IFC Satellite Seminar on "Granular data: new horizons and challenges for central banks"

On the need for granular, forward-looking physical risk data to support policy analysis[1]

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STATISTICS

On the need for granular, forward-looking physical risk data to support policy analysis

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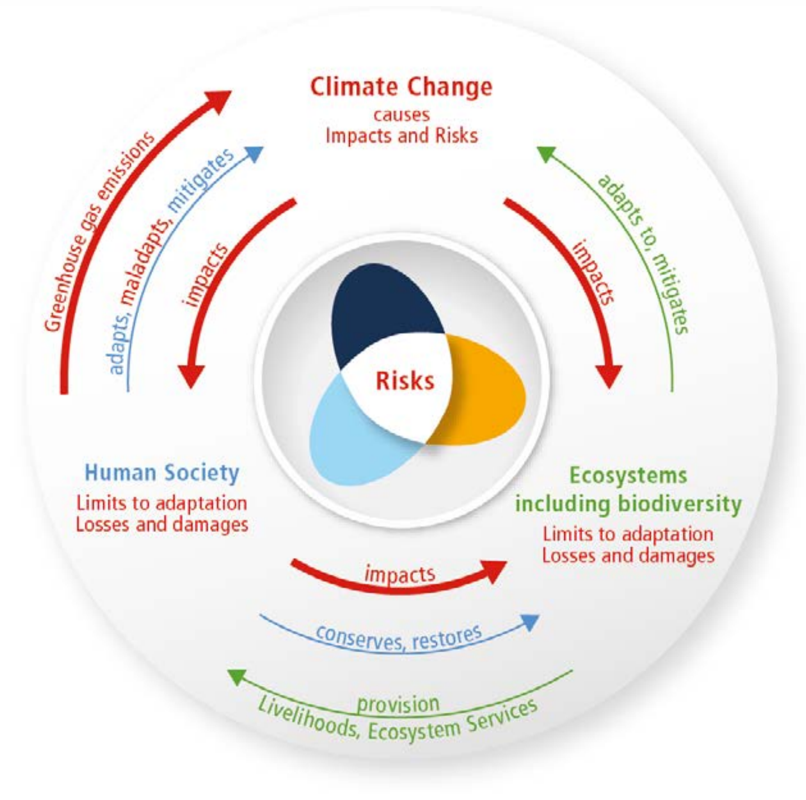
The definition of risk



Source: https://www.ipcc.ch/

- According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), ***risk* is the potential for adverse consequences**.
- In the context of **climate change *impacts***, risks result from dynamic interactions between **climate-related hazards with the exposure and vulnerability to the hazards** (~ "physical risk").
  - **Hazard:** The potential occurrence of a physical event or trend.
  - **Exposure:** The presence in places and settings that could be adversely affected.
  - **Vulnerability:** The propensity or predisposition to be adversely affected.

The definition of risk (cont'd)

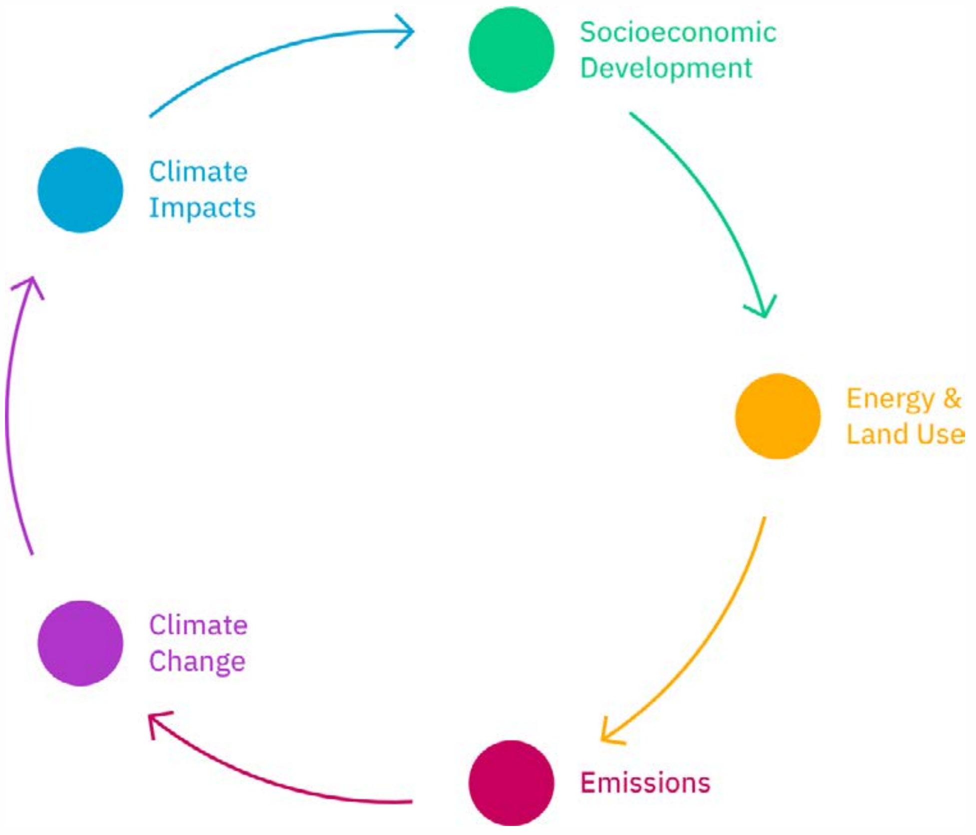
- The revised **definition of risk clarifies and refines** previous definitions.
  - The "core" definition of *risk* is **"the *potential* for adverse consequences" – not to describe physical hazards** (not "the risk *of* …").
  - Risk should be used where **potential adverse consequences and the uncertainty** relating to those consequences are explicitly considered.
  - And to improve the ability for decision-makers to **understand and manage risk**.

- <u>Example</u>: The **risk from flooding** to human and ecological systems is caused by
  - the flood **hazard** – the frequency and/or magnitude of flood events,
  - the **exposure** of the system affected – e.g., topography, or infrastructure in the area potentially affected by flooding –, and
  - the **vulnerability** of the system – e.g., design and maintenance of infrastructure, existence of early warning systems.

Physical risk

- In much of the business and financial literature, the term “physical risk” relates to those derived from the **hazard × exposure × vulnerability framework**.
- ***Physical* risks** affect the economy in two ways.
  - **Acute impacts** from extreme weather events can lead to business disruption and damages to property.
  - There is some evidence that with increased warming they could also lead to persistent longer-term impacts on the economy.
  - These events can increase underwriting risks for insurers, possibly leading to lower insurance coverage in some regions, and impair asset values.
  - **Chronic impacts**, particularly from increased temperatures, sea levels rise, and precipitation, may affect labor, capital, land, and natural capital in specific areas.
  - These changes will require a significant level of investment and adaptation from companies, households and governments

What are climate change scenarios?



Source: https://climatescenarios.org/primer

- Climate change scenarios are not about predicting the future, but come in the form of **projections of what can happen or pathways of how to reach certain goals**.
- **Socioeconomics and climate change are inseparably intertwined.**
  - Socioeconomics define for example our land and energy needs,
  - which are closely linked to emissions.
  - Increased emissions lead to higher GHG concentrations,
  - which leads to climate change and its impacts.
  - Climate impacts close the cycle as they will also influence our socioeconomics.

Extreme events

- With an increase in global mean temperatures, extreme events like droughts, floods, and heatwaves become **more frequent and severe**.
- Under climate change, e.g., the **mean temperature rises**, and the **distribution shifts to higher temperatures**. Hot days that have been rare in the past occur now more frequently and reach even higher temperatures.
- Additionally, the **variance increases**. Formerly average temperature become less frequent, and the distribution spreads out. Hot temperatures become even more frequent and extreme. Cold days still occur but become rarer.
- Thresholds of what constitutes an extreme event can be defined **relative to the preindustrial climate**. This allows examining changes under temperatures that already occur today, as well as a glimpse at future global warming levels.
- **Uncertainties** across climate and impact models originate from various stages in the modelling chain. Still, the overall picture remains clear: the world is **(already) increasingly exposed to extreme events**.

Climate scenario analysis

- The distinct nature of climate risks poses a challenge to **standard risk assessment approaches**.
  - Climate risks have **long time horizons with high uncertainty** about how policy and socioeconomic factors might evolve;
  - they are **global and economy-wide** in nature; and
  - they are complex, **varying from region to region and sector to sector**.
- These **distinct characteristics are not captured** by risk assessment approaches that rely on top-down modeling and historical trends, are narrowly focused, and assume the structure of the economy and financial system remain unchanged.
- **Scenario analysis** is an essential tool to overcome these challenges. It provides a flexible **“what-if” framework** for exploring how the risks may evolve in the future.
- These scenarios can help a wide range of players better understand how climate factors will **drive changes in the economy and financial system**.

Data needs and data sources

- **"Zero" layer:** Geographic resolution, e.g., topographical map with elevation.
- **Hazard layer:** Geospatial data for different climate-related hazards, e.g., temperature, precipitation, or drought; different metrics for each hazard (e.g., return periods) and uncertainty measures (e.g., confidence intervals).
- **Exposure layer:** Gridded data on population (urban and rural), GDP/capital stock, and infrastructure (real properties and agricultural land).
  - **Grids often coarse**, e.g., 5 arcminutes equal 9.277 km at the equator; global average area of a grid cell is about 55 km^2 (21 mi^2).
- Also, **geospatial data** on banks' loans and investments, firms' and households' balance sheets, and insurance exposure and (un)insurability.
- **Vulnerability layer:** Hazard-specific damage functions, linking the intensity of individual hazards to economic damages.

➢ Need for **public, global, geospatial, forward-looking data and tools**.

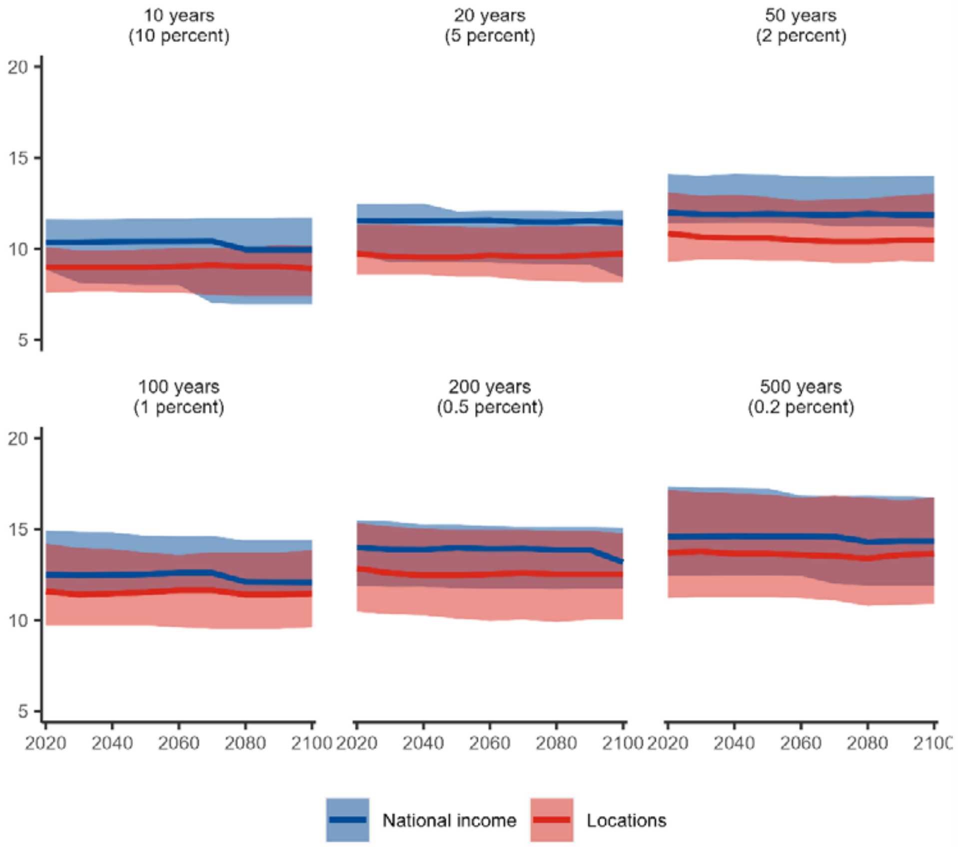
Data needs and data sources (cont'd)

- **"Zero" layer:** Google Maps API and GADM shapefile.
- **Hazard layer:** Jupiter Intelligence (vendor data).
  - **Geographical coverage:** 100,000 geospatial locations, covering 97 percent of global GDP (at 15 arcmin resolution) – **example: Canada, Ottawa**.
  - **Hazards:** inland and coastal flooding, high winds, extreme heat, drought, hail, wildfires, precipitation, and extreme cold – **example: flood depth at 200-year return period** (0.5 percent annual exceedance probability).
  - **Emissions scenarios:** "low" (SSP1-2.6), "intermediate" (SSP2-4.5), and "very high" (SSP5-8.5) – **example: SSP2-4.5**.
  - **Years:** 2020 to 2100 in five-year increments, and a historical baseline (1986–2005) – **example: 2050**.
- **Exposure layer:** Socioeconomics compatible with the Shared Socioeconomic Pathways (at 5 arcmin resolution) – **example: gridded GDP** from Murakami et al.
- **Vulnerability layer:** None (yet). ☹

Digression on macro indicators

Canada's Susceptibility to Floods at Different Return Periods

Percent, SSP2-4.5



Sources: Jupiter Intelligence ClimateScore Global; and IMF staff calculations.
Note: Median and intervigintile range shown. Annual exceedance probability in parentheses.

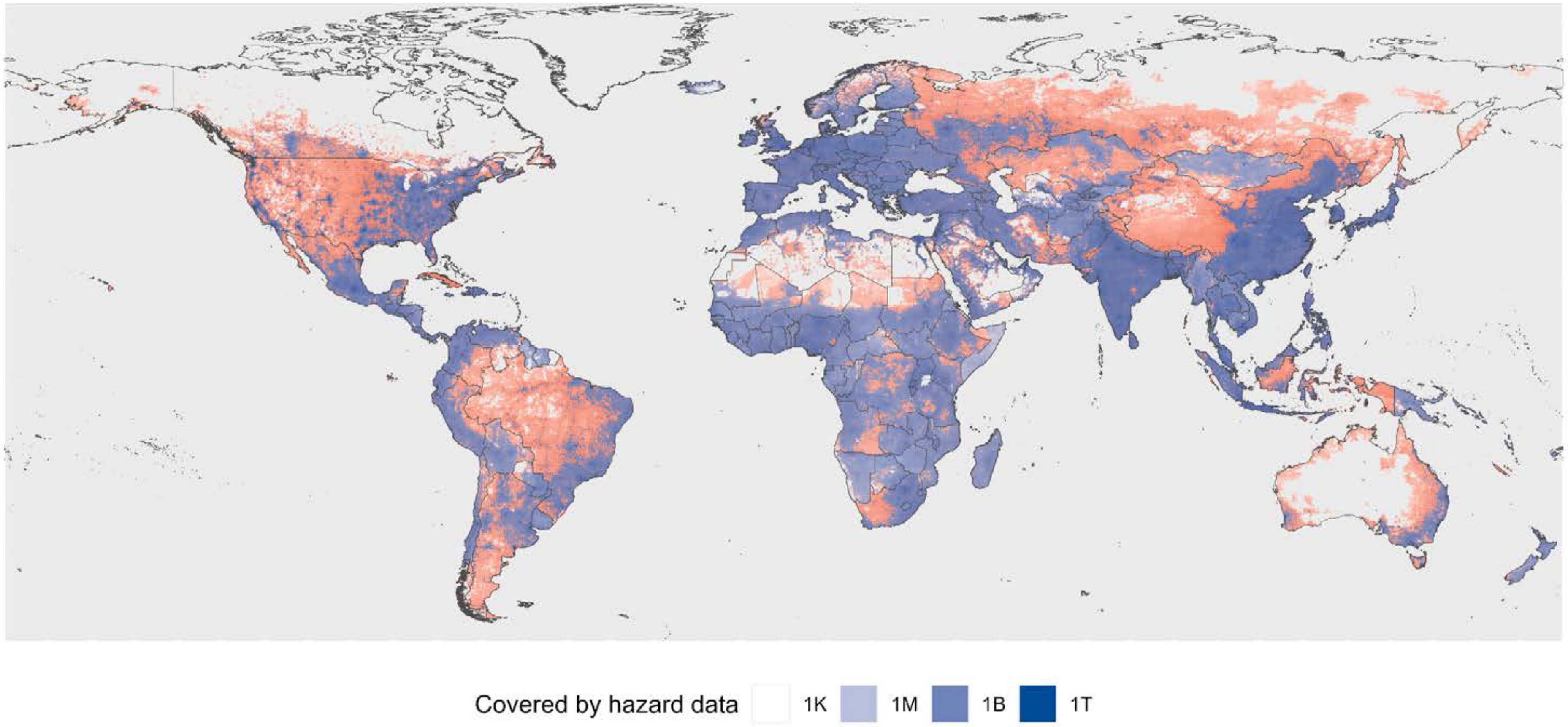
- Obviously, the **potential impact of a rarer event would be larger**, but that is more of a level than a climate change effect.
- **Susceptibility** – not necessarily equal to risk(!) – **increases in all scenarios** but more so for higher emissions scenarios.
- While **Canada's GDP exposure tends to fall over time**, this is not the case for the (fixed) locations.
- This is hence due to **GDP moving away from more hazardous areas** – this is not possible in all regions or countries though.

➢ More details in IFC-sponsored **IPS 205 – Sustainable finance statistics**, Wednesday 2 pm, room 213.

GDP exposure and hazard(s) data

Gridded GDP and Hazard Data

SSP2-4.5, 2050

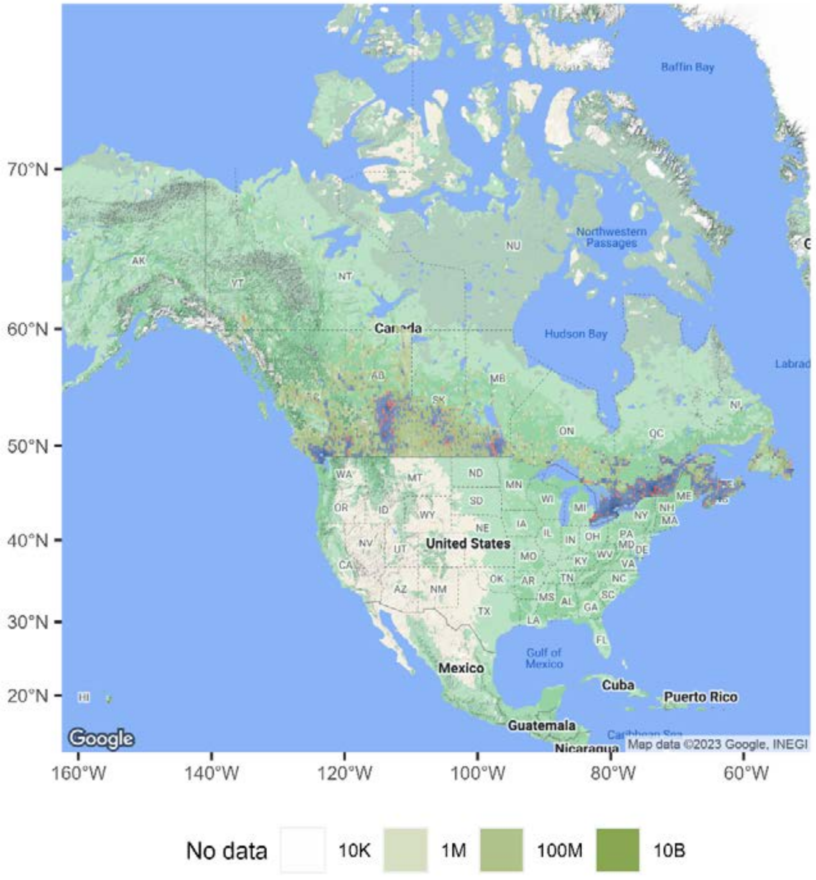


Sources: Jupiter Intelligence ClimateScore Global; and IMF staff calculations.

Flood hazard and GDP exposure

National Income Susceptible to a 200-Year Flood

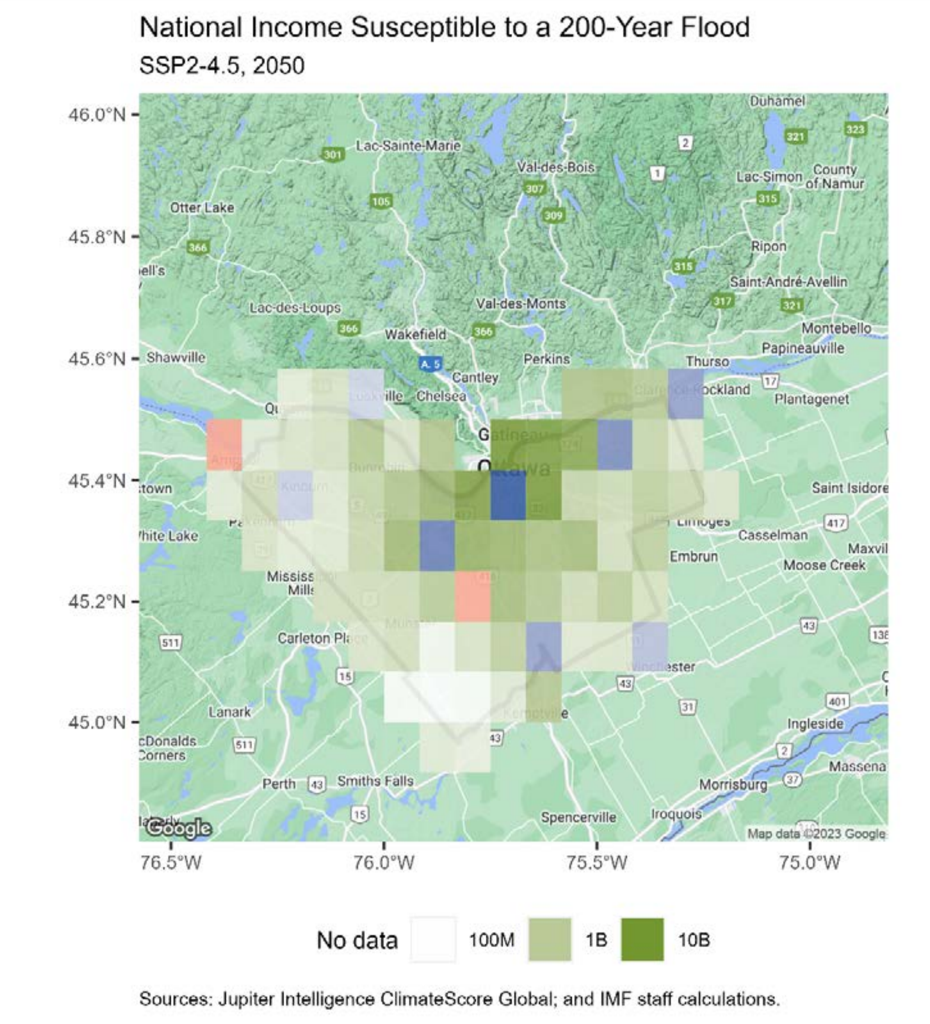
SSP2-4.5, 2050



Sources: Jupiter Intelligence ClimateScore Global; and IMF staff calculations.

- A **grid cell** can be
  - **not susceptible** to floods at a 200-year return period in 2050 under SSP2-4.5;
  - **susceptible** to floods; or
  - **not covered** by the hazard data.
- The **hazard data are geospatial observations (places on a map)**, and are assumed representative for the grid cell they are contained in.
- The **GDP coverage for Canada** (at 15 arcmin resolution) **is 94 percent**.
- The **aggregate susceptibility**, as shown on the slide before, is **14 percent for GDP** in 2050 under SSP2 and **12 percent for the (fixed) locations**.

Flood hazard and GDP exposure (cont'd)



- The variation in the distribution of hazards **within a region or country** matters.
- However, the coverage of the 100,000 locations the IMF secured access to is **somewhat limited at a granular resolution** (not only for cities, also for small islands states, for example).
- For Ottawa, **only 1 percent of GDP** would be susceptible to floods.
- But the point in the hazard data set closest to the Bank of Canada is about 1.5 km south-southeast – and thus also **not in the same proximity to the Ottawa River**.
- Yet, the **grid cell represented by this one observation** accounts for almost 12 percent of the city's GDP.

Discussion

- Need for **public, global, geospatial, forward-looking physical risk data** to support policy analysis.
  - Requires **bias correction and statistical downscaling** – see e.g., World Bank Climate Change Knowledge Portal: https://climateknowledgeportal.worldbank.org/
- Need for **interactive tools** to make geospatial data (more) accessible.
  - **Dynamic data visualization**, e.g., zoom in/out, and add/remove layers; and
  - **Aggregation across layers**, e.g., filter by area of interest, and combine hazards and exposures.
- There is a wide range of **existing data sets and resources** (including open-source data sets, tools, and models, along with methods to improve data granularity), and it is important to identify which ones can be used to best support the climate risk assessment.
- A **country-specific approach** that is tailored to the needs and objectives identified by local stakeholders should be adopted, **factoring in the country's specificities and (data) constraints**.