

# ***Physical risk and resilience: using open-source to bring the system in-house***

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BNP Paribas, OS-Climate *physrisk* project



Fintech  
Open Source  
Foundation



# OS-Climate “physrisk” (what is it; what is it not?)

A co-operative to create the pre-competitive building blocks for physical climate risk models

- OS-Climate physrisk project is a **co-operative** to develop the building blocks of physical (climate and nature) risk models.
- A Bank’s view: “We do not want a vendor selling public-domain data back to us”.
  - [“But we don’t mind paying for core IP”]
- It is not a vendor solution but intended for those who want to run/host their own tool.
  - some members have built a vendor solution;
  - others are using it as basis for an in-house risk platform.
- It does not use purely public-domain data:
  - major aim is to facilitate combining public-domain and commercial data;
  - *with targeted use of commercial data, possible to match best-in-class commercial solutions without black-box / model-risk problem.*

# Physical climate risk

## Introduction to the modelling approach

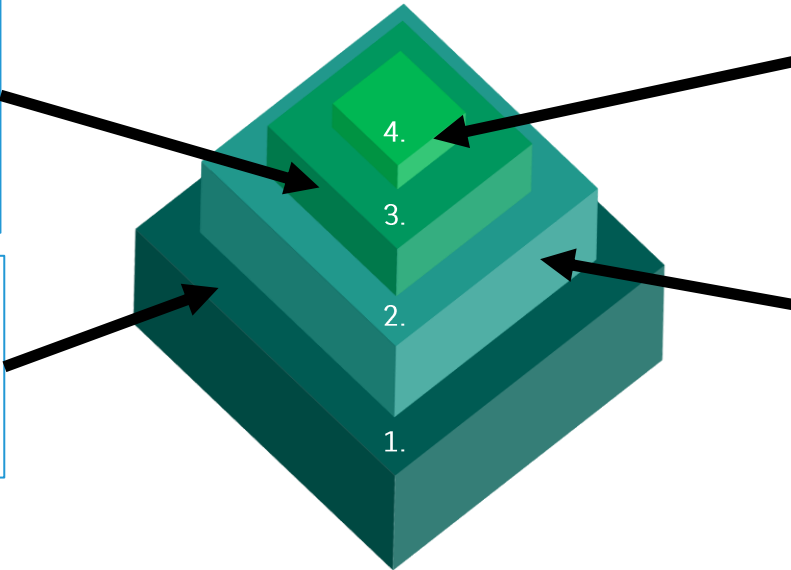
### EBA Definition <sup>(1)</sup>

“The **risks of any negative financial impact** on the institution stemming from the current or prospective impacts of the physical effects of environmental factors on its counterparties or invested assets. They include i) **acute physical effects**, which arise from particular events, especially weather-related events such as storms, floods, fires or heatwaves or other environmental hazards that may damage production facilities and disrupt value chains; and ii) **chronic physical effects**, which arise from longer-term trends, such as temperature changes, rising sea levels, reduced water availability, biodiversity loss and changes in land and soil productivity.”

<sup>(1)</sup> *Management & Supervision of ESG Risks* (European Banking Authority, June 2021)

**3. Vulnerability:** a measure of assets' **susceptibility to the risk hazards' impact** in the given location (in terms of physical damage or operational disruption); where data allows, this should consider physical defences (e.g. flood walls) and adaptation / resilience measures (A&R).

**1. Physical Hazards:** **intensity and frequency of physical climate risk events** (e.g. flood) per geographical location, for a given time horizon (e.g. 2050) and in a given climate scenario (e.g. SSP585).

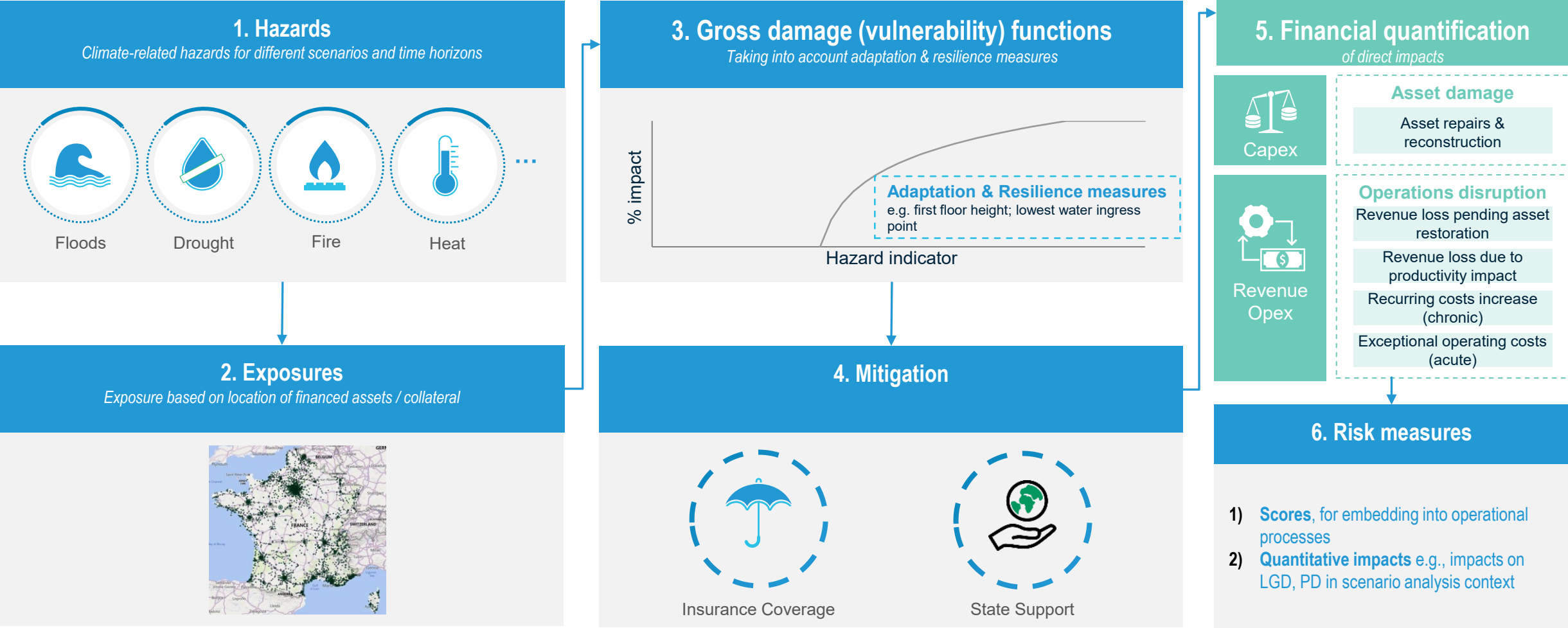


**4. Mitigation:** information about (i) **insurance designed to mitigate financial risks** associated with climate hazards providing liquidity for repair, reconstruction or compensation for revenue loss after an event ; (ii) **public support mechanisms**.

**2. Gross exposure:** a given counterparty will be exposed through the **location of its operational assets** and their **criticality** (direct exposure), but also through its **value chain** or **dependencies on infrastructure** (indirect exposure).

# Physical climate risk

## Introduction to modelling approach



# Model risk

Physical risk is especially prone to model risk / the 'black-box issue'

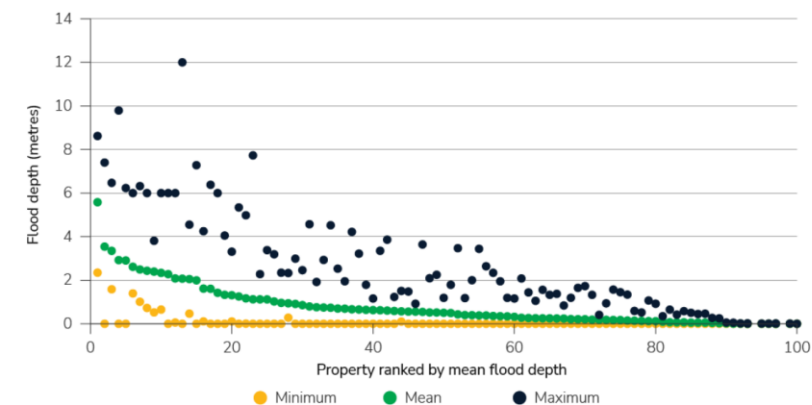
- **The risk of making incorrect decisions** based on a model – perhaps because the model is wrong, or because its limitations are not well-understood.
- A 2025 GARP analysis found 'significant variation in both hazard and damage estimates across vendors'. What to conclude from this?
  - 1) Need for establishment of 'good practices' (role for e.g. European Banking Federation);
  - 2) Reduce reliance on black-boxes wherever possible: use open-source data; favour building blocks over end-to-end system.

## Findings: Dispersion and Drivers of Variation

### Wide Dispersion in Vendor Estimates

The study found significant variation in both hazard and damage estimates across vendors. These variations highlight that even when vendors assess identical properties under the same scenario, methodological choices drive substantial dispersion. For instance, a property could be assessed as highly exposed to flooding by one vendor and not at all by another (Figure 1).

Figure 1: Defended Flooding Depths Across Properties For a one-in-200 year flood in 2030



As Figure 2 illustrates, there was also considerable variation in the damage ratios calculated for these properties.

[Comparing Climate Risk Vendors: A User's Guide to Physical Risk Assessments](#)

# Physical climate risk

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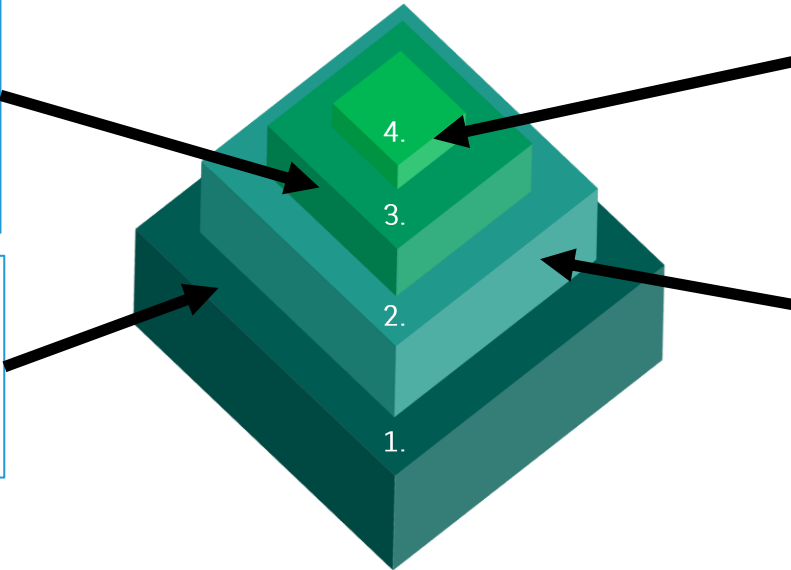
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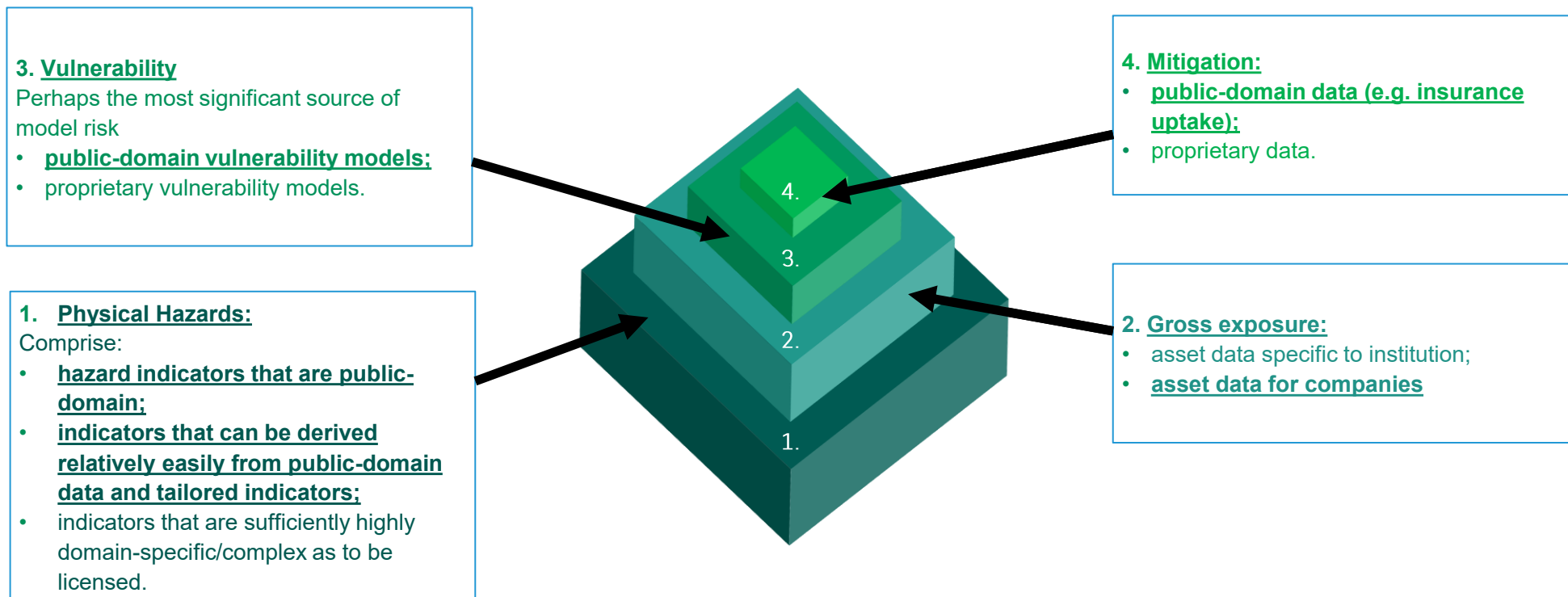


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# Where open-source plays a part

What to pay for; what not to pay for; what to own

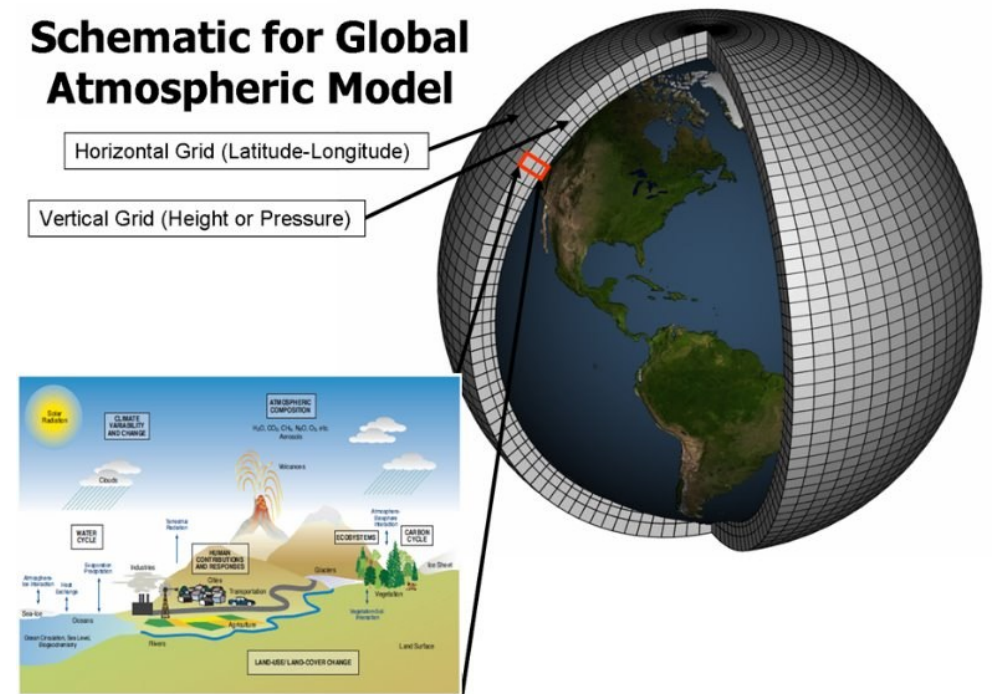


# Physical climate risk concepts

Forward-looking modelling relies on Global Climate Models (or regional counterparts)

- Global Climate Model (GCM): mathematical representation of the major climate system components (atmosphere, land surface, ocean, and sea ice), and their interactions.
- ‘CMIP’ (Coupled Model Intercomparison Project) provides runs of ensembles of Global Climate Models.
- CMIP6 – 48 scientific institutions from 26 countries; participating institutions around the world (e.g. CNRM, Institute Pierre-Simon Laplace, France; UK Met Office Hadley Centre; NOAA; Institute of Atmospheric Physics, Chinese Academy of Sciences; AEMET, Spain; BSC, Spain).
- *CORDEX stands for the Coordinated Regional climate Downscaling Experiment:* advance and coordinate the science and application of regional climate downscaling through global partnerships. For Europe CORDEX is organized into EURO-CORDEX (<https://euro-cordex.net/>) and Med-CORDEX (<https://www.medcordex.eu/>).

## Schematic for Global Atmospheric Model



NOAA illustration

# Hazard modelling: a 'bank-like' configuration

A combination of public domain and commercial data can give a solution similar to the best commercial offerings

Hazard	License <sup>(1)</sup>	Indicator(s)	Resolution	Coverage
Drought (excl. shrink-swell)	P	Days per year with SPEI 3m/12m < X	25 km	Global
Fire	BC	Probability of occurrence	50 m	Global
Flood: coastal	C + P	Flood depths for return periods (10, 20, ..., 1500 years)	30 m	Global
Flood: pluvial	C	Flood depths for return periods (10, 20, ..., 1500 years)	5 m / 30 m	Global
Flood: riverine	C	Flood depths for return periods (10, 20, ..., 1500 years)	5 m / 30 m	Global
Hail	P	Days per year of 'large hail'	25 km	Global
Heat	P	Various, e.g. days per year with WBGT > X °C	25 km	Global
Precipitation	P	Max. daily water-equivalent precipitation	25 km	Global
Shrink-swell subsidence	BC	Probability of occurrence	100 m	Europe
Water stress	P	Various (Aqueduct, WRI)	Catchment	Global
Water temperature	P	Days per year with temperature > X °C	10 km	Global
Wind – extratropical cyclone	P	Max. sustained wind speed for return periods (10, 20, ..., 1500 years)	10 km	Europe
Wind – tropical cyclone	P	Max. sustained wind speed for return periods (10, 20, ..., 1500 years)	10 km	Global



Illustration: Days with wet bulb globe temperature above 20 °C (chronic productivity models); internally developed from CMIP6 data

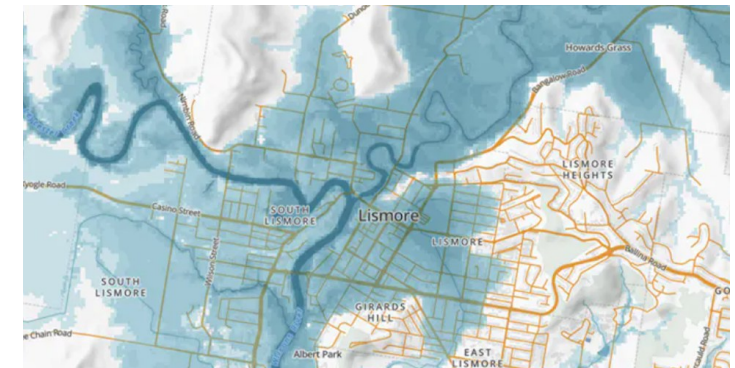


Illustration: JBA Risk management commercial data

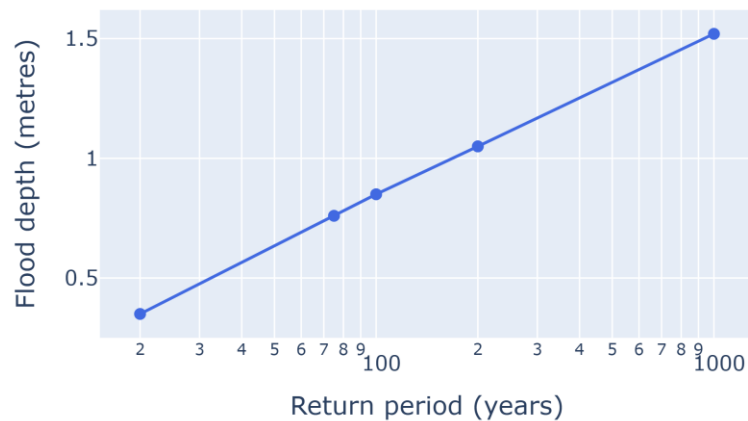
Note commercial vendors are just examples for illustration; we are aware of multiple vendors providing high resolution, high quality data.

# Model risk revisited

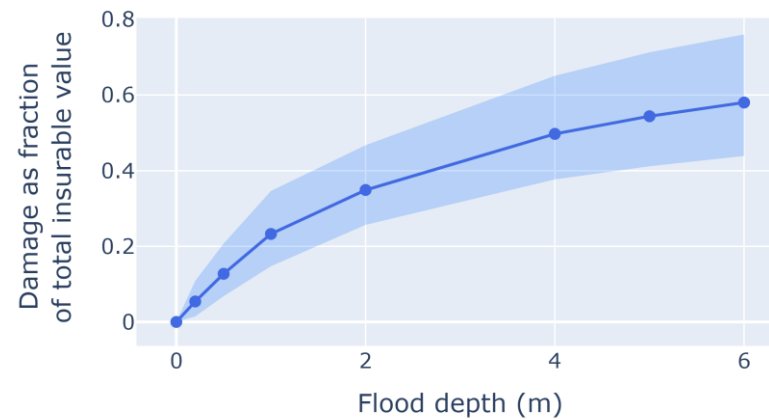
Primary and secondary uncertainties are both highly material

- Hazard indicators for acute risks (frequency/severity) are return-period/exceedance probability-based.
- Other important cases are simple probability of occurrence and threshold-based approaches.
- A deeper look at acute risks:
  - Primary uncertainty from hazard model – return-period-based or event-based
  - Secondary uncertainty from vulnerability model
- Aleatory and epistemic uncertainty

**Primary uncertainty**  
(from asset location/footprint)



**Secondary uncertainty**  
(from asset characteristics)



=> Impact (for given year, scenario)



# Status and road-map

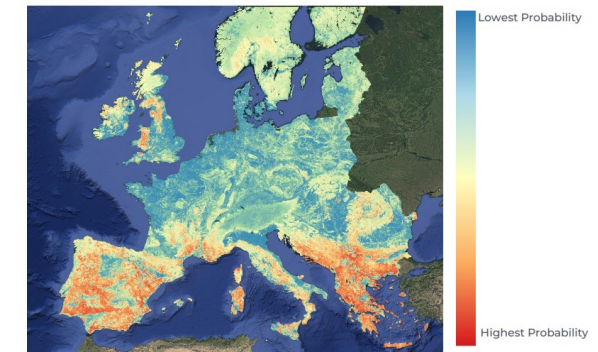
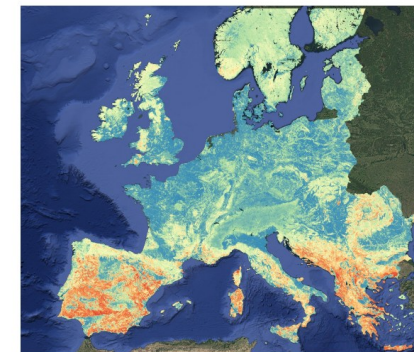
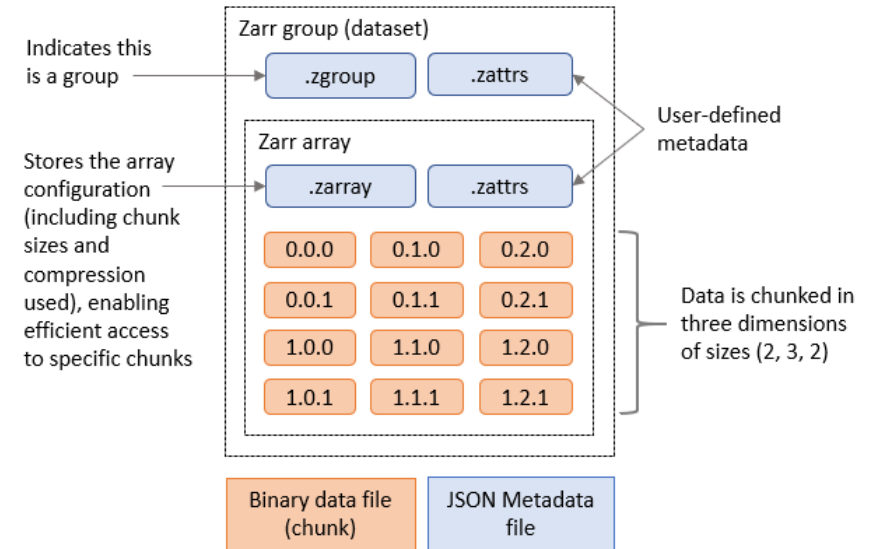
Focus of 2026 is on end-to-end financial calculations at company-level

- Low-hanging fruit use-cases such as real estate portfolios are a good starting point for new users / exploratory purposes
  - can start with all open-source data,
  - as needed switch in commercial data,
  - or leverage high-quality local models if desirable.
- Focus for 2026:
  - company-level risk: defining a standard approach;
  - higher granularity of vulnerability models (e.g. leveraging USACE resources);
  - *improve documentation, walk-throughs*, including link to commercial data;
  - work with professional bodies such as EBF.

# Physrisk: technical challenges

Cloud-optimised chunked, compressed storage gives good performance across typical use cases (with options to optimize as necessary)

- Hazard data can be large (50 m wildfire model ~2 TB), even chunked and compressed.
- Highly desirable to process and visualise as N-dimensional arrays, but very common use-case is to access a portfolio: from 1 to order 1,000,000s lats/lons.
- Public-domain data onboarded in original co-ordinate reference system; map tiles calculated (web mercator).
- OS-Climate uses chunked, compressed storage, optimised for physical climate risk:
  - chunks sized to give reasonable performance for 1-1,000,000 assets.
  - chunks optimised for most common access pattern (e.g. return periods in a chunk).
  - data gathered in parallel.
- Hazard models are plug-and play, maintaining an inventory of models.



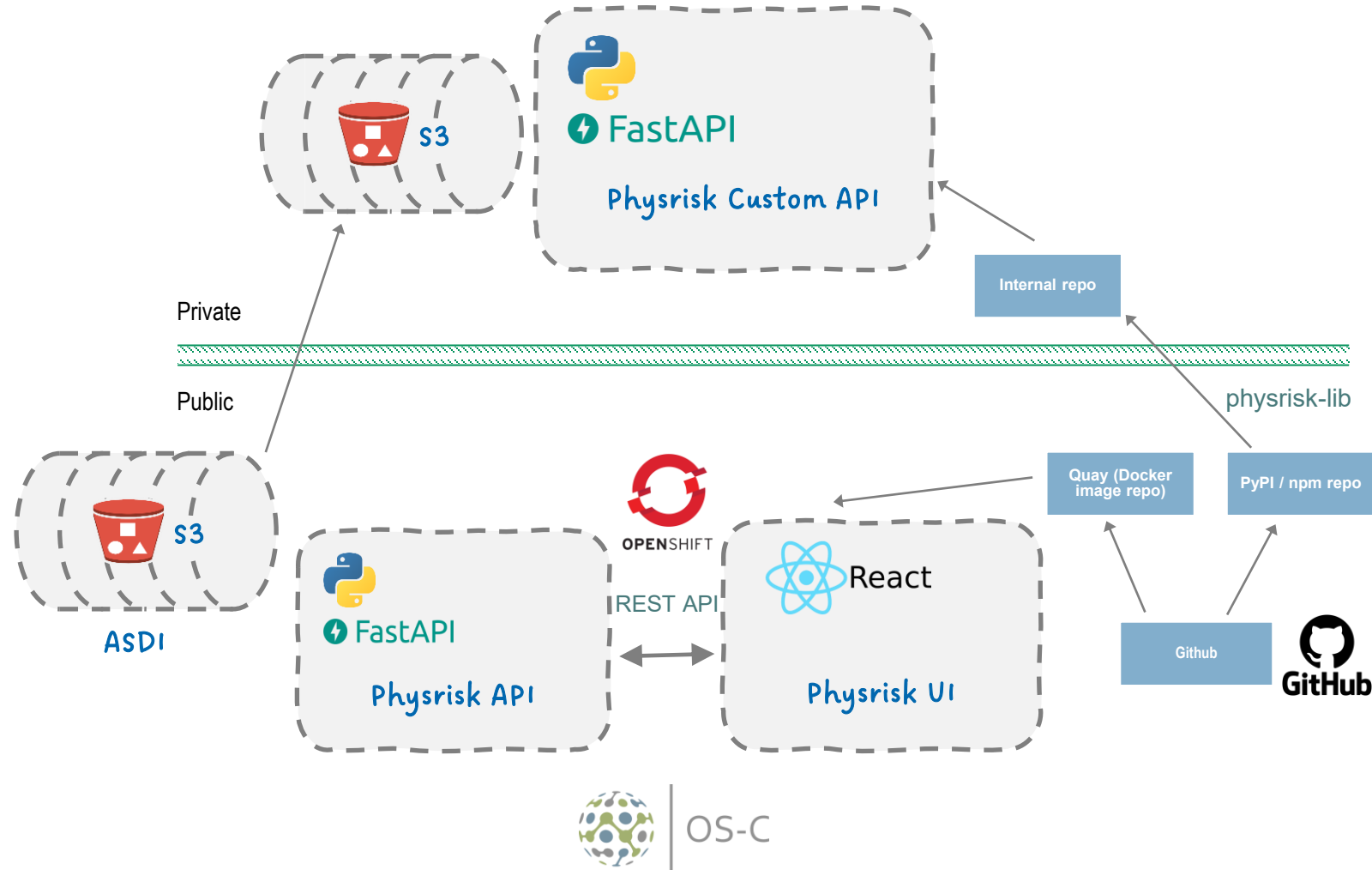
# Technical overview

physrisk project comprises four main repos, with a demonstrator implementation maintained

- The physrisk project comprises four OS-Climate repos:
  1. *physrisk* <https://github.com/os-climate/physrisk>: core library written in Python\*.
  2. *hazard* <https://github.com/os-climate/hazard>: library to 'on-board' or derive (model) hazard indicators for use in *physrisk*.
  3. *physrisk API* <https://github.com/os-climate/physrisk-api>: example of hosting using Fast API.
  4. *physrisk UI* <https://github.com/os-climate/physrisk-ui> example of user interface in React; mainly used:
    - to visualize hazards
    - demonstrate functionality and UI building blocks  
(i.e. intended as a physical climate risk system)
- A demonstrator implementation is maintained:
  - <https://physrisk.com>
  - <https://physrisk.com/docs>
- Documentation:
  - <https://physrisk.readthedocs.io/en/latest/>

# Set-up and use in-house

Typical use is to replicate data and otherwise treat like any other open-source project





**FINOS**

With thanks to:

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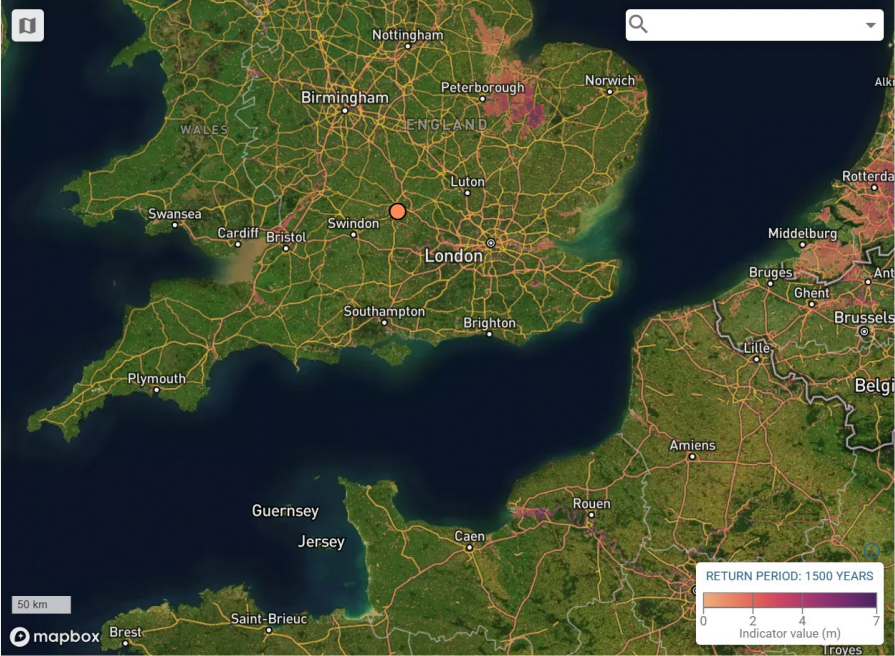
[finos.org](https://finos.org)

https://physrisk.com
OS-C

- HAZARD
- ASSETS
- ABOUT
- SETTINGS

### Asset-level analysis

LOAD PORTFOLIO | EXAMPLE PORTFOLIOS | CALCULATE IMPACTS



COLUMNS	FILTERS	ADD ROW	EXPORT JSON	GEOCODE
Identifier	Occupancy code	Storeys	First floor height (metres)	Buffer (metres)
1	2780 (Industrial Facilities Model, IFM: Airport)	0.305	0	
2	1050 (Residential, General residential)	0.305	0	
3	1119 (Commercial, Restaurant, café, bar, pub,	0.305	50	
4	1050 (Residential, General residential)	2	0.305	0

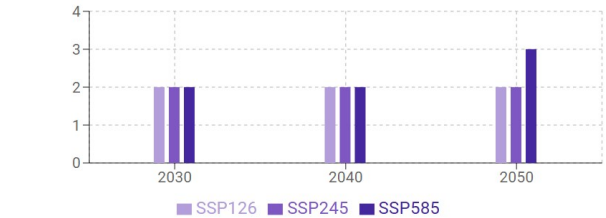
Projected year: 2050

Scenario: SSP585

#### Risk scores (2050)

Hazard	SSP126	SSP245	SSP585
Coastal Flood	0	0	0
Riverine Flood	2	2	3
Pluvial Flood	0	0	0
Heat	0	0	0
Wind	0	0	0
Drought	0	0	0
Wildfire	0	0	0
Hail	0	0	0

#### Riverine Flood score evolution

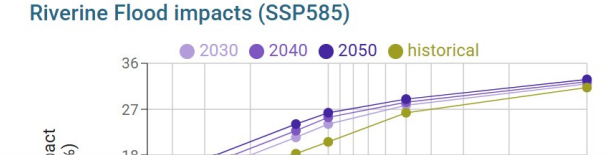


Legend: SSP126 (light purple), SSP245 (medium purple), SSP585 (dark purple)

Year	SSP126	SSP245	SSP585
2030	2	2	2
2040	2	2	2
2050	2	2	3

SCORE DETAILS | IMPACT DETAILS | HAZARD DETAILS

#### Riverine Flood impacts (SSP585)



Legend: 2030 (light purple), 2040 (medium purple), 2050 (dark purple), historical (green)