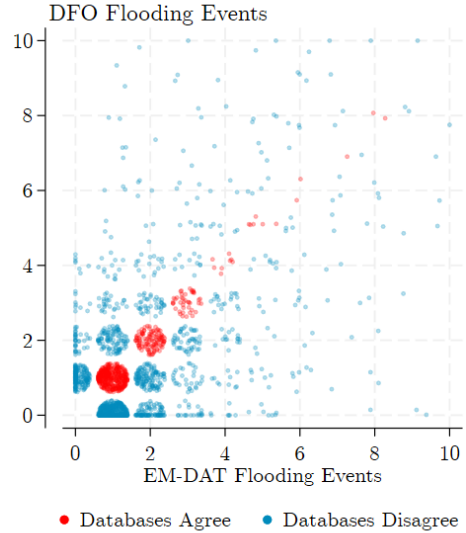
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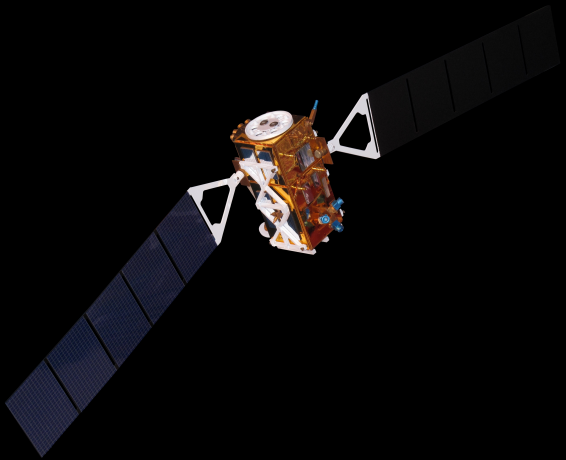
Limitations of Existing Flood Measurement Approaches

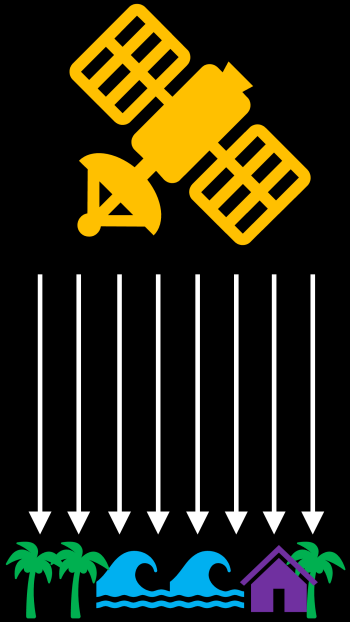
Much more in the paper "Floods" available on my website:

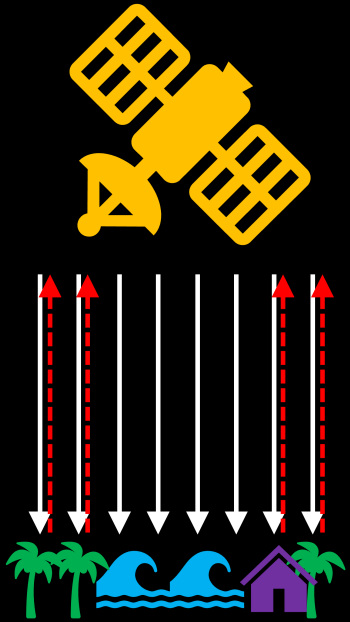
- Biased against poor countries
  - Far more floods in rich places—opposite of what we expect
- Almost entirely misses small and flash floods
  - Farmers say these are extremely important
- Existing satellite-based approaches suffer from similar biases
  - Rely on newspapers first identifying where/when to look
- Inaccuracies of *in-situ* river station data
  - Omit coastal and rainfall-fed floods
  - Very sensitive to hydrological modeling assumptions
  - Sparse coverage in poor countries

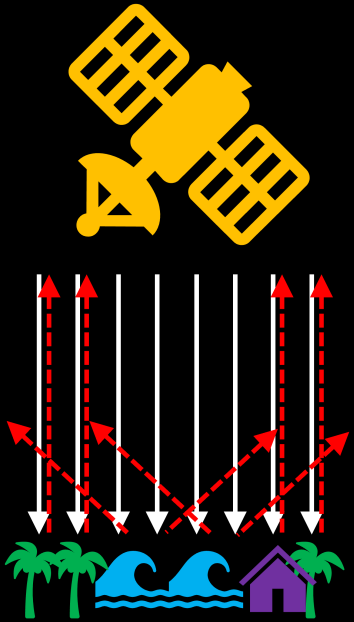
New Approach to Flood Measurement

- Works for all types of floods $\Rightarrow$ includes fluvial (water body overflowing), pluvial (rainfall), and coastal floods
- Directly measures surface water $\Rightarrow$ does not require structural assumptions of hydrological models
- Statistical definition of “inundation of normally dry land” $\Rightarrow$ consistent measurement across places and over time
- Globally available $\Rightarrow$ no biased underreporting in poor places
- Accurate at high spatial resolution, every day $\Rightarrow$ can detect even short-term and small floods



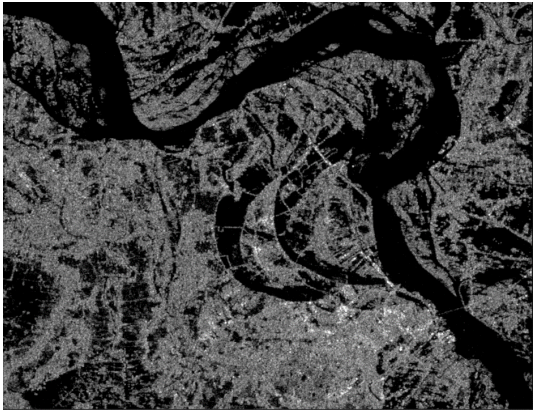




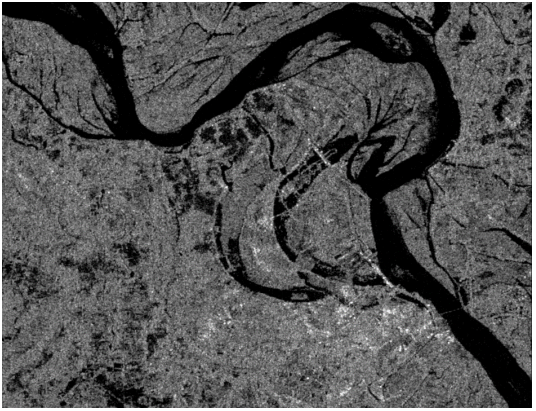


Measuring Floods from Space

July 27, 2020 (Flood)



July 22, 2021 (No Flood)



A Tale of Two Satellites

1. **Radar Satellites:**
    - *High Quality*: sees through clouds
    - *Low Quantity*: orbits infrequently

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1. **Radar Satellites:**
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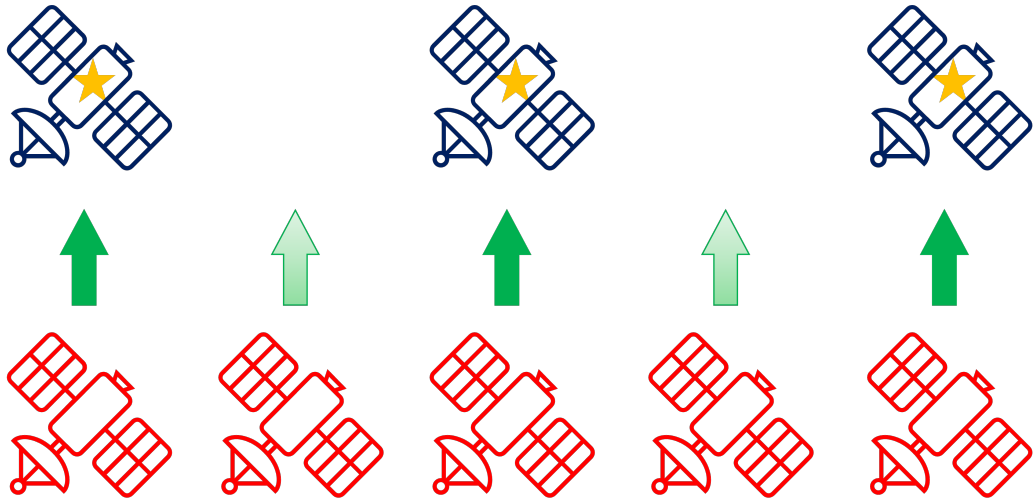
   - *Low Quantity*: orbits infrequently

2. **Optical Satellites:**
   - *Low Quality*: can't see through clouds
   - *High Quantity*: orbits very frequently

Using Machine Learning to Get the Best of Both Worlds



“Floods” (2024)

- Lots more details on flood detection methodology
  - Geophysics & computer vision techniques to analyze satellites, ML details, statistically removing “permanent” water, calibrating to human definition of floods, validation against other data …

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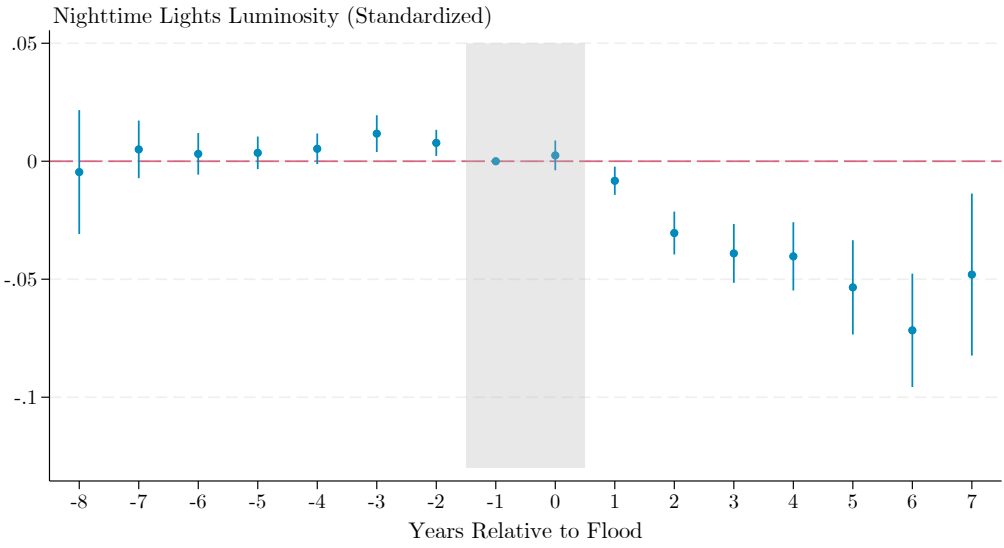
- Lots more details on flood detection methodology
  - Geophysics & computer vision techniques to analyze satellites, ML details, statistically removing “permanent” water, calibrating to human definition of floods, validation against other data …
- **Research Question:** What are the impacts of floods, and how do households adapt?
- Focus in Bangladesh (180 million people)
- Granular flood data provides much cleaner causal natural experiment than most environmental settings

Impact of Floods on Nighttime Luminosity



Impacts of and Adaptation to Floods

- Floods cause persistent declines in economic activity
  - Lower luminosity
  - Reduced physical capital
- Floods force structural transformation
  - Decline in agricultural employment
  - Increase in out-migration
  - Increase in school attendance
- Past experience with floods mitigates damages by 1/3
  - Use surveys & natural experiments to show evidence of learning-by-doing adaptation

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An Illustration Using Flood Forecasts

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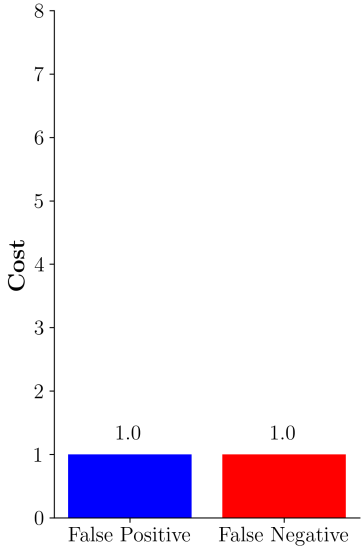

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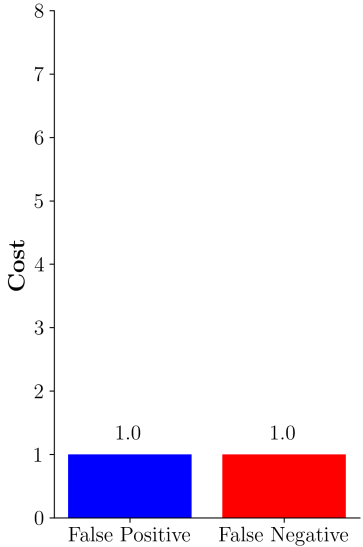

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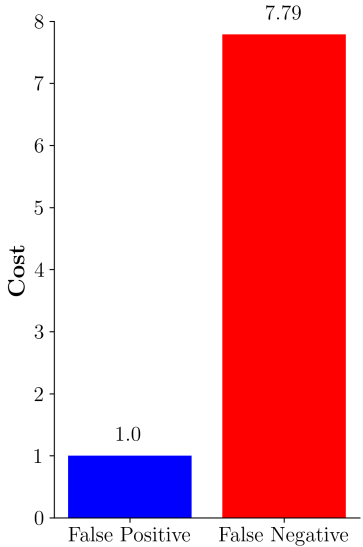
- Standard prediction algorithms are **symmetric:** treat over- and under-estimation equally
- People's utility are often **asymmetric:** type of error matters!
- Directly elicit this asymmetry using surveys with farmers about flood forecasts



Evaluation of Flood Prevention and Adaptation Policies

Flood Prevention: Freetown the Treetown

- Working with the Mayor's office to evaluate Freetown's landmark tree planting program
- 500,000 (mostly mangroves) this year
- Study impact on floods $\Rightarrow$ local businesses & labor markets

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Flood Adaptation: Crop Insurance *(joint with Emily Breza and Arun Chandrasekhar)*

- Study PMFBY, India's crop insurance policy serving 40 million farmers
- Ran experiment last summer spreading awareness about program $\Rightarrow$ large increases in take-up in administrative data
- About to launch main survey to measure impacts on agriculture, consumption, migration, social networks, mental health, …

Thank You!

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