Harnessing Geospatial Data for Effective Climate Risk Assessment

SEVENTH HIGH-LEVEL FORUM ON UNITED NATIONS GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

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The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management

Outline

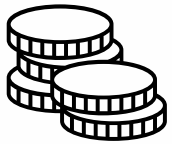
- IMF and Climate Change
- Geospatial Data to Inform Climate Policy
- Harnessing the Power of Geospatial Data: Policy Cases
- Key Challenges and Way Forward

IMF and Climate Change

- Climate change is an **existential threat** to long-term growth and prosperity
- IMF's Climate Strategy (2021) goal: "*provide high quality, granular, and tailored advice to the membership on macroeconomic and financial policy challenges related to climate change*"
- Systematic and strategic integration of climate change into the IMF's activities

Surveillance and Analytical Work

Capacity Development and Data



Lending

Cooperation and Coordination

Link to the climate strategy document: Here

STA's Environment and Climate Change Statistics Program
Three Main Pillars

1 Capacity Development (CD)

- Enhance expertise in member countries by offering courses and targeted technical assistance (e.g. SECO Project) on macro-relevant climate data.

2 Data

- Provide high quality, comprehensive and comparable data through the publicly available Climate Change Indicators Dashboard (CID) to support informed policy-making.

3 Statistical Methodology

- Advance climate-related statistical methods through global partnerships, updating statistical manuals, and addressing data gaps with international organizations and G20 countries through the Data Gaps Initiative 3 (DGI 3).

Capacity Development (CD)
Providing Training and Technical Assistance

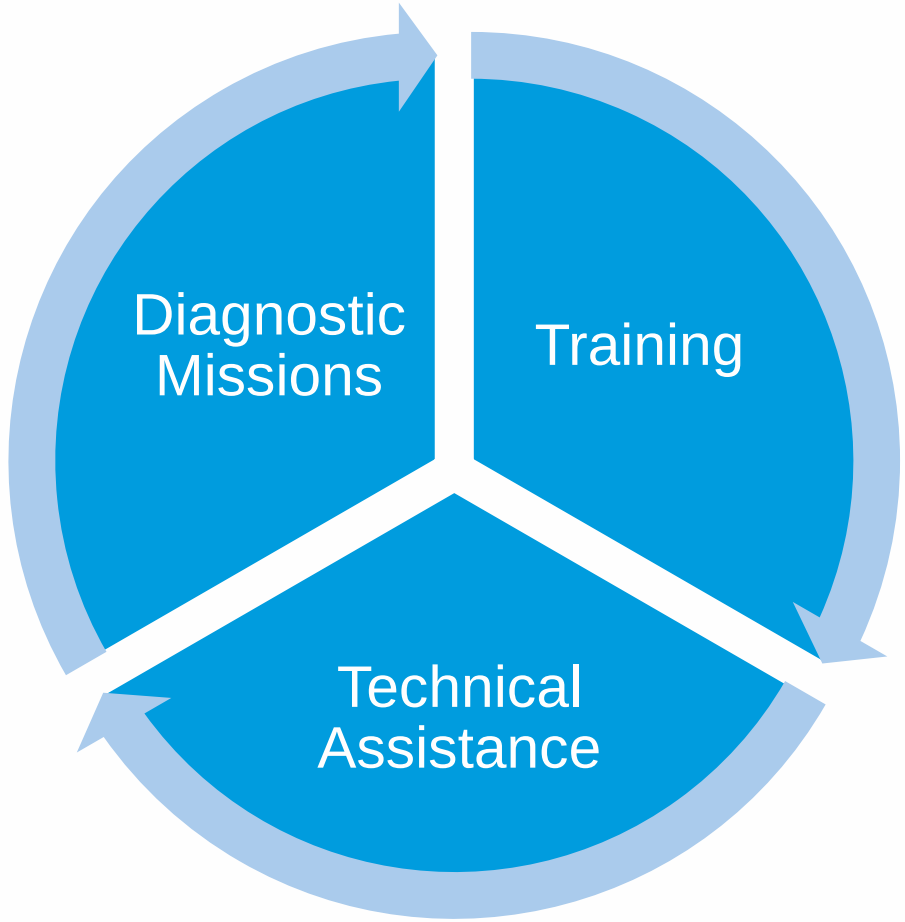
Training

- **Course on "Macro-relevant Environment and Climate Change Statistics"**
  - ➢ Introductory and advanced versions of the course are offered in many regional training centers and IMF HQ
  - ➢ Physical and transition risk is a separate module

Technical Assistance

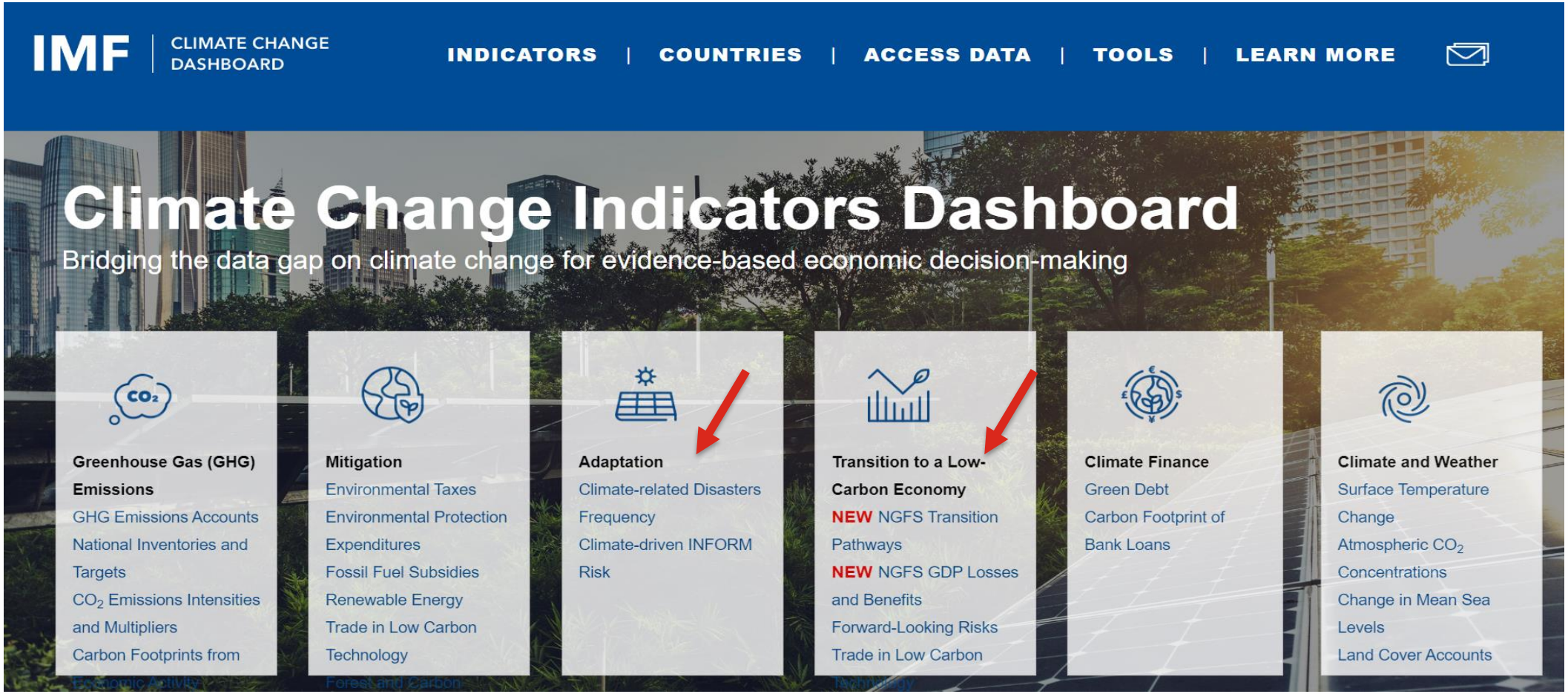
- **Country projects funded by SECO (10 countries)**
  - Algeria, Bangladesh, Colombia, Egypt, Ghana, Indonesia, Mozambique, Peru, South Africa, Vietnam.
- **Other technical assistance projects**
  - Azerbaijan, Barbados, Jamaica, Tanzania, Pakistan, Seychelles, Morocco, Iraq and others.

SECO Project: Three Phase Approach



Data: Climate Change Indicators Dashboard (CID)

- ✓ The CID addresses the growing need for climate-related data used in macroeconomic and financial stability analysis by identifying and developing a range of distinctive indicators, including experimental ones.



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

G20 DATA GAPS INITIATIVE 3

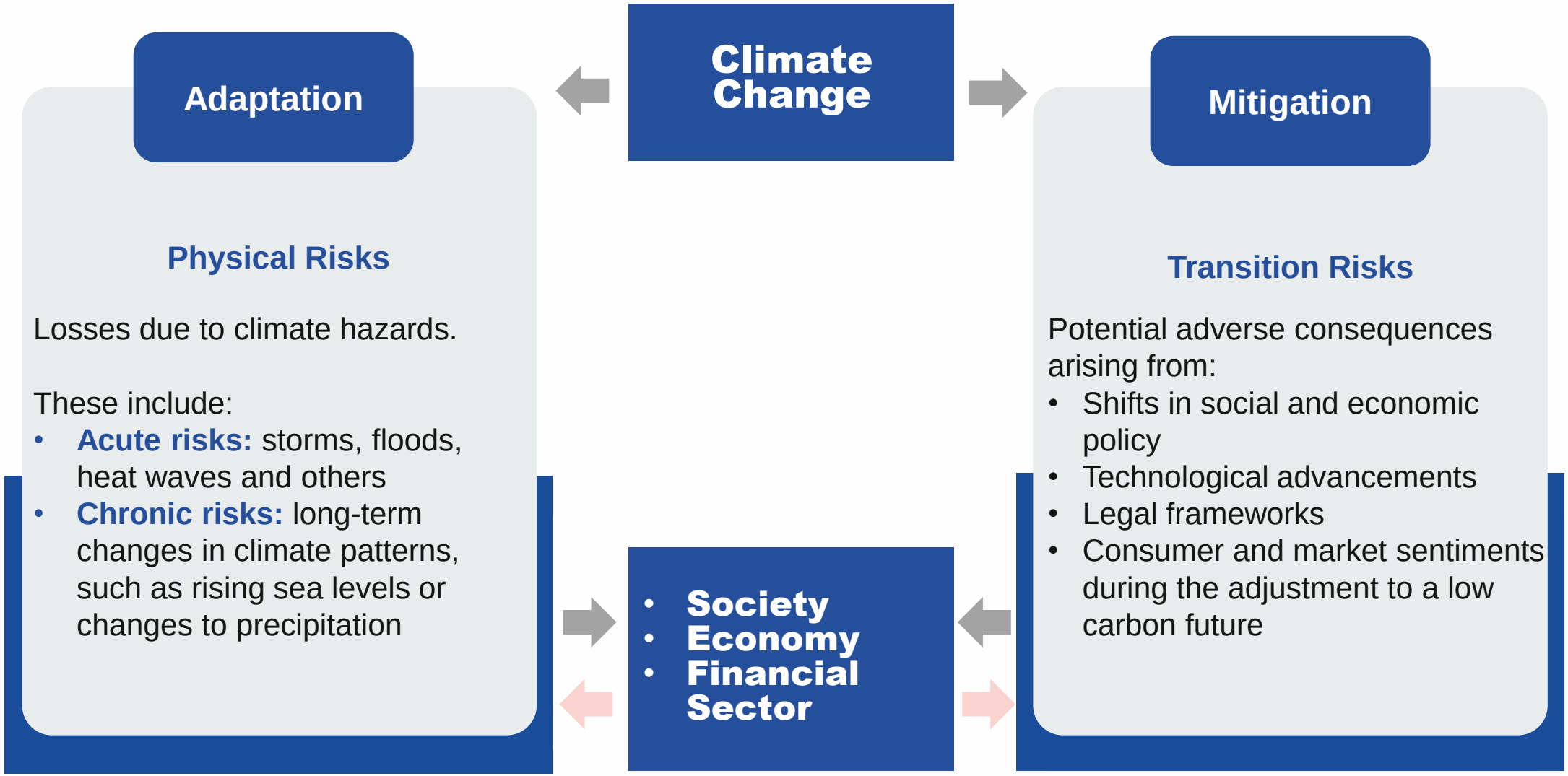
- The new DGI-3 endorsed by the G20 FMCBG will play an important role in addressing climate-related data gaps
- Seven out of the fourteen recommendations are on climate-related data
- **Rec # 5 is on forward looking physical and transition risks, where the role of geospatial data is critical**

DELIVERING INSIGHTS FOR ACTION

Benefits of Using Geospatial Data to Inform Climate Policy

WHAT IS THE IMPACT OF CLIMATE HAZARDS AND CLIMATE POLICIES ON THE FINANCIAL SECTOR AND THE ECONOMY?

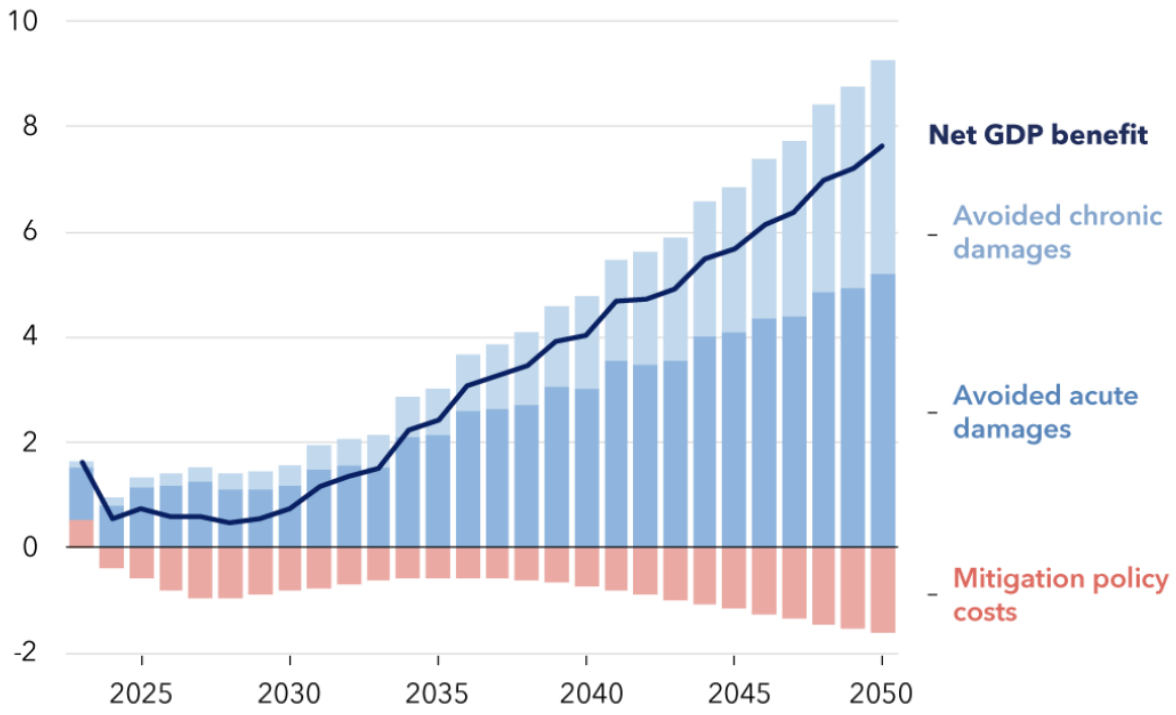
Measuring Physical and Transition Risks for Better Adaptation and Mitigation Policies



The Case for Immediate Action: Climate Transition Benefits Exceed Costs

- Avoiding physical damage from climate change can have sizable benefits
- Making an orderly transition to net zero by 2050 could result in global gross domestic product being 7 percent higher than under current policies, based on NGFS estimates.
- Supporting countries with the development of indicators that quantify physical and transition risks for better policy analysis is critical
- Geospatial data is critical to bridge data gaps

World potential GDP benefit under net zero carbon emissions by 2050
(percent deviation from reference scenario)



Sources: NGFS (2023), Scenarios Portal; IIASA (2023), NGFS Phase 4 Scenario Explorer; and IMF staff calculations. Note: NiGEM model with REMIND-MAgPIE inputs. The reference scenario is the Current Policies scenario with no transition but physical risk.

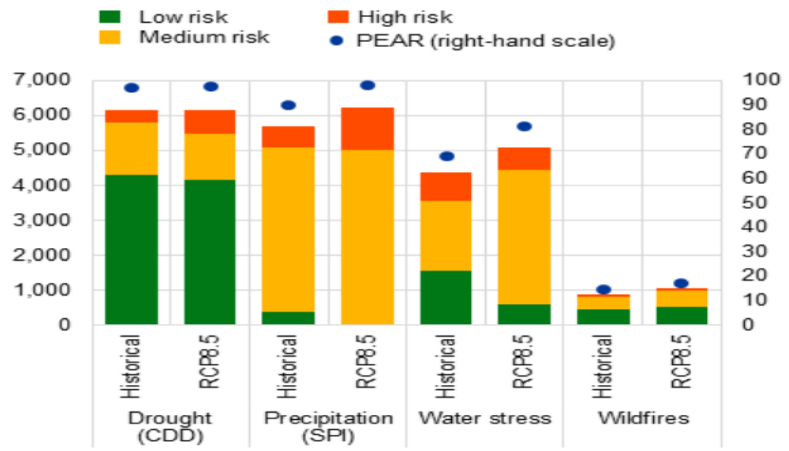
IMF

Linking Physical Risks to Financial Sector: ECB

- Assessing financial institutions' exposure to physical risks is important from a financial stability perspective
- ECB's indicators and risk scores provide that assessment for their member countries. For example:
  - Potential exposure at risk (PEAR); Normalized exposure at risk (NEAR); Collateral-adjusted exposure at risk (CEAR)

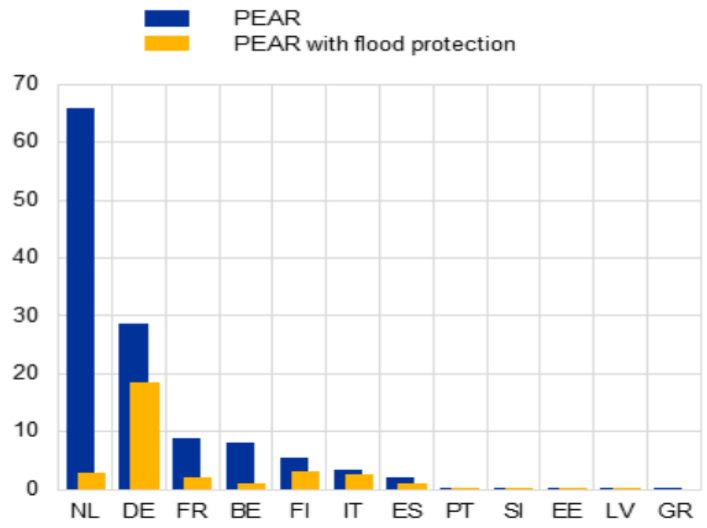
Portfolio exposures of euro area financial institutions to different hazards by risk score

(left-hand scale: EUR billions; right-hand scale: percentage of portfolio)



Potential exposure at risk: Coastal Flooding

(EUR billions)



Source: ECB

Benefits of Geospatial Data for Policy Analysis

Accurate Mapping of Vulnerable Areas

Real-Time Monitoring

Enhanced Forecast Accuracy

Informed Policy & Planning

Natural Hazards
(Hazard * Exposure * Vulnerability)

Damages

Financial Sector Risk Analysis

Economic Risk Analysis

Harnessing the Power of Geospatial Data: Policy Cases

Overview of Key Projects for Better Climate Policy Analysis

- **Measuring physical and transition risk indicators under G20 DGI-3**
  - Ongoing work on building a geospatial platform
  - Working with several partners
  - Computing experimental indicators

- **“Census of Structures Project”: Physical Asset Exposure to Climate Hazards**
  - Provides an assessment of climate risks, including both fiscal and financial impacts
  - Vital for climate adaptation policies

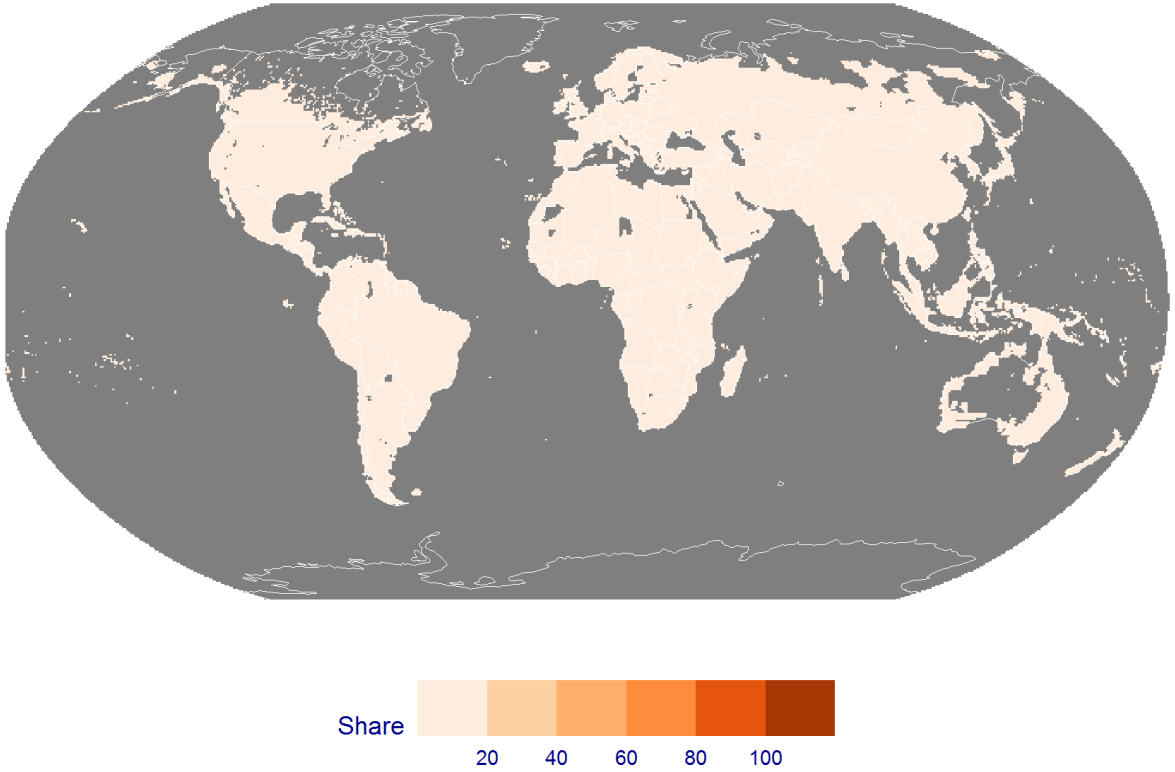
- **PortWatch**
  - Explore climate risks posed to international trade

- Overall, the goal is to help Fund staff and IMF members better integrate climate risk into policy

Exposure to Heat Stress Indicators | People

Share of population (SSP245 projection)

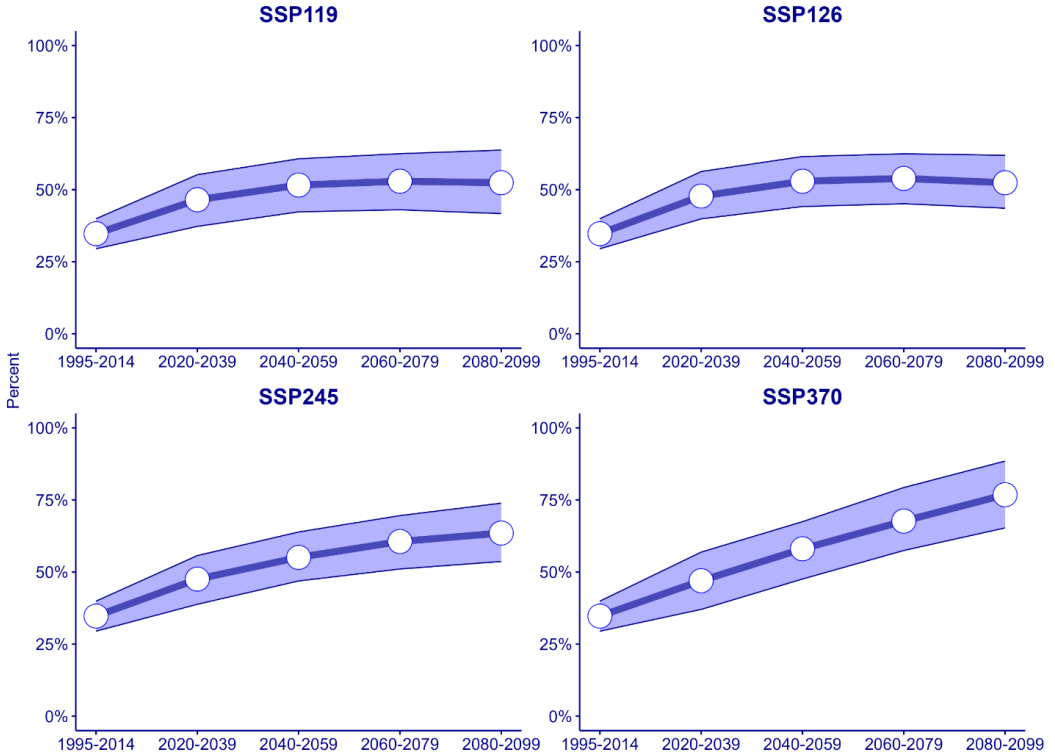
Exposed to at least 10 days with daily maximum temperature >= 35°C
2010



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

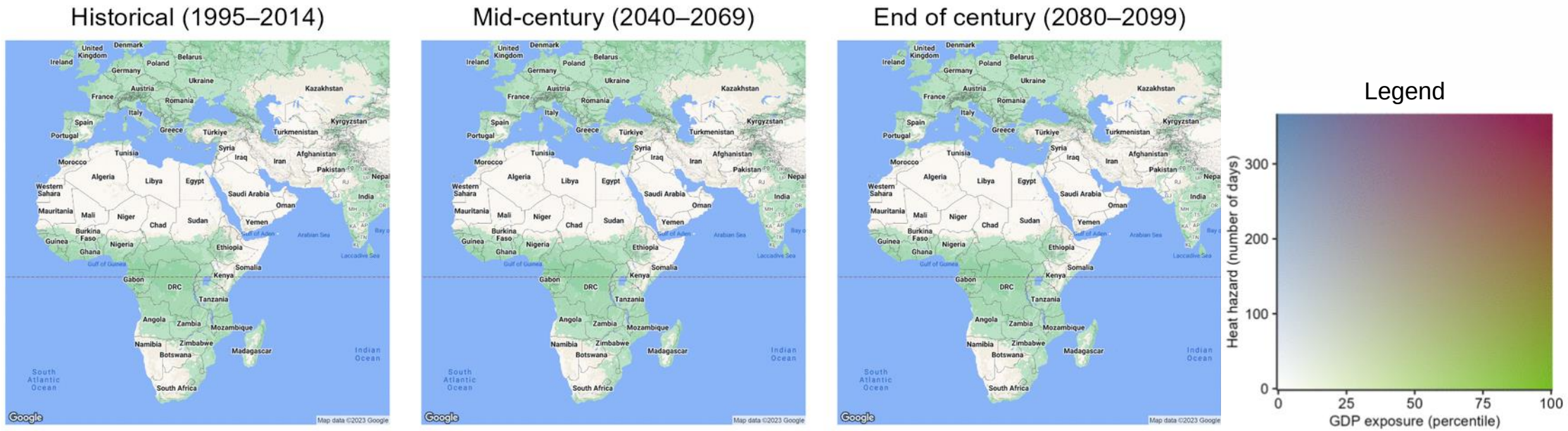


Source: IMF|Statistics computations using World Bank Climate Change Knowledge Portal gridded climate data.
Original citation: Eyring, V. et al. (2016): Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, Geosci. Model Dev., 9, 1937-1958,
DOI: https://doi.org/10.5194/gmd-9-1937-2016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

Exposure to Heat Stress Indicators | GDP

- Working on utilizing geospatial tools and integrating publicly available data on hazards, exposures, and vulnerabilities along with climate scenarios to generate estimates of risk.

Susceptibility of GDP to Heat Stress in Africa in an Intermediate Emissions Scenario (SSP2-4.5), 15 arcminutes resolution



Source: World Bank (2023), Climate Change Knowledge Portal; Marukami, D., Yoshida, T., and Yamagata, Y. (2021), Front. Built Environ. 7; and IMF staff calculations.
Note: Scenarios are referred to as “SSPx-y”, where “SSPx” refers to the Shared Socio-economic Pathway describing the socio-economic trends underlying the scenario, and “y” refers to the approximate target level of radiative forcing (in watts per square meter) resulting from the scenario in the year 2100.

Geospatial tool to better understand future physical risks

- Ongoing work to develop a geospatial tool with partners
  - BC3, ESA, ESRI, World Bank, G20 DGI-3 and others.
- Integrate different layers on hazards and exposures to identify hot spots for climate risks using global data sets
- Synergies with other ongoing work: Digital Twin Project (France, Netherlands, Hong Kong) and ECB's work

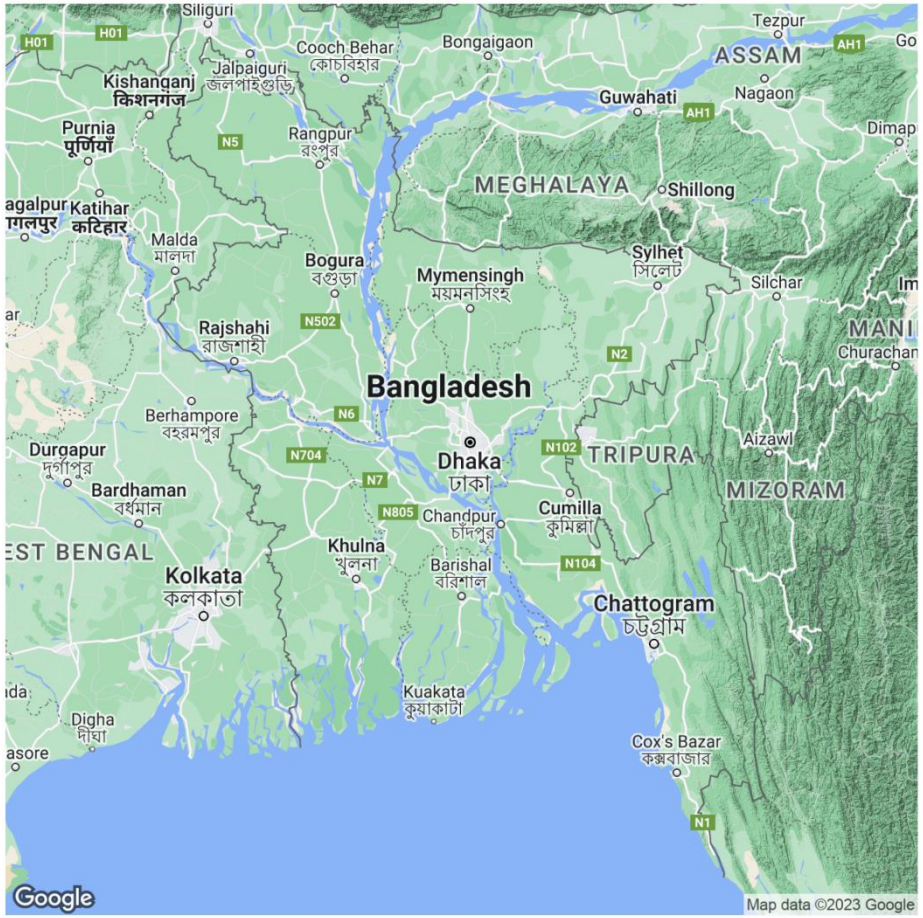
Example: Bangladesh

Hazard layer: # of days per year with heat index greater than 35°C

Exposure layer: Gridded GDP

Vulnerability layer: Damage functions – not yet

Terrain Map of Bangladesh



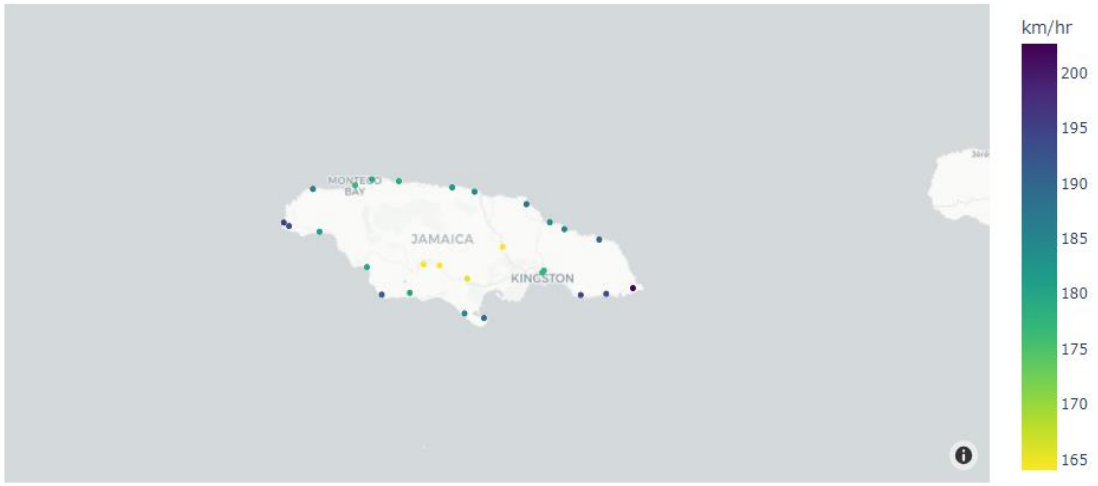
Sources: Google (2023), Maps Platform; and GADM (2022), version 4.1.

The boundaries, colors, denominations, and any other information shown on maps do not imply, on the part of the IMF, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

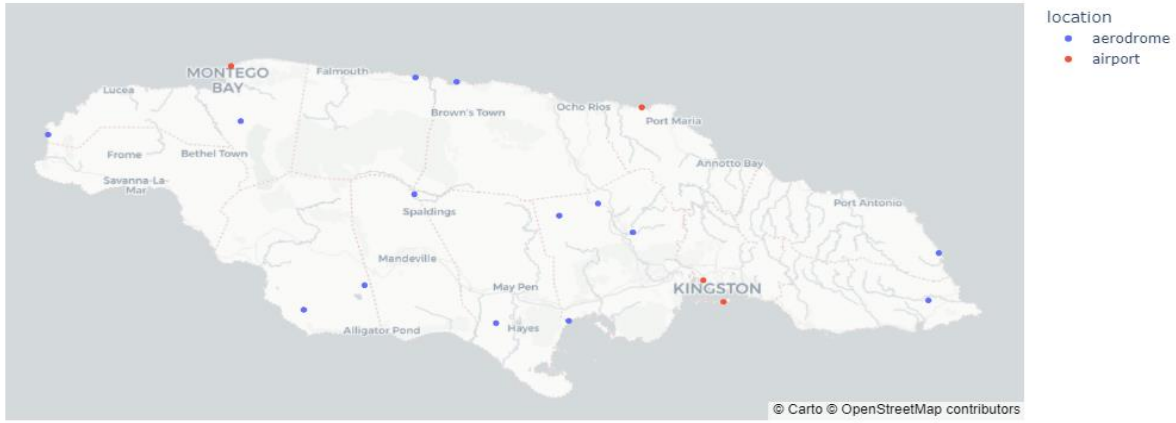
Gridded Gross Domestic Product (GDP) ...
Bangladesh detailed
Dec 31 2000
1/1
Bangladesh detailed
Gridded Gross Domestic Product (G...
1000000
20000000000
Urban Land Extent Projection
0
1
Multi-model ensemble anomaly of d...
75days
200days
Datasets: 3
BANGLADESH
MEGHALAYA
MANIPUR
ASSAM
JHARKHAND
WEST BENGAL
TR
MZ
Dhaka
Pabna
Jessore
Khulna
Chittagong
Mymensingh
Jamalpur
Rajshahi
Sylhet
Shillong
Guwahati
Dergaon
Biratnagar
Purba Muzaffarpur
Muhammadabad
Bhagalpur
Nalhati
Dhanbad
Asansol
Ranchi
Jhalida
Manbazar
Salbani
Jamshedpur
Raurkela
Kolkata
Calcutta
Diamond Harbour
Baleshwar
Cuttack
Imphal
Pinlebu
Indaw
Kawlin
Kanbalu
Aizawl
Hakha
Ye-u
Kani
Budalin
Monywa
Pauk
Taungtha
Kyauktaw
Mahlaing
Salin
Thazi
Pyawbwe
3D

Jamaica Case Study | Forward-Looking Damages

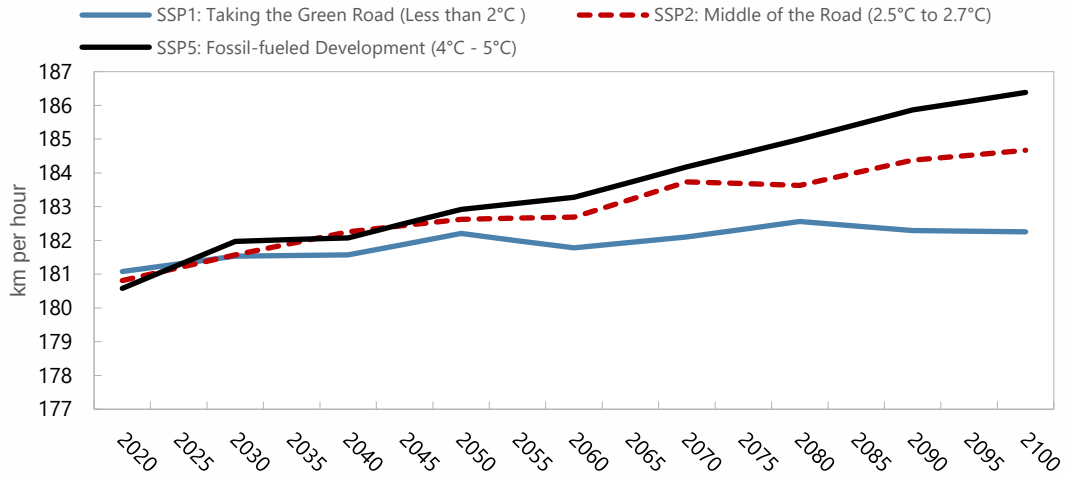
Wind speed 1-in-100 years, 2050, SSP2 RCP 4.5 (kilometers per hour)



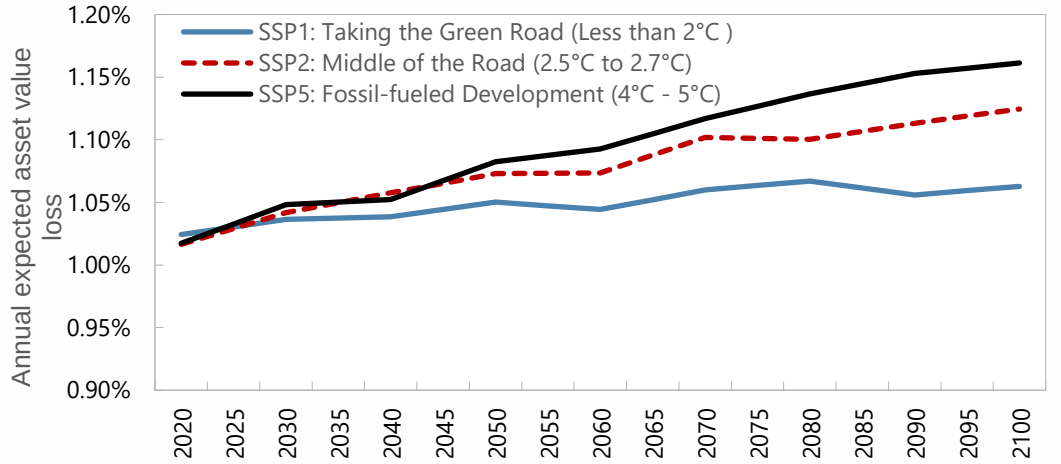
Airports' locations



Wind speed by scenario 1-in-100 year - Average of locations



Forward Looking Damage Rates Under Various Climate Scenarios – at a select location



Physical Asset Exposure to Climate Hazards | Buildings

- Some climate hazards are highly localized (e.g. floods), requiring granular geospatial data on assets:
  - Residential and commercial buildings
  - Industrial structures
  - Critical infrastructure

- Such data allow accurate analysis of climate risks to:
  - Financial systems:
    - Banking sector (mortgages)
    - Insurance sector (losses and premiums)
    - Central bank regulation and supervision
  - Government sector (revenue and spending)
  - Overall economy

Illustration: Buildings exposure to coastal flooding, historical and 2050

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

Monitoring Trade Disruptions | PORTWATCH

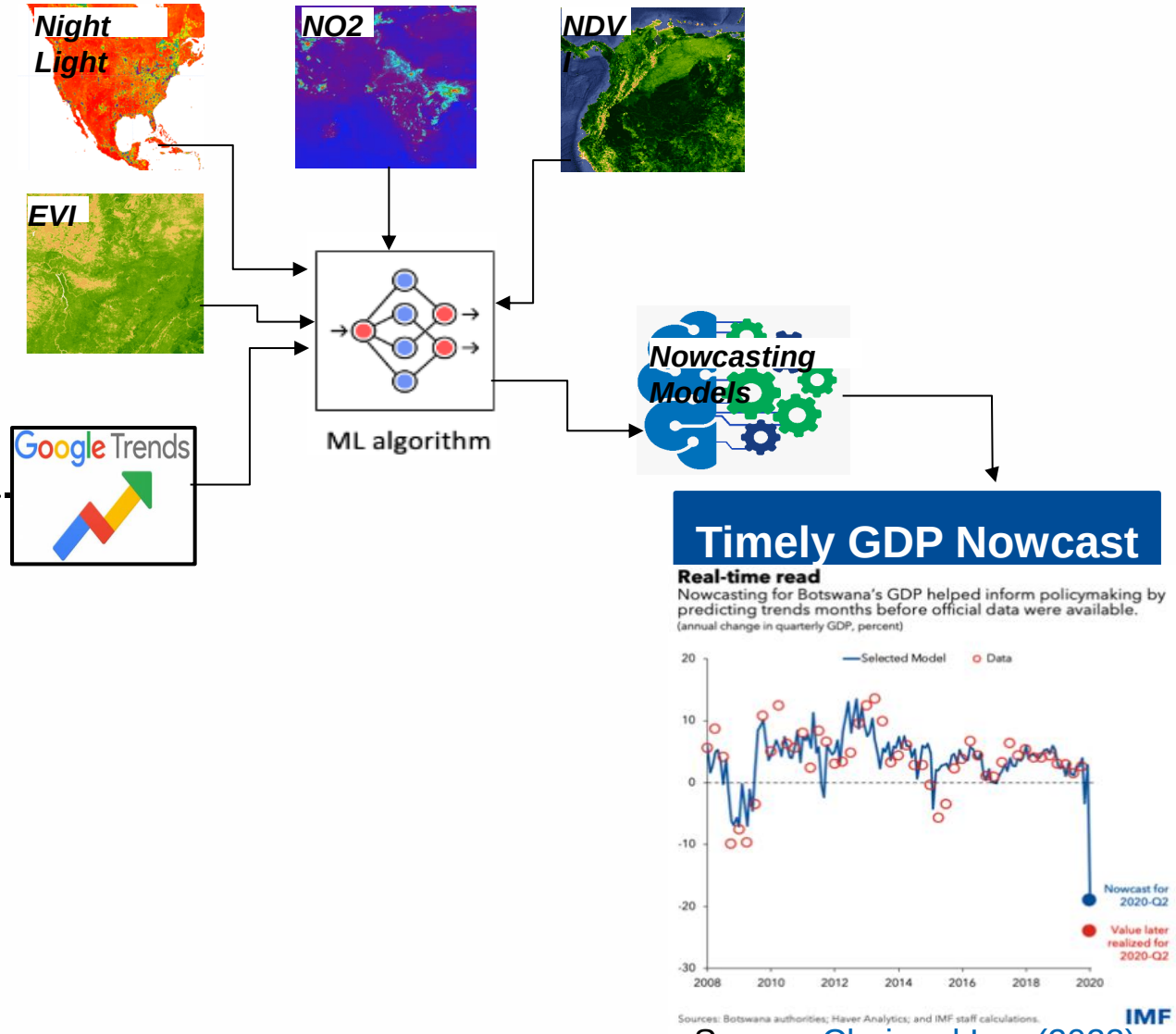
In partnership with:

- PortWatch has introduced the spillover simulator and climate scenarios tools
- It allows users to explore the risks that climate extremes pose to ports and analyzes the resulting
  - port downtime
  - infrastructure damages
  - trade spillovers
- Present data derived from real time/big data information
- Future projections based on climate scenarios until 2050 by ports are also available

Figure: 7-day disruption at the port of Singapore

Additional Geospatial Projects at the IMF | GDP Nowcasting

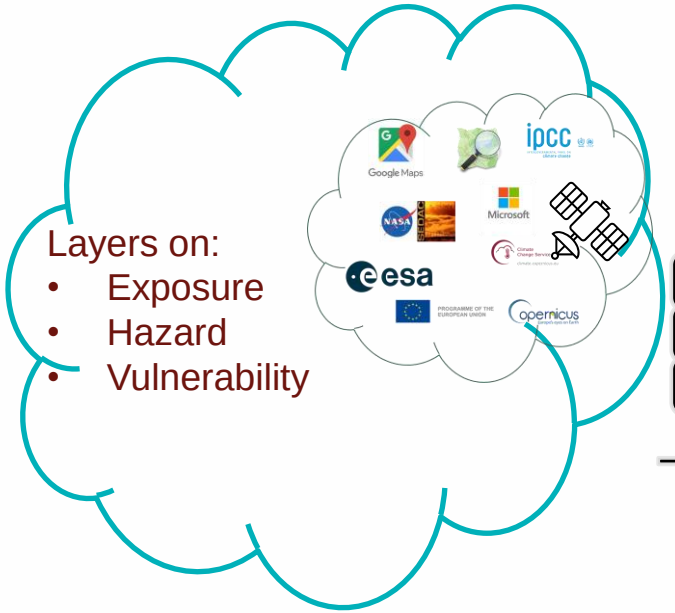
- **Data Challenges:** Many countries, particularly LICs in Africa, do not have frequent, timely, and reliable GDP data
- This information is critical for macro policy analysis, particularly in times of economic volatility (e.g. Covid)
- **Solution:** Geospatial and High Frequency Data.
- **GDP Nowcasting** has been highly effective for IMF surveillance activities.
- **IMF AFR Department** Nowcasting Hub Near Realtime GDP nowcasting for sub-Saharan African countries.
- **Examples:** Botswana, Kenya, Nigeria, Ghana.



Source: Choi and Iyer (2022).

Harnessing the Potential of Geospatial Data
Key Challenges and Next Steps

Geospatial Data



Layers on:
- Exposure
- Hazard
- Vulnerability

Challenges

- Technology
- Skills mismatch
- Lack of collaboration (local and international)
- Lack of institutional frameworks
- Communication
- Data curation

Ai

Better Policies

- Adaptation
- Mitigation
- Transition to low carbon economy
- Climate finance
- Financial stability

Thank You!

Questions?

Way Forward

- Climate is a local issue and geospatial data and tools are crucial for closing climate-related data gaps and integrate different data layers
- Financial institutions and regulators are looking to harness geospatial information to enhance integration with economic data for better decision-making
- The growing demand for geospatial solutions has driven both global and national institutions to advance efforts in this area
- However, enhanced collaboration between institutions (global and local) and the development of structured institutional frameworks are essential to maximize the potential of geospatial data
- The IMF is developing a tool that integrates multiple layers of hazard and exposure data to identify high-risk hotspots using publicly available global datasets
- Our goal is to assist countries in creating their own risk estimates, utilizing these global datasets as a starting point

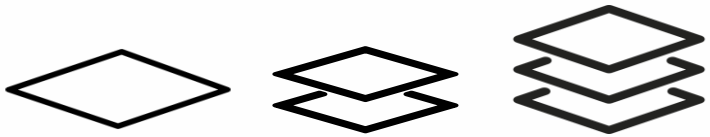
Methodological Framework: Measuring Risk using Geospatial Data

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

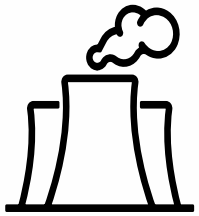
Forward-looking Physical and Transition Risk Indicators

(Preliminary Draft)

I. INTRODUCTION

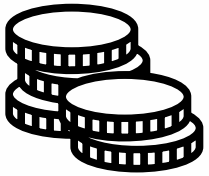
1. The new Data Gaps Initiative – DGI 3 – endorsed by the G20 Finance Ministers and Central Bank Governors in November 2022 highlighted the need for robust, comprehensive, and comparable data for the most urgent policy needs. The IMF staff, in close cooperation with the Financial Stability Board (FSB) 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.

Main Topics of CD Engagement



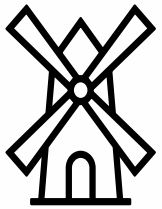
Energy, GHG Emissions and Carbon Footprints

- Air emission accounts
- Energy accounts
- Carbon footprints



Climate Finance

- Taxonomies
- Data collection
- Experimental indicators

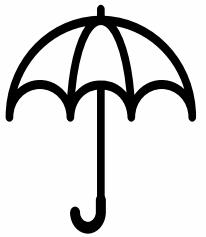


Natural Resources Accounting

- Mineral and energy resources
- Renewable energy

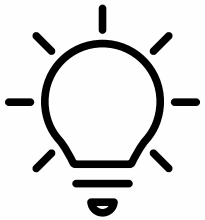
Climate Risk Data

- Physical and transition risk indicators
- Methodological framework
- Climate scenario analysis
- Tools (including geospatial tool)



Climate Mitigation and Adaptation

- Environment and climate related expenditures
- Environmental taxes
- Climate related subsidies



Emerging Areas

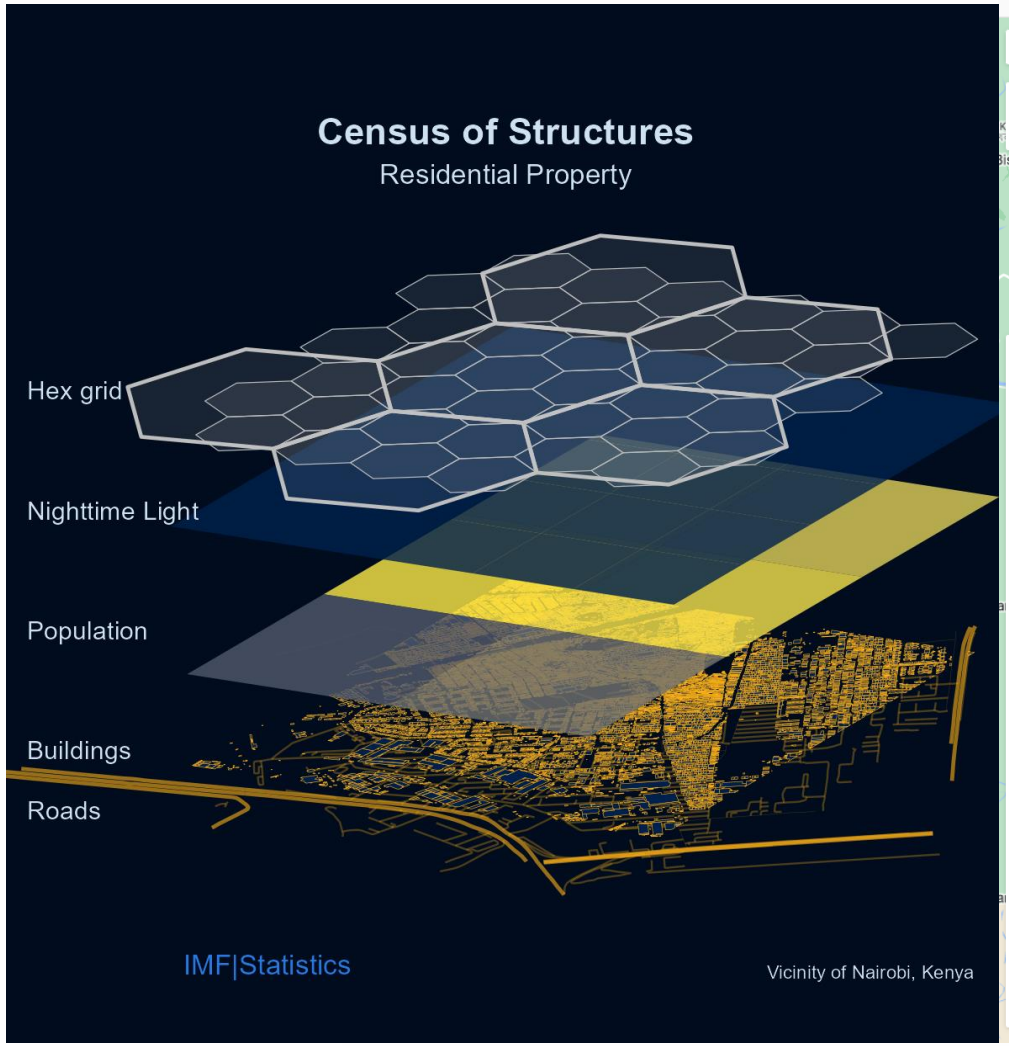
- Land cover/ Water accounts Energy/Forest/Biodiversity

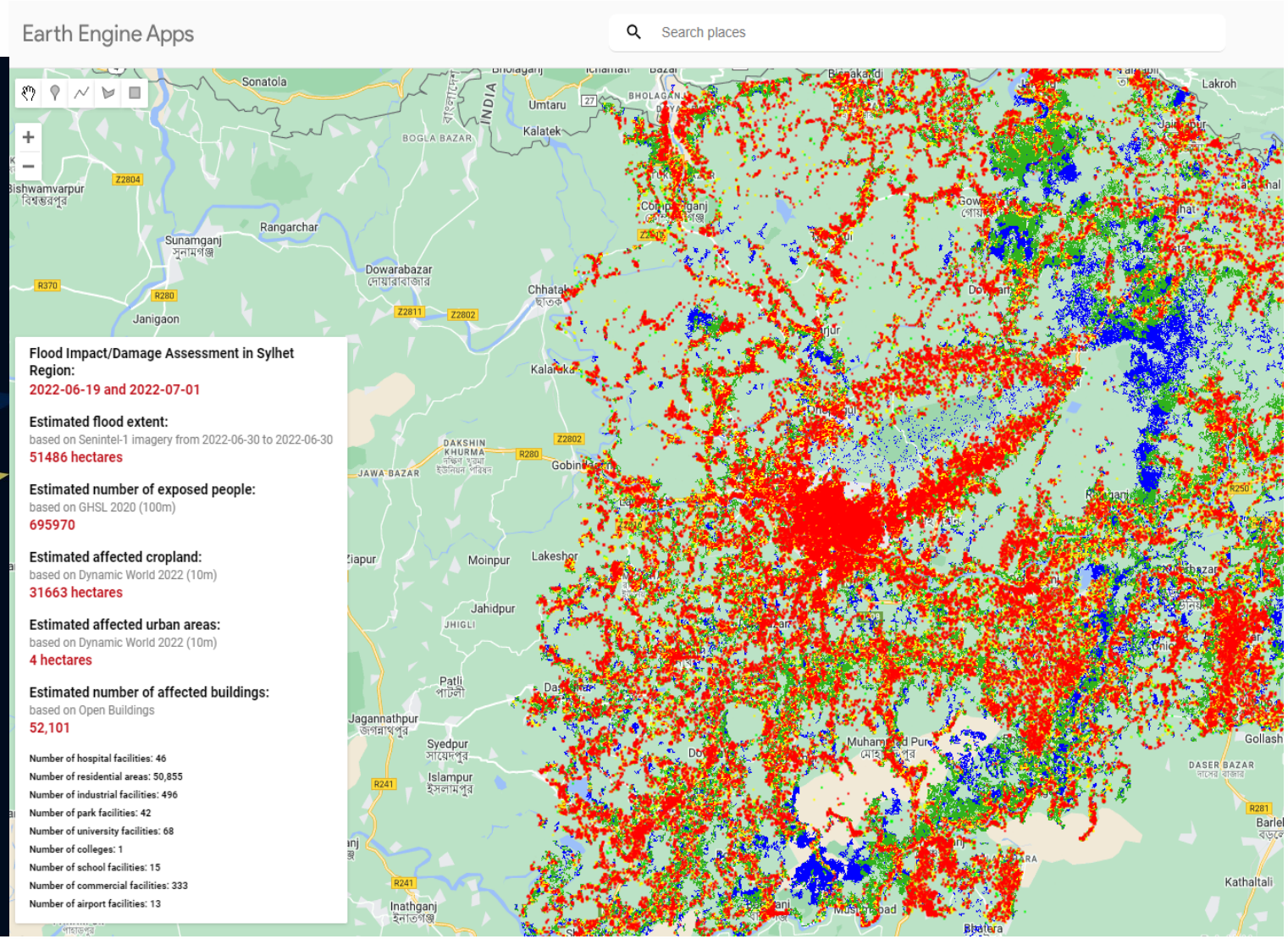
STA's Initiatives on Statistical Methodology

Data Gaps Initiative 3

International statistical standards updates

Census of Structures for climate change physical and transition risk indicators





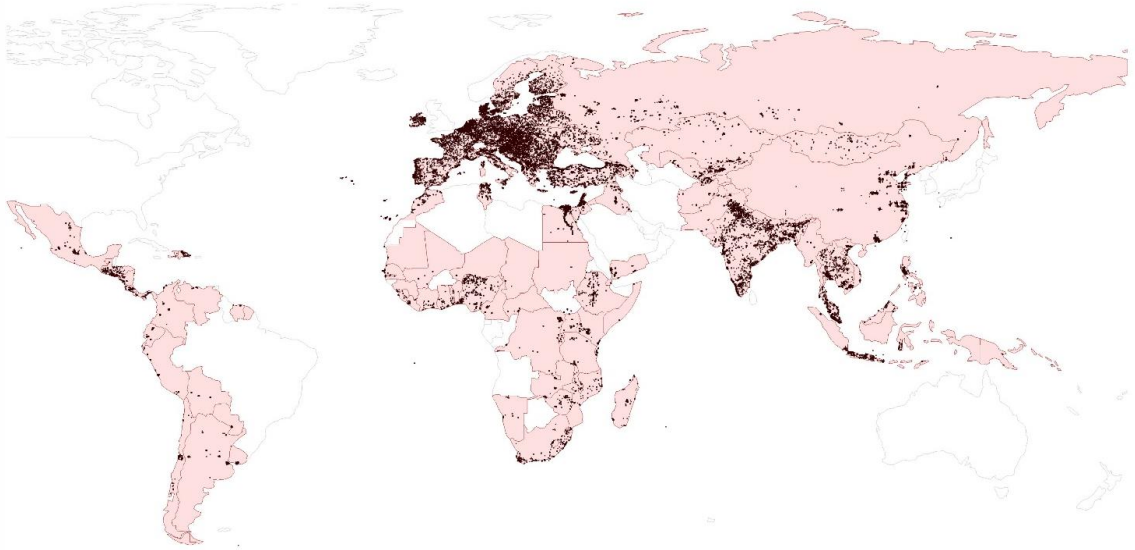
Leveraging Geospatial Data | Firms Exposure

- Climate hazards have detrimental effects on businesses across the globe:
  - Firm performance (productivity, profitability)
  - Labor market dynamics
  - Trade
  - Growth

- Transition risk also has implications for firms
  - Changes in climate policy offer both risks and opportunities
  - Financial sector implications: Carbon footprints of bank loans

- CID provides experimental forward-looking transition risk indicators

Figure: Location of businesses (Enterprise Survey)



Note: These are nationally representative firms from the Enterprise Survey of the World Bank

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 are major climate change-related risks affecting agricultural activities.
- Climate risk assessment in therefore necessitating granular geospatial data on
  - Location and size of parcels
  - Crop type
  - Agronomy
  - Irrigation, etc.

Figure: 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)

Global Datasets and Geospatial Tool

Climate Risk Indicators

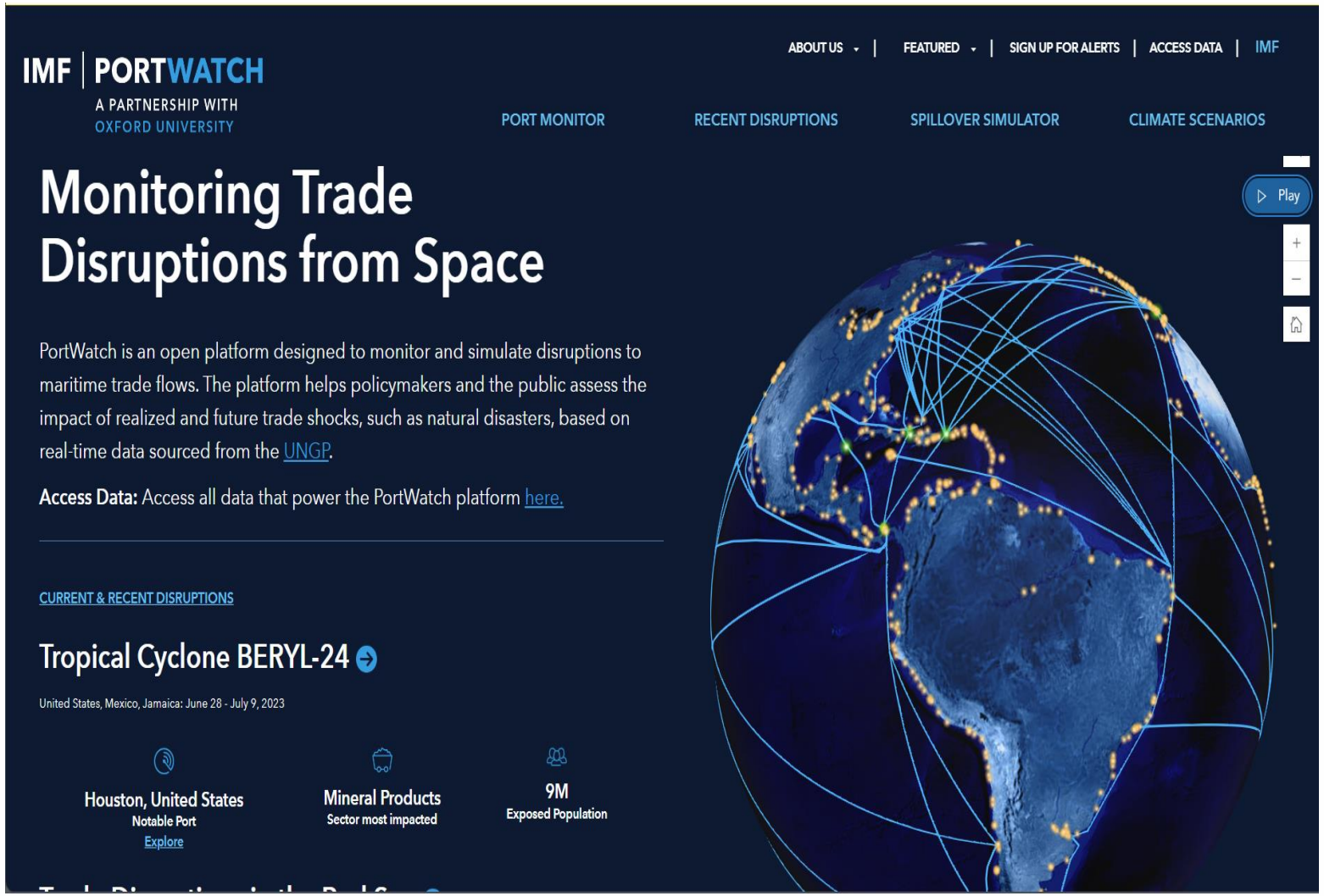
Work is in progress to develop a tool that integrates different layers on hazards and exposure to identify the hot spots for risk using global data sets

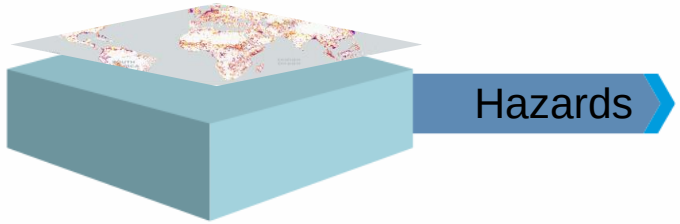
Working with many institutions to develop this information

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

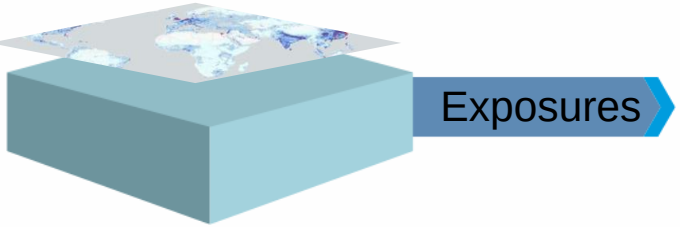
Support countries to develop its own estimates building on global data sets

Monitoring Trade Disruptions | PORTWATCH

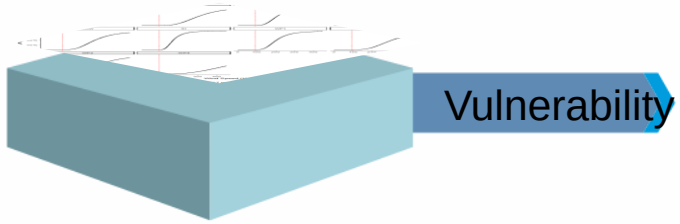




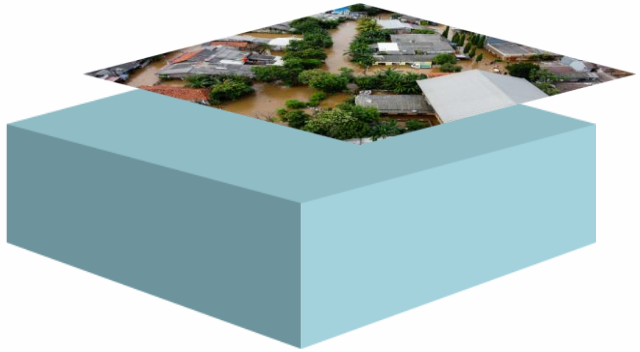
Hazards



Exposures



Vulnerability

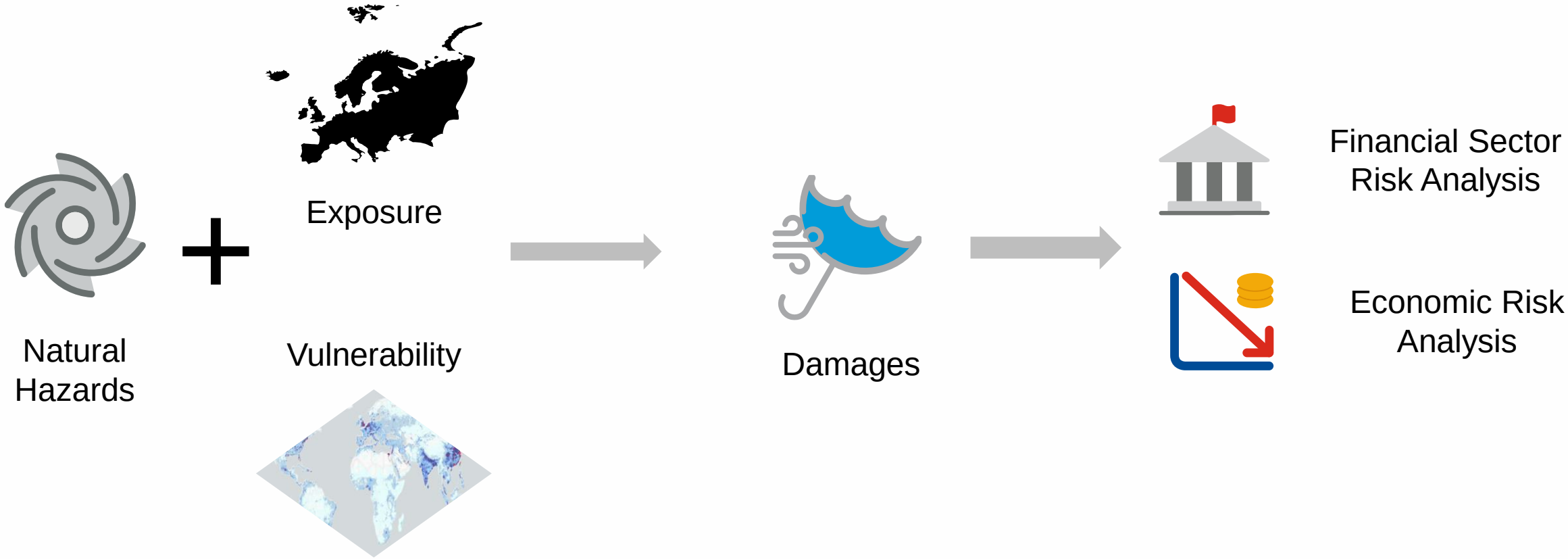


Damages

Financial Sector Risk Analysis

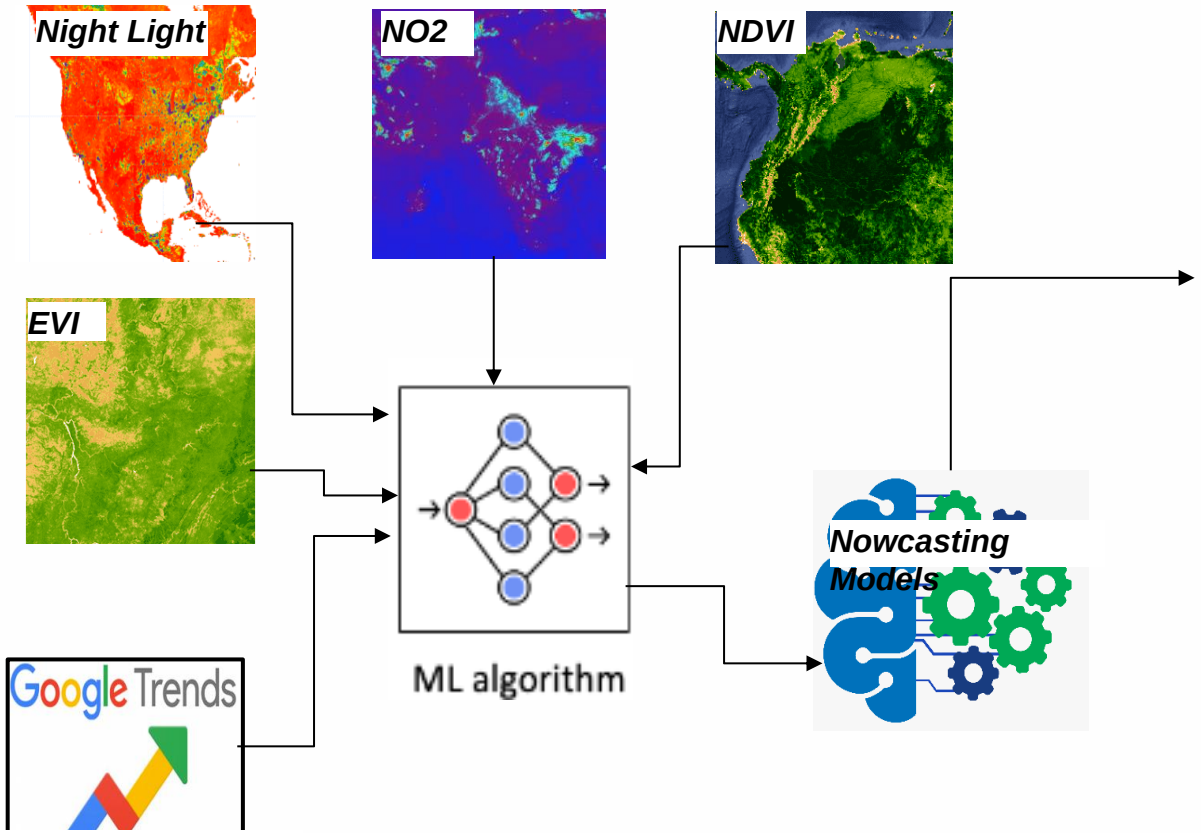
Economic Risk Analysis

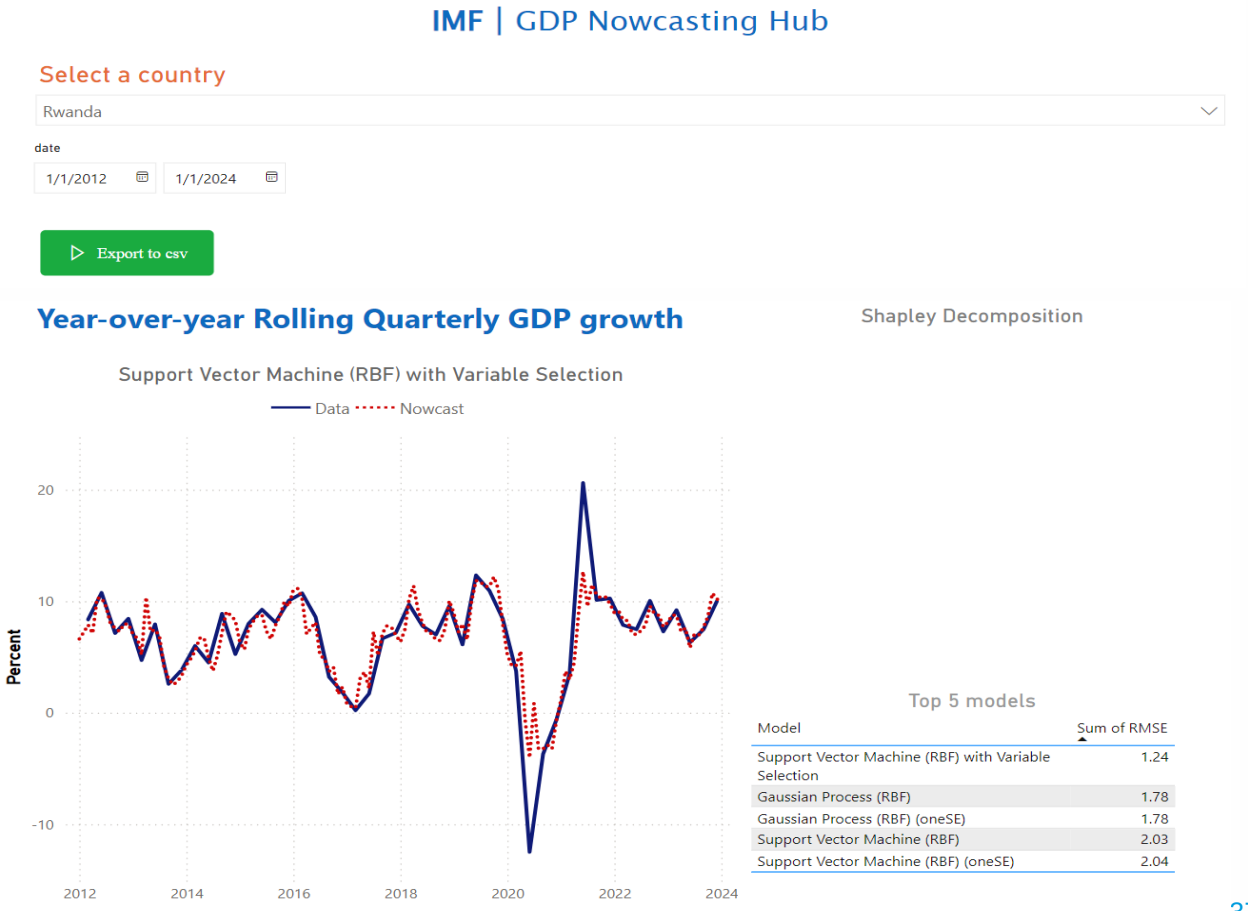
Benefits of Geospatial Data for Policy Analysis



GDP Nowcasting

- Role of geospatial data for GDP nowcasting is also critical
- This project leverages big (non-traditional) data to addresses delays in GDP data dissemination or lack of capacity to publish quarterly GDP data, enriching policy advice.





DATA TO SUPPORT A BETTER UNDERSTANDING OF FUTURE PHYSICAL RISK

Base layer

- Topographical map

Hazard layer

- Number of days per year with heat index greater than 35°C

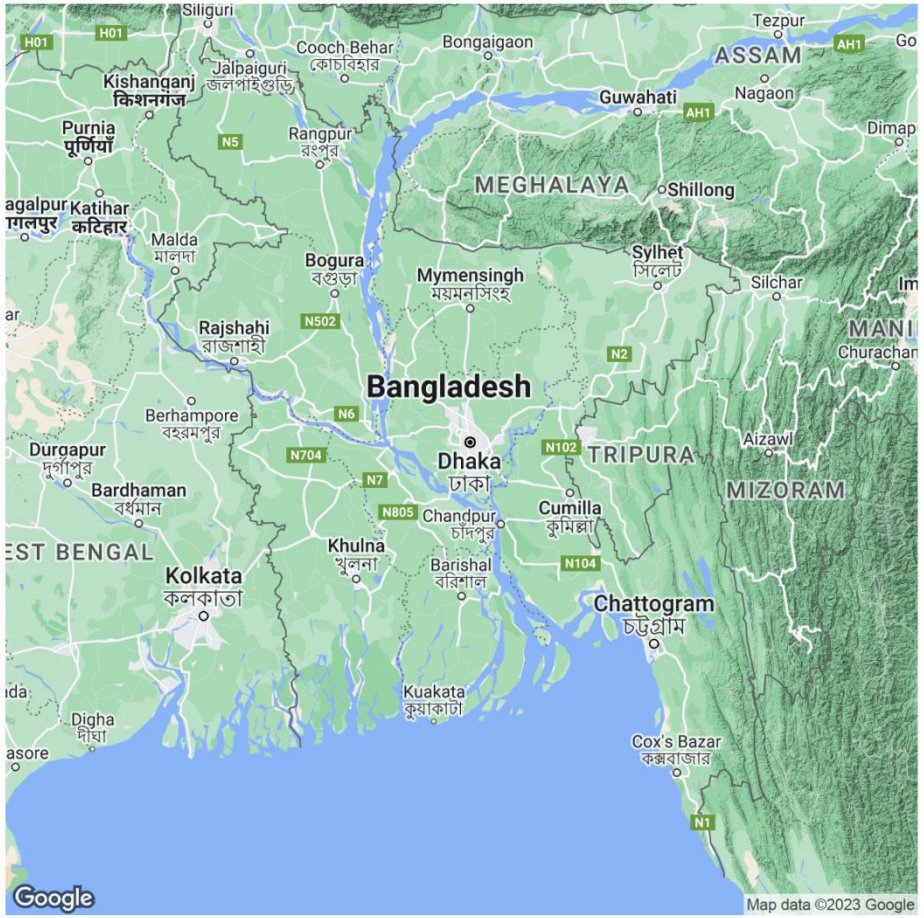
Exposure layer

- Gridded GDP

Vulnerability layer

- Damage functions – not yet

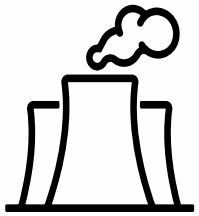
Terrain Map of Bangladesh



Sources: Google (2023), Maps Platform; and GADM (2022), version 4.1.

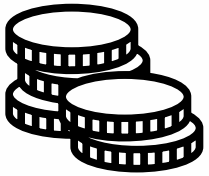
The boundaries, colors, denominations, and any other information shown on maps do not imply, on the part of the IMF, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

Main Topics of CD Engagement



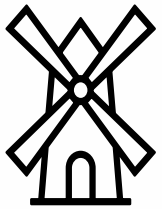
Energy, GHG Emissions and Carbon Footprints

- Air emission accounts
- Energy accounts
- Carbon footprints



Climate Finance

- Taxonomies
- Data collection
- Experimental indicators

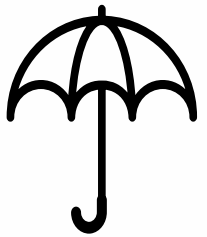


Natural Resources Accounting

- Mineral and energy resources
- Renewable energy

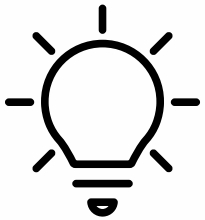
Climate Risk Data

- Physical and transition risk indicators
- Methodological framework
- Climate scenario analysis
- Tools (including geospatial tool)



Climate Mitigation and Adaptation

- Environment and climate related expenditures
- Environmental taxes
- Climate related subsidies



Emerging Areas

- Land cover/ Water accounts Energy/Forest/Biodiversity

DGI-3 Recommendation 5:
Forward-looking Physical and Transition Risk Indicators

- Monitoring risks from frequent and severe climate hazards (e.g., floods, droughts) and the impact of climate policy on populations, national wealth, and firms' stability is essential.
- These indicators help policymakers determine climate policy timing, scope, and support for climate action.

Policy Driver

- **Quantify and monitor forward-looking risks to help prioritize and develop support for climate action.**

Statistical Output

- **Forward looking physical and transition risk indicators (risk to populations, economic growth, financial markets, profits, ecosystems, etc.)**

Co-lead organizations

- **IMF**
- **BIS**
- **ECB**
- **FSB**
- **OECD**
- **World Bank**