Regional Workshop on Measuring Disaster Risks and Impacts

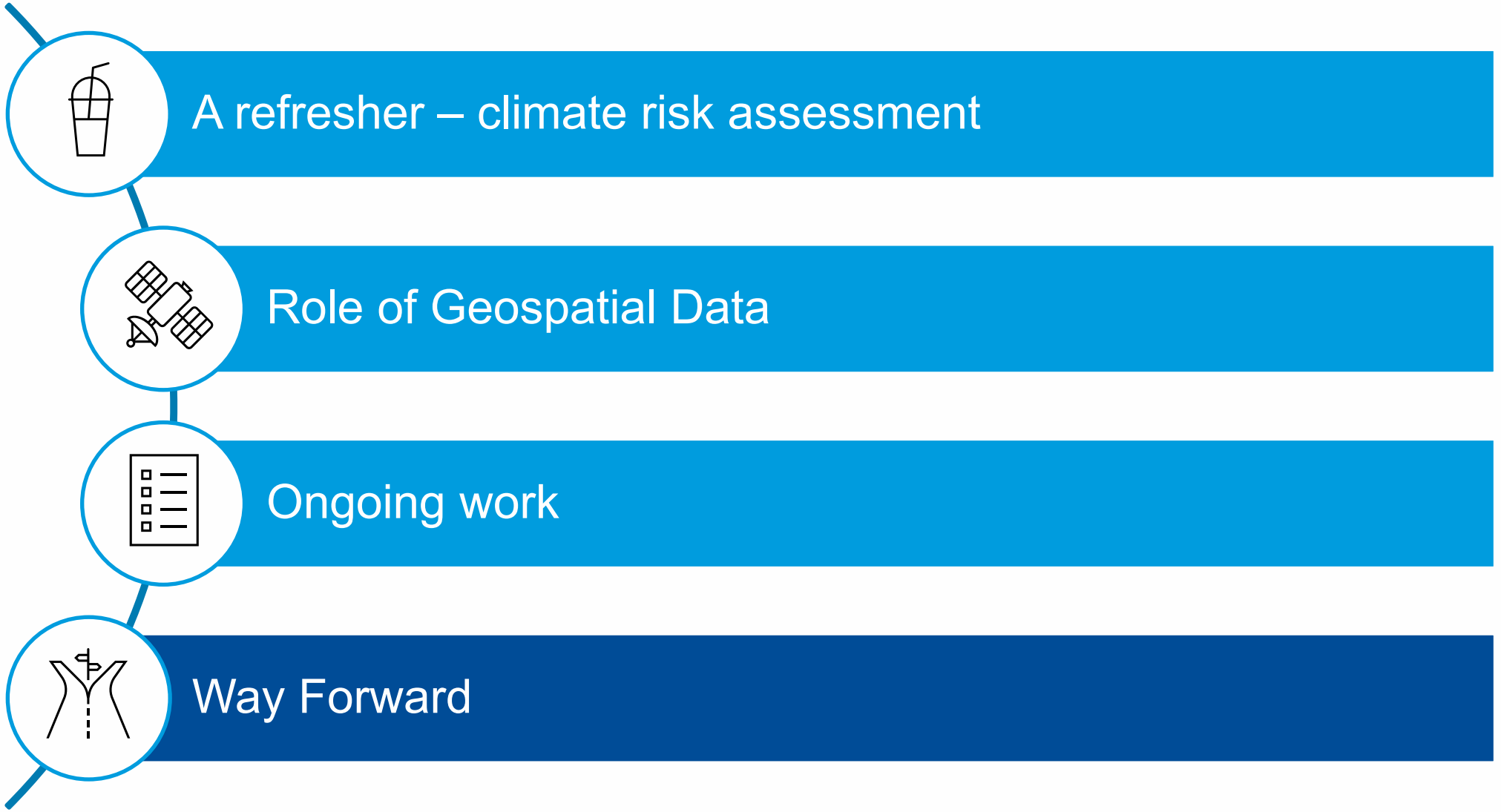
STATISTICS

Harnessing Geospatial Data for Effective Climate Risk Assessment

OCTOBER 29, 2025

Mahmut Kutlukaya
Senior Economist
Statistics Department

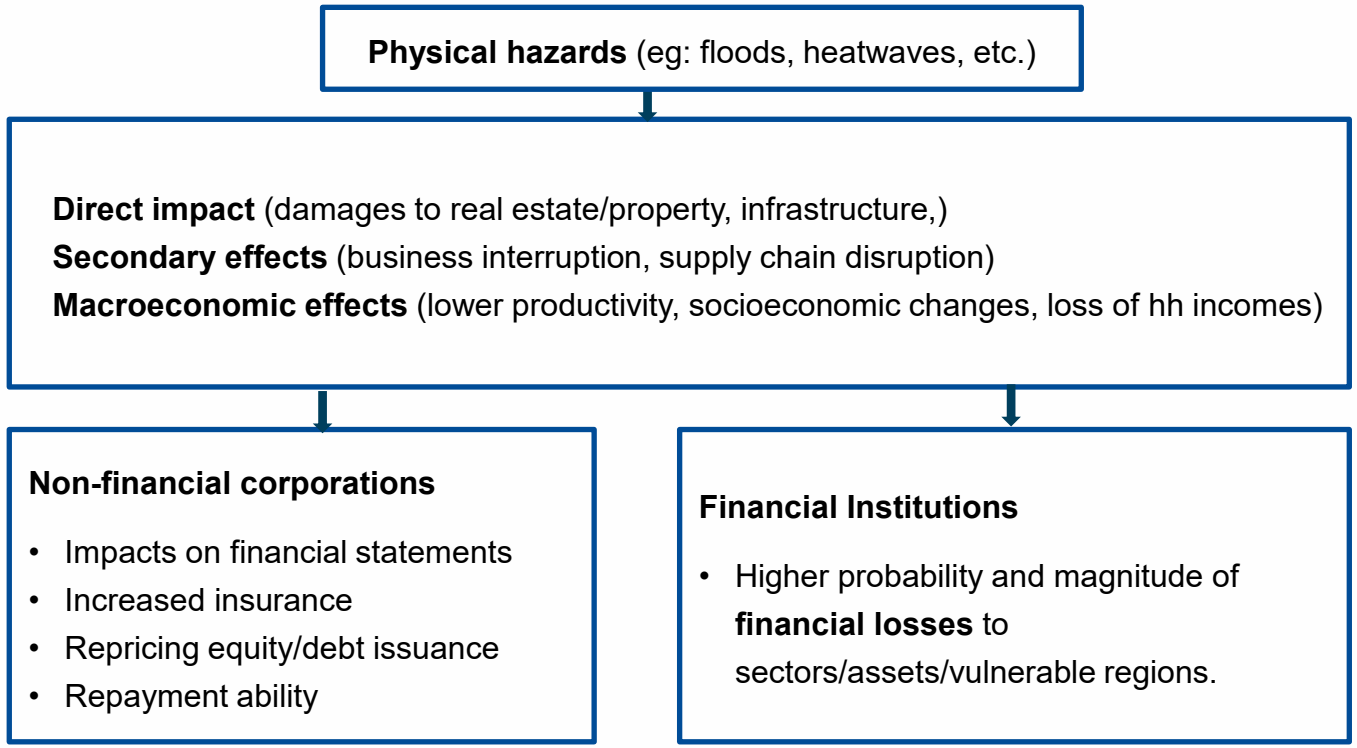
Outline of the Presentation



A refresher: climate risk assessment

- **Central Bank Perspective**
  - The objective is to assess the propagation of physical risks into the economy and the financial systems.

Spillovers from physical hazards to **financial systems**



A refresher: climate risk assessment

- **Ministry of Finance Perspective**
  - Assess the propagation of physical risks through:
    - Lower tax revenues
    - Lower dividends of SOEs
    - Higher cost of borrowing
    - Lower fiscal spaces
    - Stranded SOE capital
    - Infrastructure damage, etc.
  - These assessment requires granular and spatially explicit data on exposure and vulnerability to hazards
    - Households (income, productivity, health, …)
    - Businesses (revenues, cost,…)
    - Government sectors (infrastructure, SOEs, assets, …)
    - Financial system (loans, insurance, ….)

G20 Data Gaps Initiative (DGI-3)
Climate-Related Recommendations

G20 DATA GAPS INITIATIVE 3

Rec #1
Greenhouse Gas Emission Accounts and National Carbon Footprints

Rec #2
Energy Accounts

Rec #3
Carbon Footprint of Foreign Direct Investment

Rec #4
Green Debt and Equity Securities Financing

Rec #5
Forward - Looking Physical and Transition Risk Indicators

Rec #6
Government Climate – Impacting Subsidies

Rec #7
Climate Change Mitigation and Adaptation Current and Capital Expenditures

DELIVERING INSIGHTS FOR ACTION

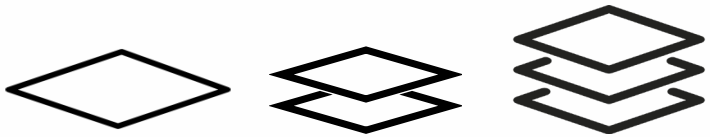
Methodological Framework: Measuring Risk using Geospatial Data

Coverage

1. Physical Events
   - Extreme Temperature
   - Precipitation
   - Drought
   - Floods
   - Wildfires
   - Tropical Cyclones
   - Sea Level Rise
   - Others

2. Transition Events
   - Shifts in Economic Policy (carbon taxation, subsidy regime shifts)
   - Technological advancements
   - Changes in Consumer and Market Sentiment
   - Changes to Legal Frameworks

Measuring Risk



Hazard/ Event + Exposure + Vulnerability

Risks to:
Population, GDP, built- up areas (properties, public infrastructure etc.), firms, financial sector

Forward-looking estimates based on climate scenarios

Definitions

G20
DATA GAPS INITIATIVE 3

Concept Note: Data Gaps Initiative (DGI 3) Recommendation 5

Forward-looking Physical and Transition Risk Indicators

(Preliminary Draft)

I. INTRODUCTION

1. The new Data Gaps Initiative – DGI 3 – endorsed by the G20 Finance Ministers and Central Bank Governors in November 2022 highlighted the need for robust, comprehensive, and comparable data for the most urgent policy needs. The IMF staff, in close cooperation with the Financial Stability Board (FSB) Secretariat and the Inter-Agency Group on Economic and Financial Statistics (IAG), and in consultation with participating economies, have developed a workplan calling for better data to understand climate change, together with indicators that cover income and wealth, financial innovation and inclusion, access to private and administrative data, and data sharing.

Overview of Potential Data Sources

- Performing bespoke climate risk assessment or computing risk indicators necessitate the utilization of **diverse datasets** (see Figure below).

- Access to **granular data** for climate change hazards, exposures and vulnerabilities can greatly enhance the ability to obtain accurate estimates of associated risks

Harness geospatial data | Better data, better policies

Geospatial Data

- Exposure
- Hazard
- Vulnerability

Better Data

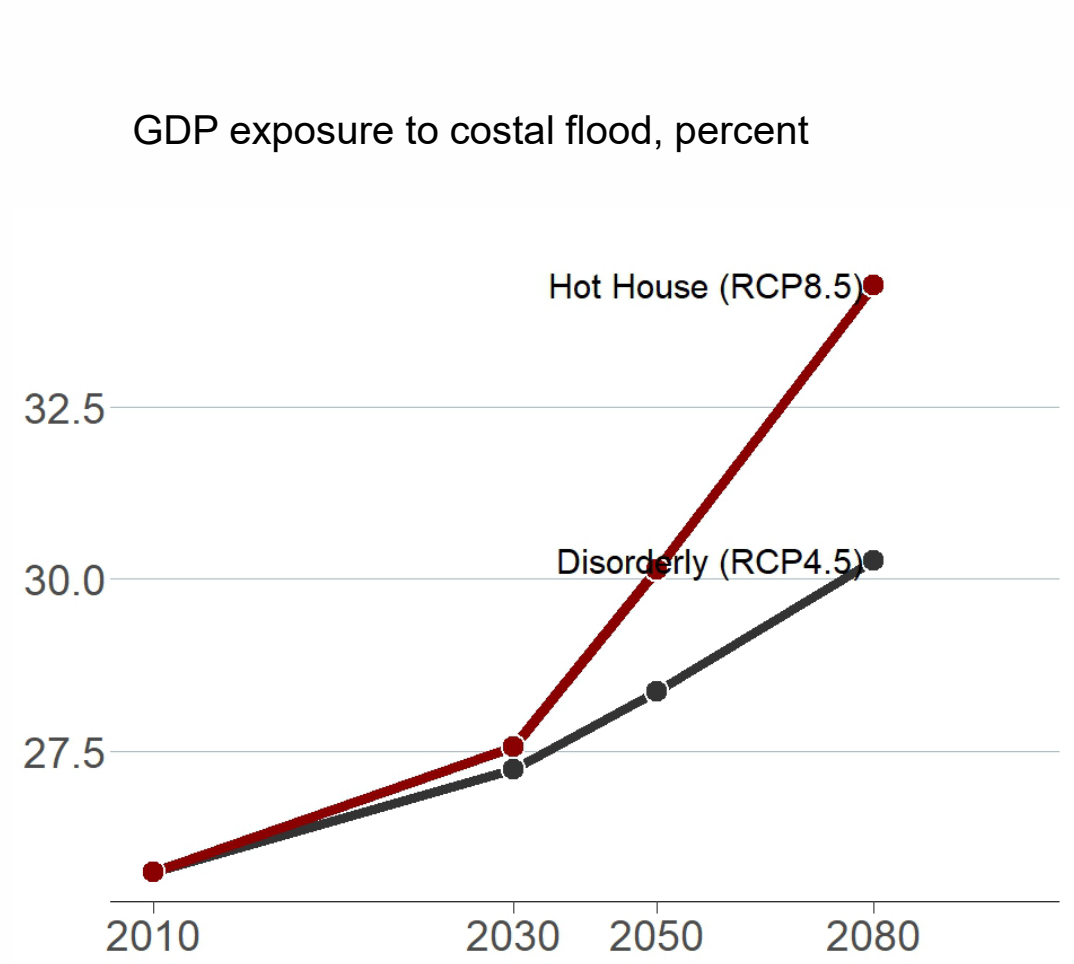
- Technology
- Models
- Skill
- Collaborations
- Curated data
- Communication

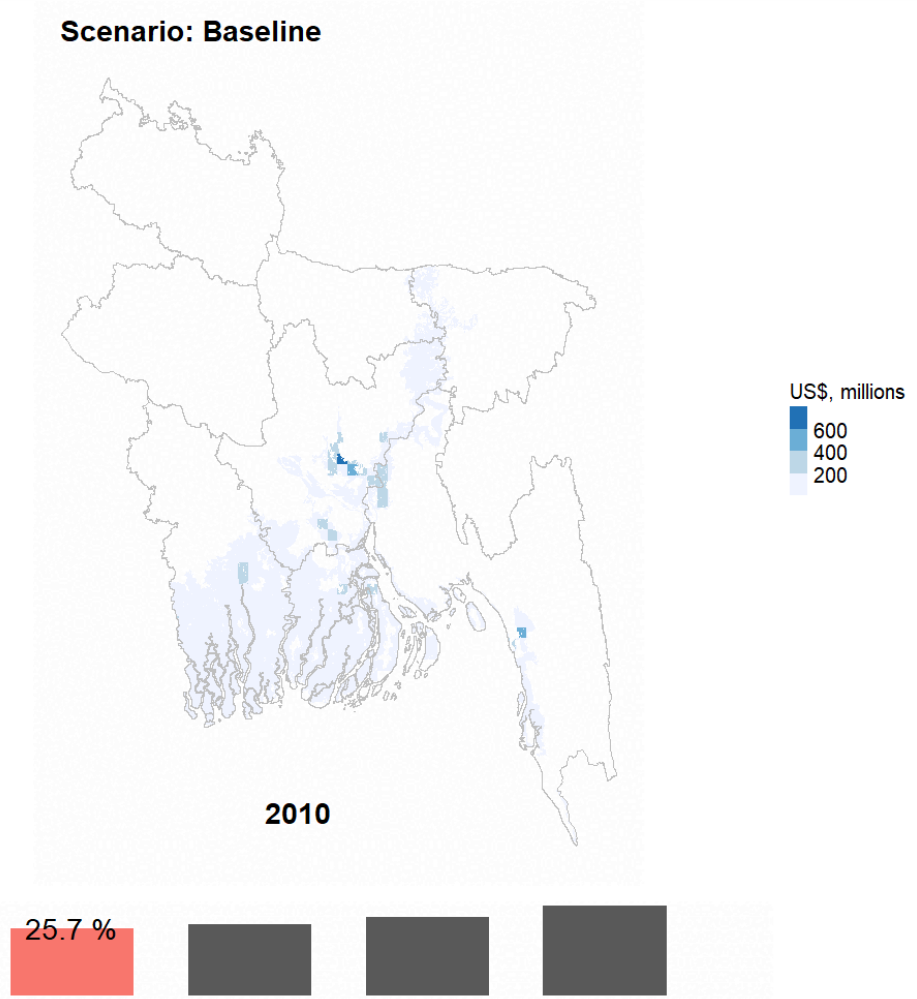
Ai

Better Policies

- Adaptation
- Mitigation
- Climate finance
- Financial stability

Floods Exposure | GDP Exposure to coastal flooding, Bangladesh



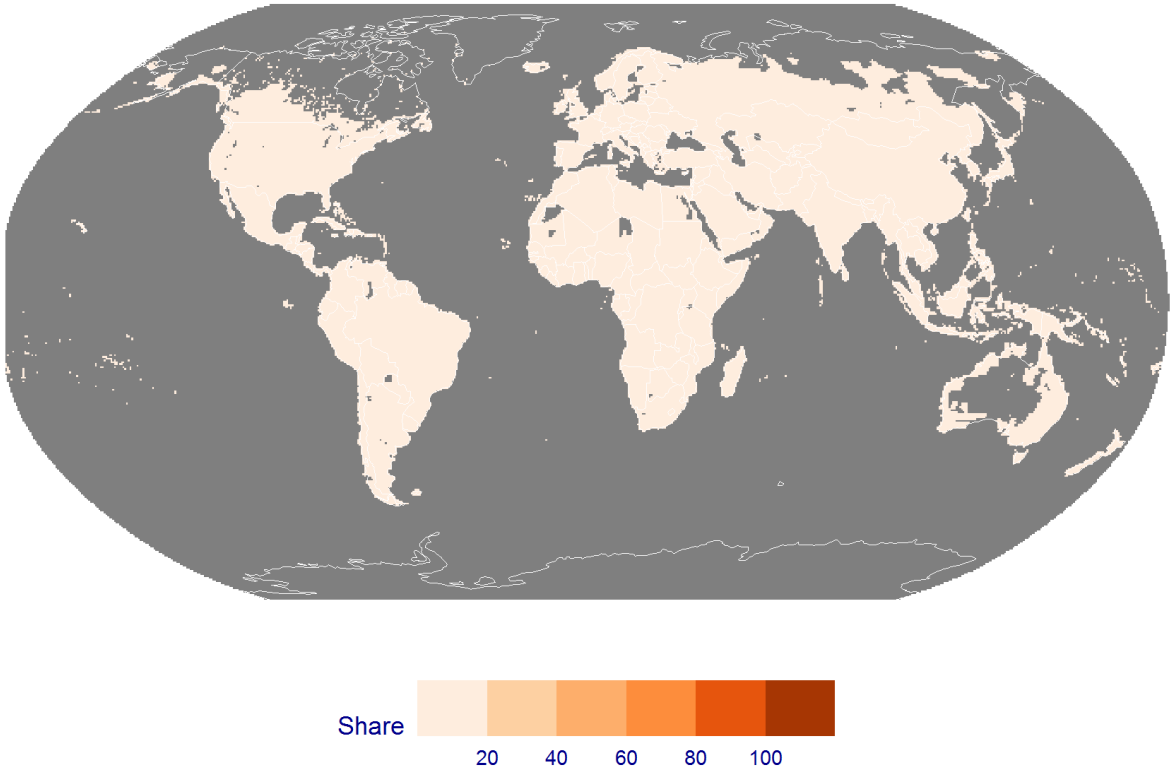


Source: Staff computations using flood data from Aqueduct Floods Map (WRI); Gridded Population (WB, CCKP); Gridded GDP (Murakami et al. (2021)

Leveraging Geospatial Data | Exposure to Heat Stress

Share of population (SSP245 projection)

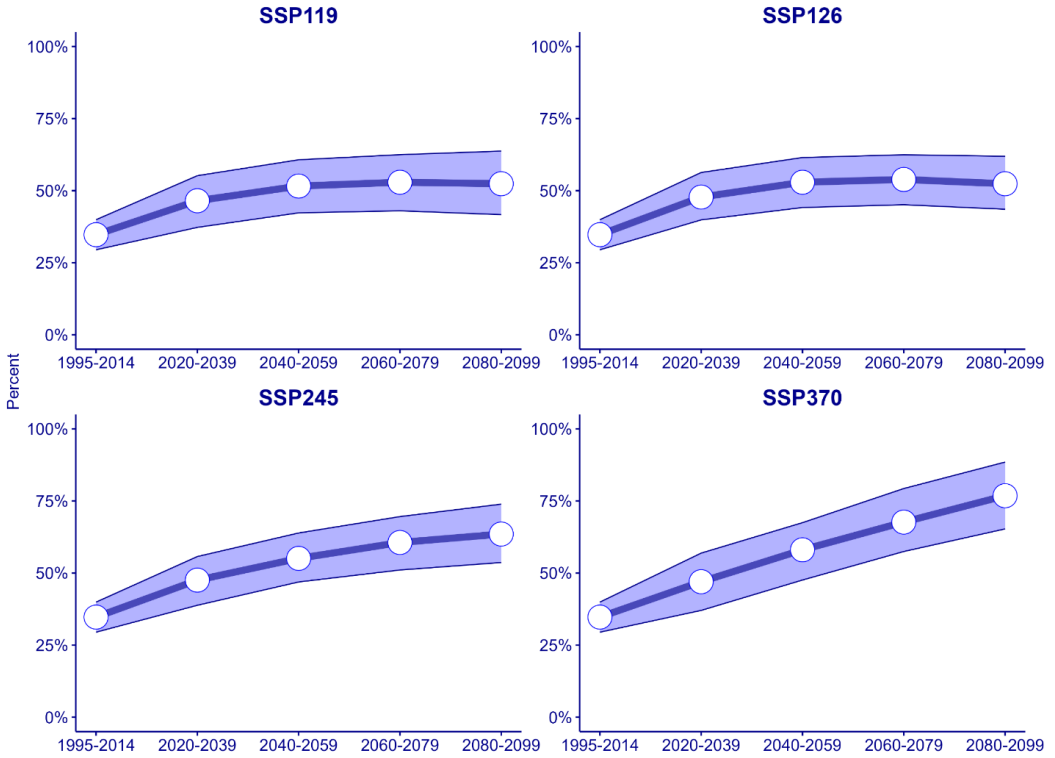
Exposed to at least 10 days with daily maximum temperature >= 35°C
2010



IMF|Statistics computations using World Bank Climate Change Knowledge Portal gridded climate data

G20 Countries

Percent of population exposed to at least 10 days with daily maximum temperature >= 35°C
CMIP6 Ensemble



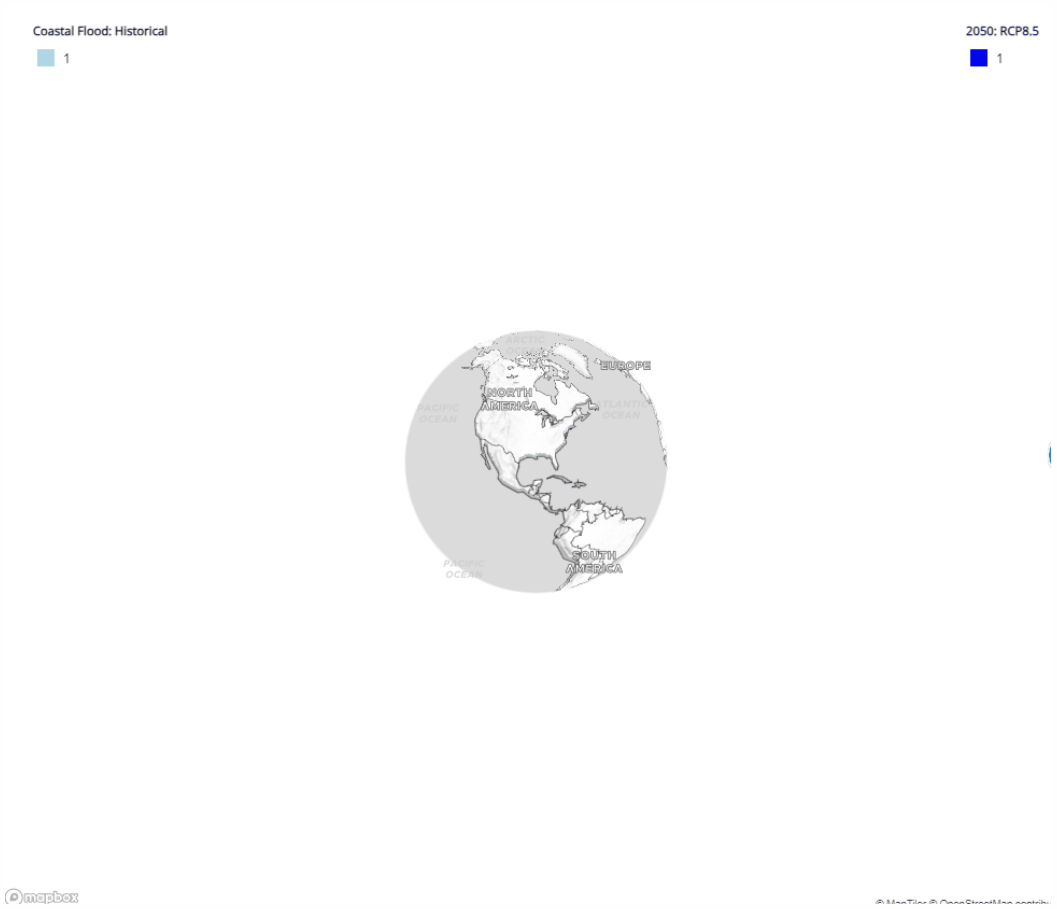
Source: IMF|Statistics computations using World Bank Climate Change Knowledge Portal gridded climate data.
Original citation: Eyring, V. et al. (2016): Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, Geosci. Model Dev., 9, 1937-1958,
DOI: https://doi.org/10.5194/gmd-9-1937-2016
Note: solid line represent median, ribon shades represent the 10th and 90th percentiles.

Leveraging Geospatial Data | Buildings Exposure

- Localized hazards (eg: floods) require granular and geospatial data on the “built environment”, such as:
  - Residential buildings
  - Commercial buildings
  - Industrial structures
  - Critical infrastructure
  - Agricultural land, etc.

- Accurate climate risk assessment is paramount to:
  - Financial systems:
    - Banking sector (mortgages)
    - Insurance sector (losses and premiums)
    - Bank regulation and supervision
  - Public sector (revenue and spending)
  - Overall economy (productivity)

Figure 1: Buildings exposure to coastal flooding, 2050

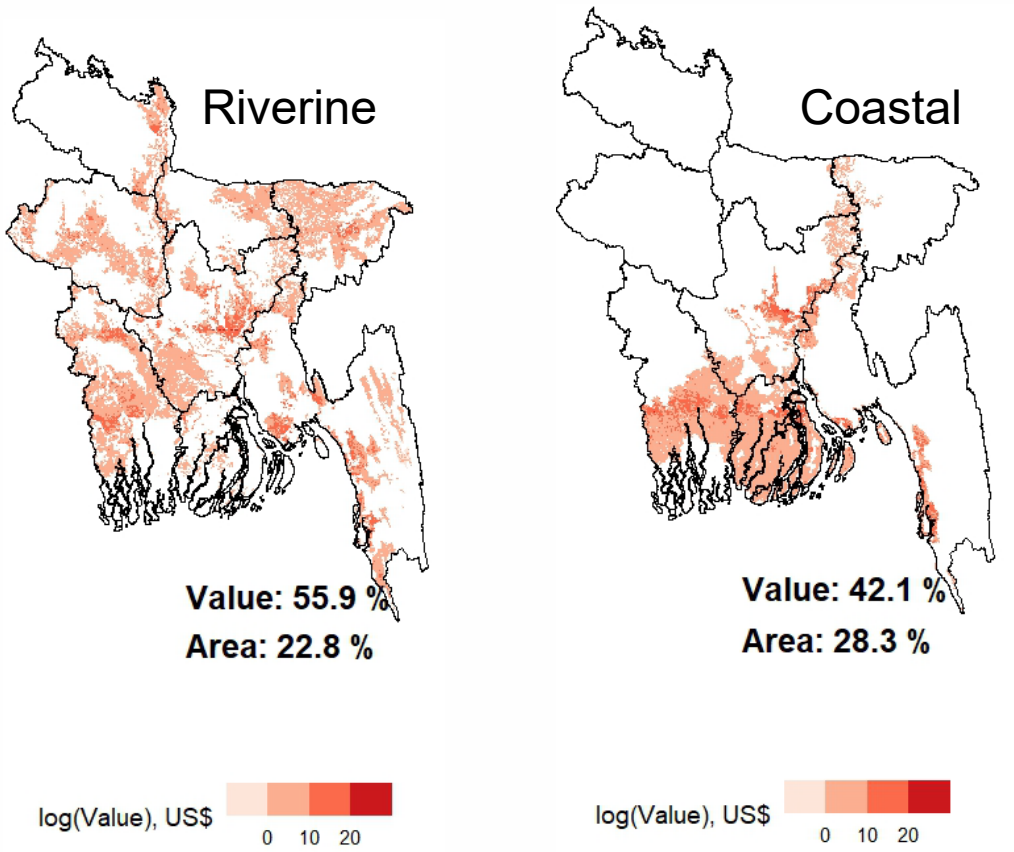


Note: Buildings exposure to coastal flood.
- Historical (lightblue) vs. 2050 projection under RCP8.5 (Business as usual) (blue).
- Fly to destination 1 (New Orleans, USA) and destination 2 (Guayaquil, Ecuador).
- Flood intensity=100-years return period

Source: Flood data sourced from Aqueduct Floods (WRI)

Floods Exposure | Buildings exposure, Bangladesh

- Preliminary computations show that significant share of buildings are exposed risks of flooding in 2023:
  - 56% and 42% of value of buildings exposed to riverine and coastal floodings, respectively.
  - 22.8% and 28.3% of buildings area exposed to riverine and coastal floodings, respectively.



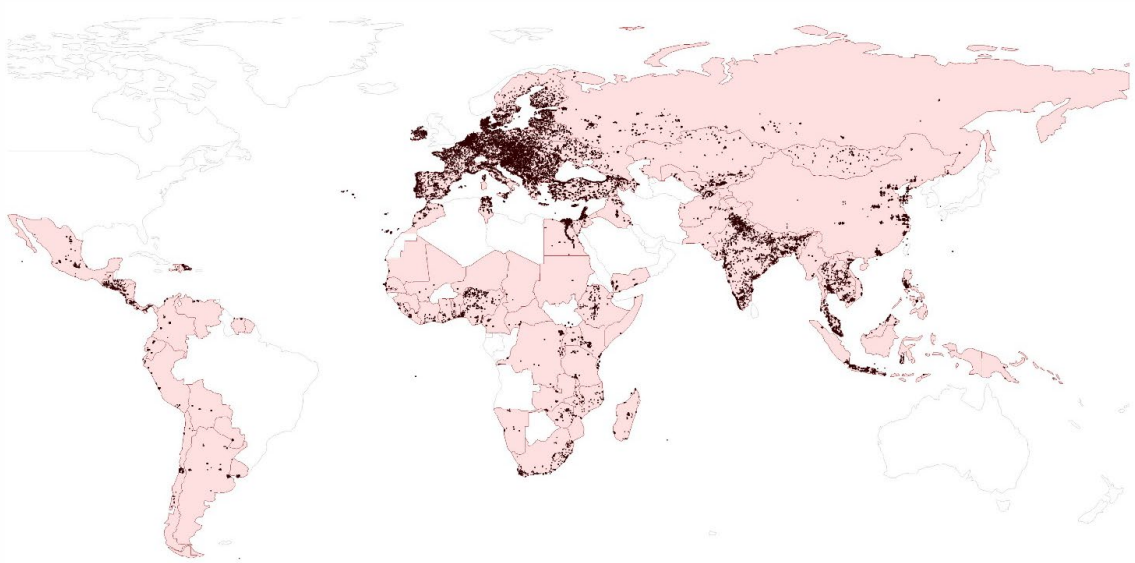
Source: Staff computations using flood data from Aqueduct Floods Map (WRI); IMF compilation of Opensource Building Footprint Data from Google and Microsoft. Imputed building values are downscaled to block level using population and nighttime light as determining factors.

Leveraging Geospatial Data | Business Exposure

- Climate change has detrimental effects on businesses across the glob:
  - Firm performance (productivity, profitability)
  - Exports (BOP)
  - Employment
  - Critical infrastructure
  - Agricultural land, etc.

- Climate risk assessment on businesses also have implications on:
  - Financial systems:
    - Banking sector (business loans)
    - Insurance sector (losses and premiums)
    - Bank regulation and supervision
  - Government sector (revenue and spending)
  - Overall economy (productivity)

Location of businesses: World Bank Enterprise Survey (2023)



Note: Buildings exposure to coastal flood (historical vs. 2050 projections under RCP8.5 (Business as usual) . Flood intensity=100-years return period
Source: Aqueduct Floods

Leveraging Geospatial Data | Agricultural Exposure

- Agriculture is a key sector for many economies with implications on
  - Export (Forex/BOP)
  - Food Inflation
  - Employment
  - Livelihood & subsistence
- Drought, unpredictable weather effect agricultural activities.
- Climate risk assessment necessitating granular geospatial data on
  - Location and size of parcels
  - Crop type
  - Agronomy
  - Irrigation

Crop land exposure to drought (in a dying Salton Sea, CA)

Source: The Salton Sea, an Accident of History, Faces a New Water Crisis - The New York Times (nytimes.com)

Census of Structures Project

- **Objectives**:
  - Develop a method to construct a global census of residential buildings (geospatial layer)
    - Information on total area of the building (including height) and $$ value
- **Relevance:** Financial sector, insurance industry.
- **Open-source geospatial data:**
  - Building footprints
  - OpenStreetMap
  - Global Human Settlement Layer
  - Gridded population; Nighttime light

Opensource Exposure Indicators: Initial Proposal

Hazards

Floods:	Coastal Riverine
Temperatures:	Heat stress Frost Urban heatwave
Precipitation:	Drought Extreme precipitation

Exposures

People:	Population Vulnerable people
Economy:	GDP Urban GDP
Assets:	Buildings - Residential - Nonresidential Built-up area
Agriculture:	Cropland

Climate Scenarios	Temporal Coverage	Granularity
SSP|RCPs: Hot house Disorderly Orderly	Baseline 2020-2100	Grid Subnational National Regional

Sources: AQUEDUCT FLOODS | WORLD BANK GROUP | Climate Change Knowledge Portal For Development Practitioners and Policy Makers | EARTHDATA | IMF|Statistics | opernicus Europe's eyes on Earth | Climate Change Service | GHSL - Global Human Settlement Layer Open and free data and tools for assessing the human presence on the planet

Flood indicators (development in progress)

Hazard

- **Flood type**:
  - Riverine
  - Coastal
- **Return periods**:
  - 50-years
  - 100-years
  - …
  - 1000-years
- **Inundation depth**:
  - Low [<0.5 m]
  - Medium [0.5 – 1.5m]
  - High [>1.5m]

- **Coverage**: Global
- **Resolution**: 30'' x 30'' (~1km)
- **Climate Scenarios**: Baseline, RCP4p5, RCP8p5
- **Projection periods**: 2030, 2050, 2080

Exposure

- **Population**
- **GDP**
- **Urban GDP**
- **Buildings:**
  - Quantity (sqr meters)
  - Estimated value (US$)

Exposure Indicators

- %[count] of **population** susceptible to flood
- %[US$] of **GDP** susceptible to flood
- %[US$] of **Urban GDP** susceptible to flood
- %[sqr m] of **buildings** susceptible to flood
- %[US$] of **buildings value** susceptible to flood

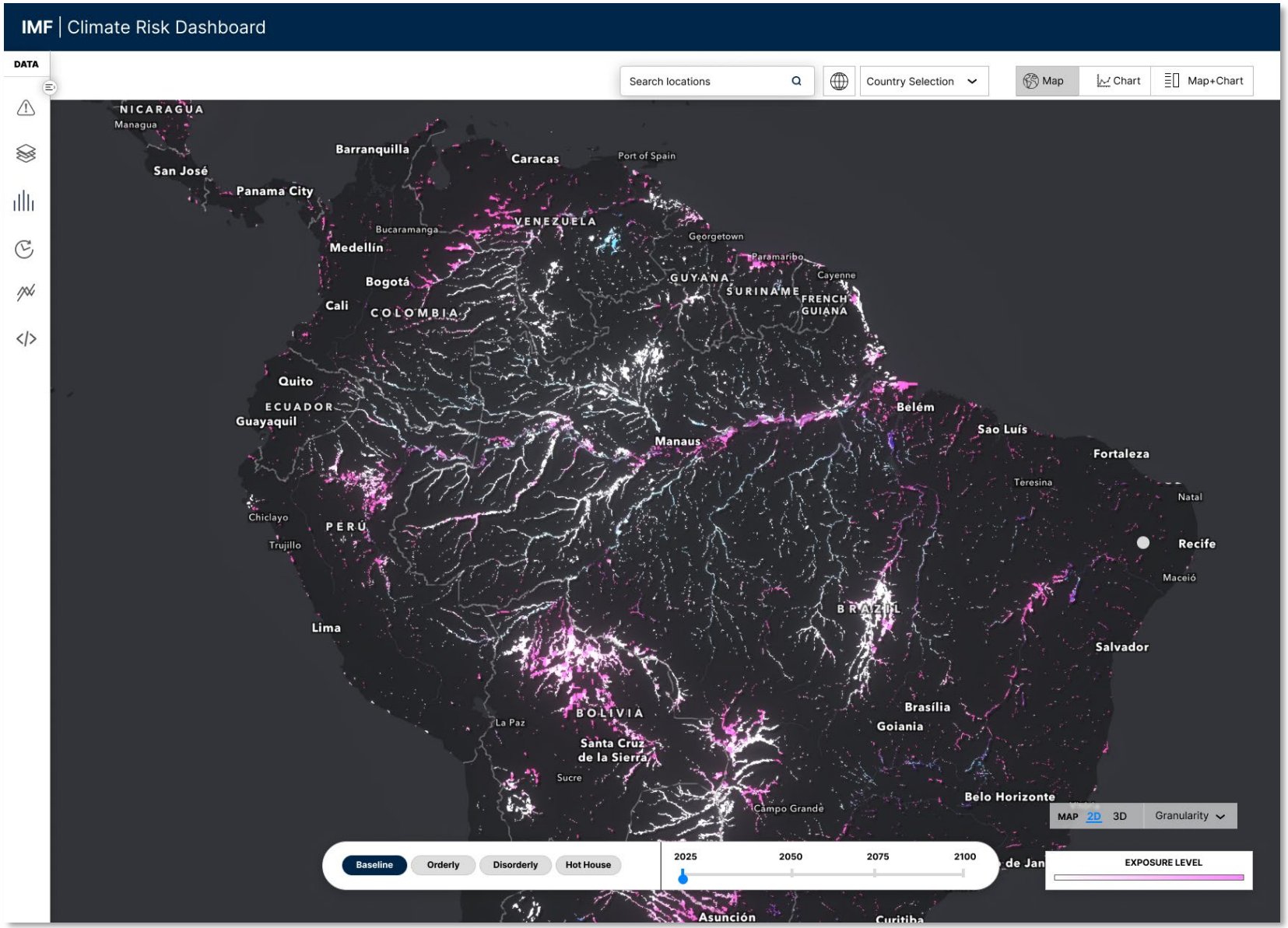
- **We plan to compile similar indicators for other hazards**

Sou AQUEDUCT FLOODS WORLD BANK GROUP | Climate Change Knowledge Portal For Development Practitioners and Policy Makers EARTHDATA IMF|Statistics opernicus Europe's eyes on Earth Climate Change Service GHSL - Global Human Settlement Layer Open and free data and tools for assessing the human presence on the planet

IMF Geospatial Data Dissemination Platform

- IMF public geospatial data dissemination platform

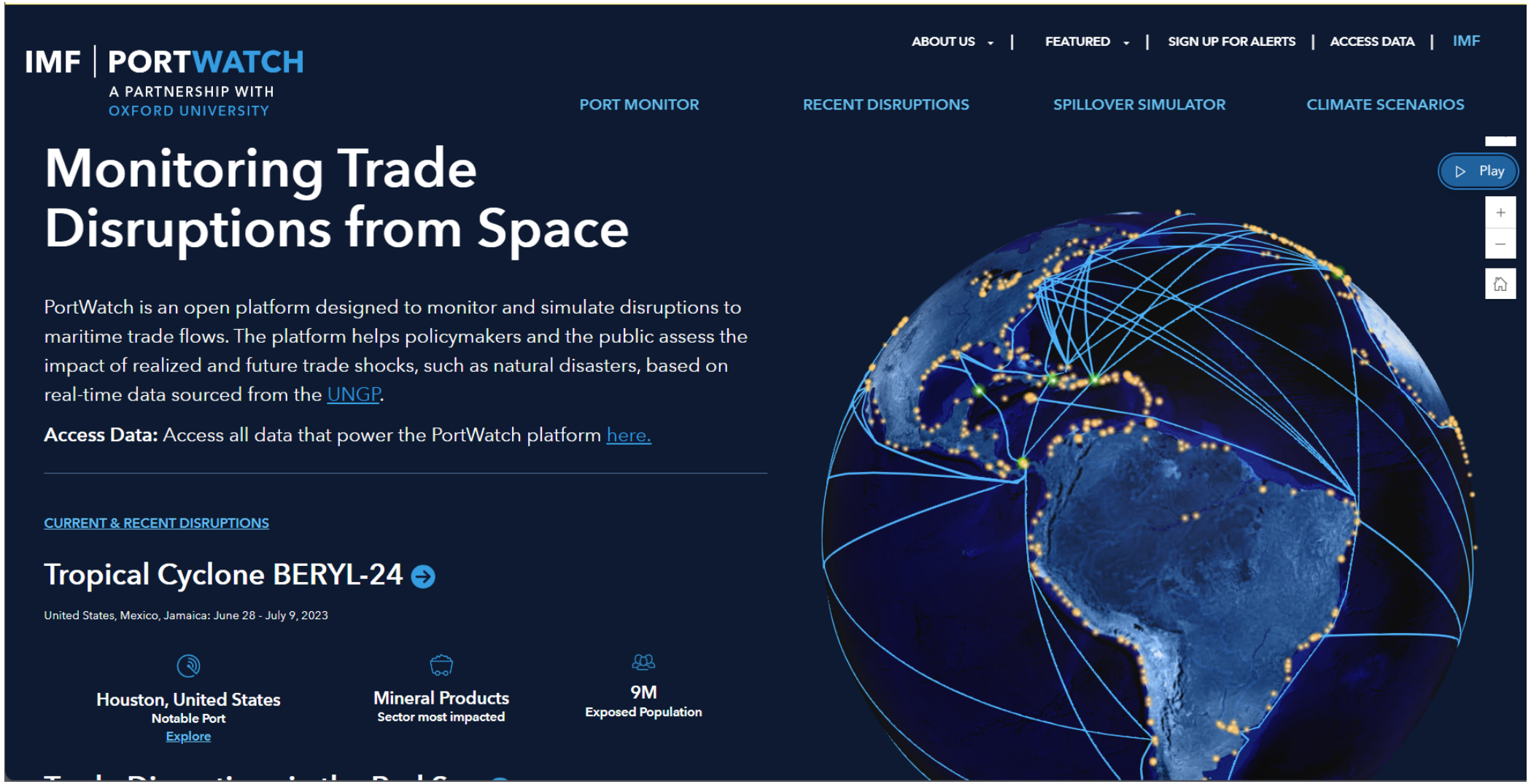
- Functionality:
  - Levels of granularity
    - Country
    - Subnational
    - Grid
  - Standardized charts
  - Visualization of data and statistics with several dimensions
  - Comparison between geographic areas, scenarios, across time



Showing population exposure to riverine floods. Historical baseline.

Source: Staff computations using flood data from Aqueduct Floods Map (WRI); Gridded Population (WB, CCKP); Gridded GDP (Murakami et al. (2021)

Monitoring Trade Disruptions | PORTWATCH



Global Datasets and Geospatial Tool

Climate Risk Indicators

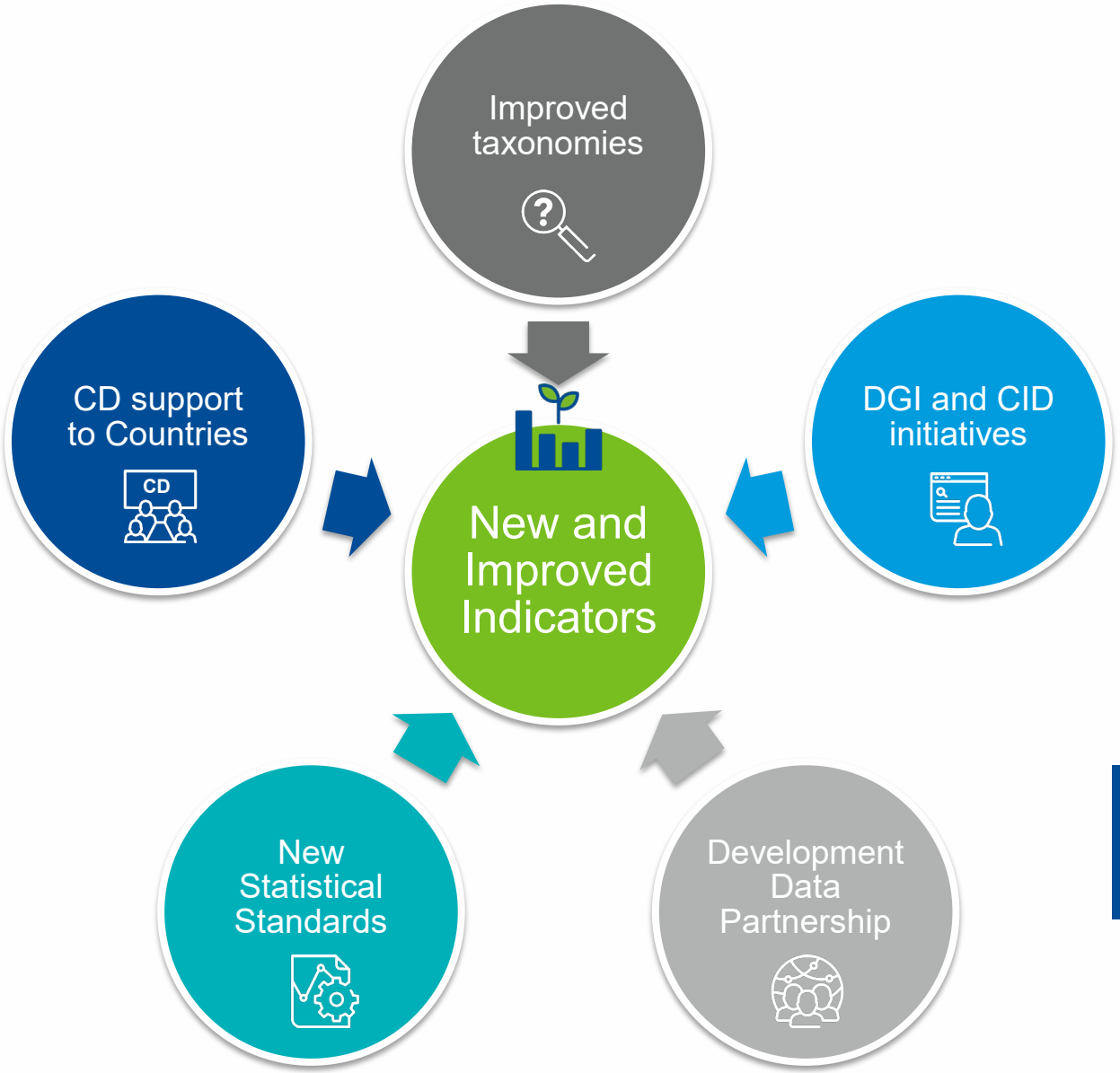
Work is in progress to develop a tool that integrates different layers on hazards and exposure to identify the hot spots for risk using global data sets

Working with many institutions to develop this information

- World Bank; European Space Agency; Basque Center for Climate Change; UN World Meteorological Organization; others

Support countries to develop its own estimates building on global data sets.

Way Forward



DEVELOPMENT DATA PARTNERSHIP

IMF | CLIMATE CHANGE DASHBOARD

Thank You!

Questions?