

# Exploring the efficient frontier in physical risk reporting

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EGU ITS4.8/CL0.1.16 – Advances in physical climate risk assessment for the financial and insurance sectors, <https://meetingorganizer.copernicus.org/EGU24/session/50334>, Bresch, D. N.: Exploring the efficient frontier in physical risk reporting, EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-11284, <https://doi.org/10.5194/egusphere-egu24-11284>, 2024.





“La finance sera verte - ou elle ne sera pas.”

*Bruno Le Maire  
Ministre de l'Economie et des  
Finances  
Décembre 2017*

# Financial Stability Board Task Force on Climate-related Financial Disclosures (TCFD) <sup>1</sup>



“Climate change is the  
Tragedy of the Horizon.”

Mark Carney, Governor  
of the Bank of England,  
29 Sep 2015, speech at  
Lloyd’s of London

<sup>1</sup> established 4 Dec 2015: <https://www.fsb-tcfd.org>, Speech: <https://www.bis.org/review/r151009a.pdf>, Video: <https://www.youtube.com/watch?v=V5c-eqNxeSQ>

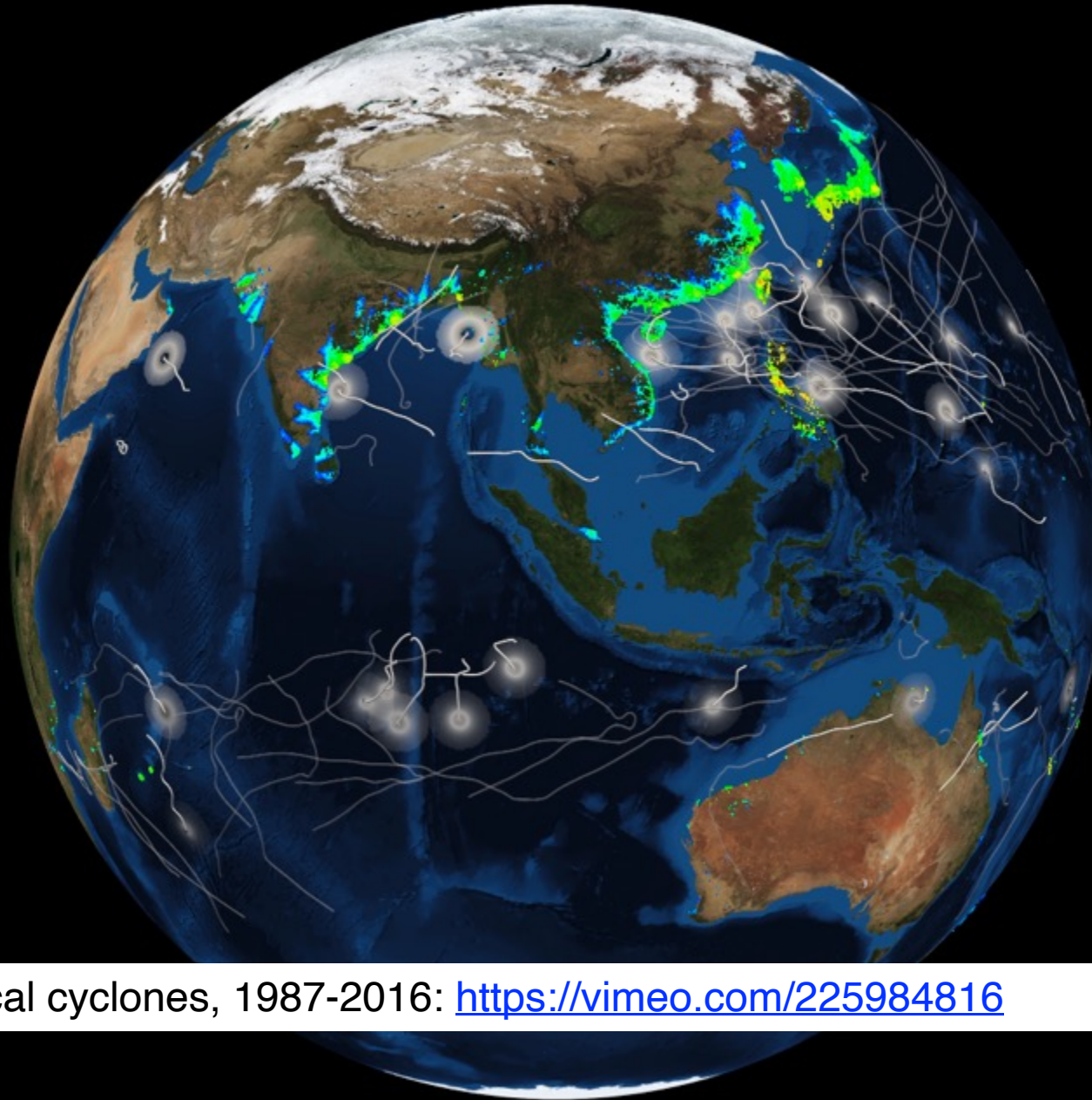
# Physical climate risks disclosure – state of play<sup>1</sup>

- An increasing number of consultancies, financial technology firms, data providers, and investment advisory groups now **offer information about localized physical climate risks**, entering a technology arms race among climate services providers (Keenan, 2019; Condon, 2023)
- The physical-risk scores produced by various commercial providers, each developing their own firm-level indicators of physical climate risk, **diverge substantially** (Hain et al., 2022).
- The proprietary nature of their products introduces significant challenges, including a lack of transparency and accessibility, for **comparison** and evaluation (Arribas et al., 2022).
- The efforts of regulatory bodies to establish **standards for measuring and reporting are still developing** (Fiedler et al., 2021)

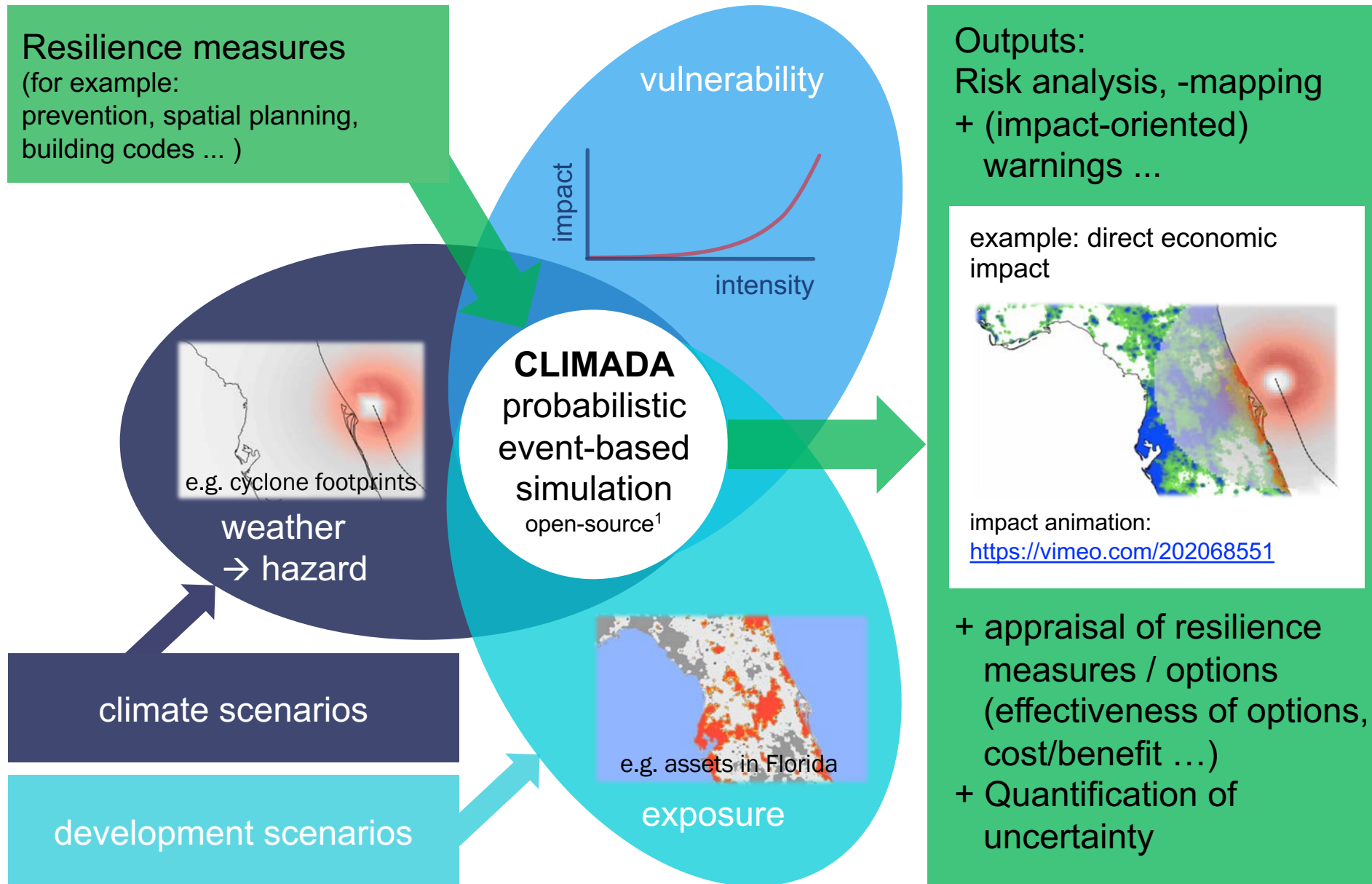
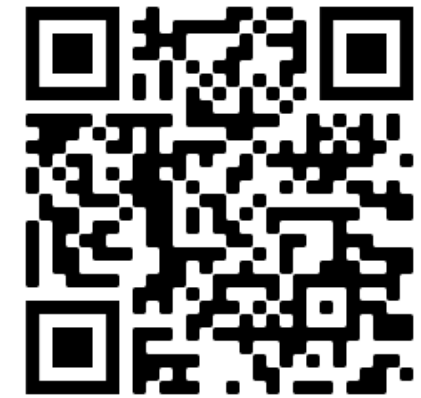
<sup>1</sup> some of the text taken from Meiler, S., PhD thesis, outlook, <https://doi.org/10.3929/ethz-b-000645395>



2011

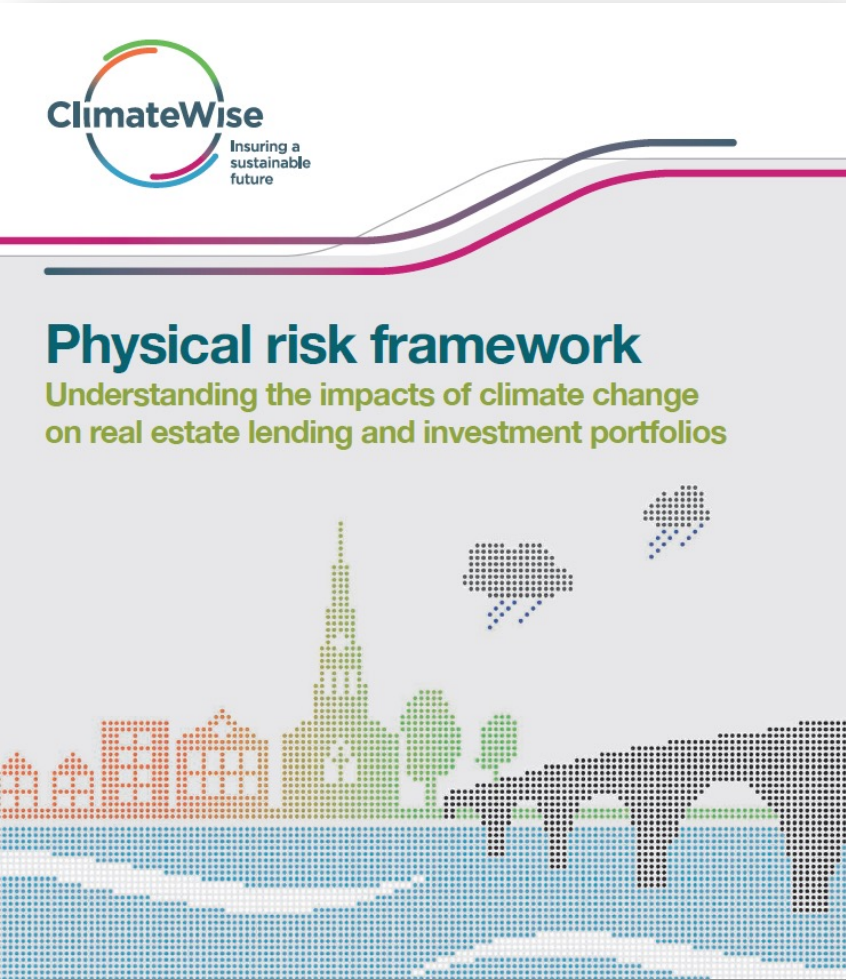


Full animation of global tropical cyclones, 1987-2016: <https://vimeo.com/225984816>

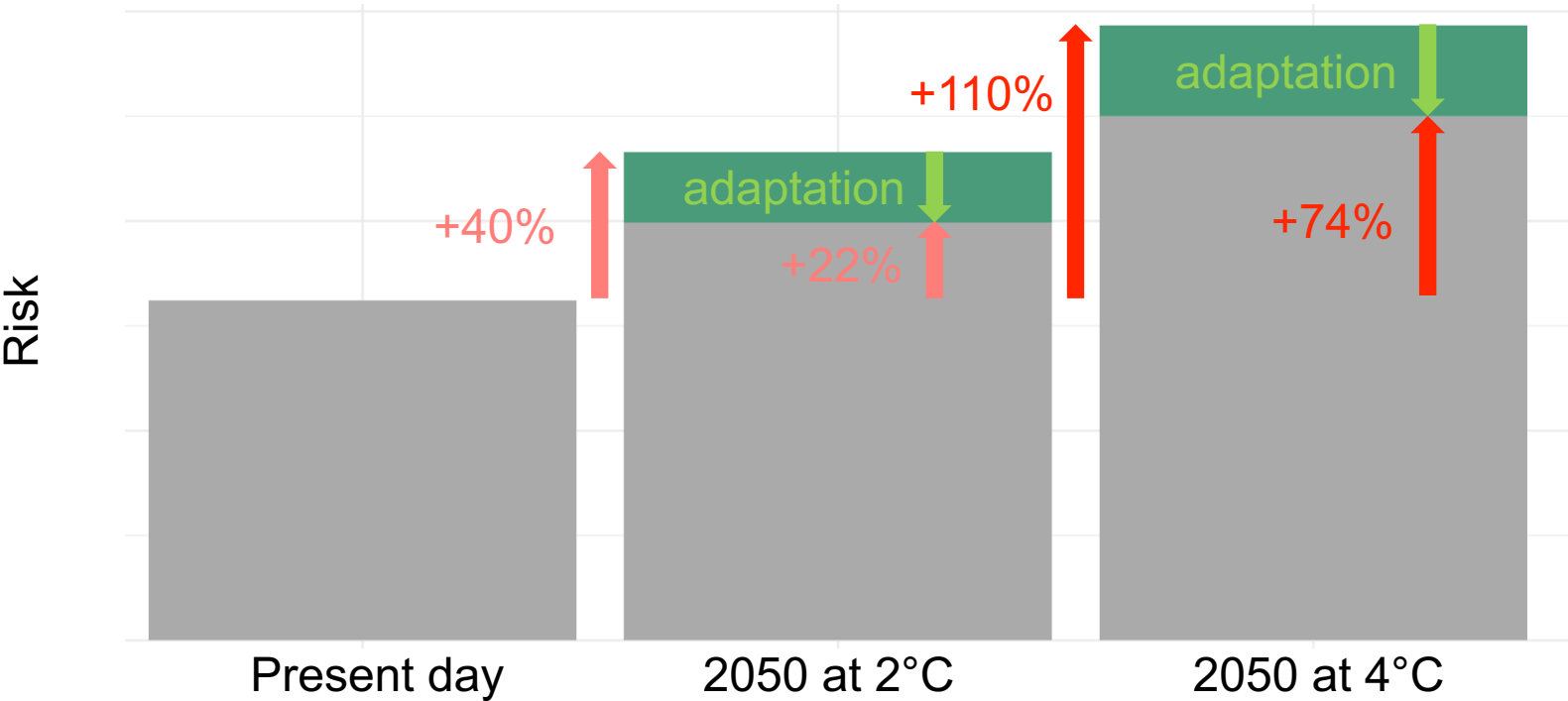


<sup>1</sup> <https://wcr.ethz.ch/research/climada.html> und Aznar-Siguan & Bresch, 2019: CLIMADA ... weather and climate risk assessment ..., <https://doi.org/10.5194/gmd-12-3085-2019>

# Physical Risk Framework (Feb 2019)



# UK banks – physical tropical cyclone risk on loan portfolios



Expected damages to assets<sup>1</sup> exposed to tropical cyclones increase by 40% with 2 degrees of warming and 110% with 4 degrees of warming. Adaptation could limit these to 22% and 74% increase.

<sup>1</sup> Westcott, M., Ward, J., Surminski, S., Sayers, P., Bresch, D.N. and Claire, B., 2020. Be prepared: Exploring future climate-related risk for residential and commercial real estate portfolios. *The Journal of Alternative Investments*, 23(1), pp. 24-34. <https://jai.pm-research.com/content/early/2020/05/09/jai.2020.1.100.abstract>  
<https://www.cisl.cam.ac.uk/resources/sustainable-finance-publications/physical-risk-framework-understanding-the-impact-of-climate-change-on-real-estate-lending-and-investment-portfolios>

<sup>2</sup> asset base: global exposure of leading 9 UK banks' loan portfolios.



# Challenges

## Availability

Natural catastrophe models mainly exist for (top) OECD countries for select hazards

→ Need for a globally consistent framework ✓ and worldwide coverage of main hazards

## Accessibility

Natural catastrophe models are proprietary either to (re)insurance companies or so-called model vendors

→ Need for open-source and -access models with full transparency (and APIs to open-data sources) ✓

## Applicability

Proprietary natural catastrophe models are myopic – ready to assess risk today, but not under future climate yet

→ Need for integration of climate impacts in a transparent scenario fashion (as in open-source models ✓)

## Aggregate-ability

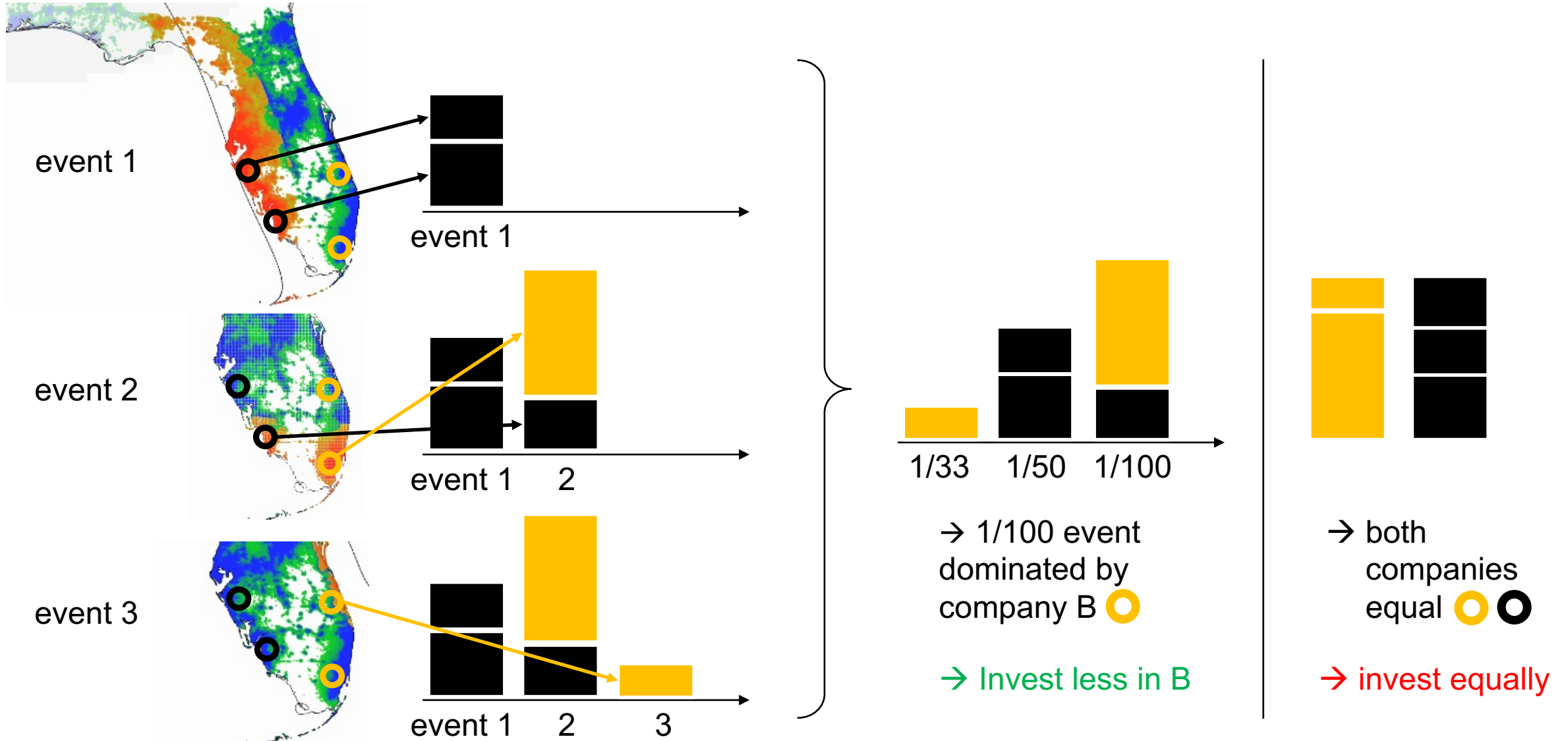
Physical risk disclosures today are company-specific, no established methodology for inter-comparison

→ Need not only for consistent approaches (scenarios, risk metrics ...), but even more so for

appropriate aggregation method (e.g. event-based)

# Event-based risk assessment – risk differentiation

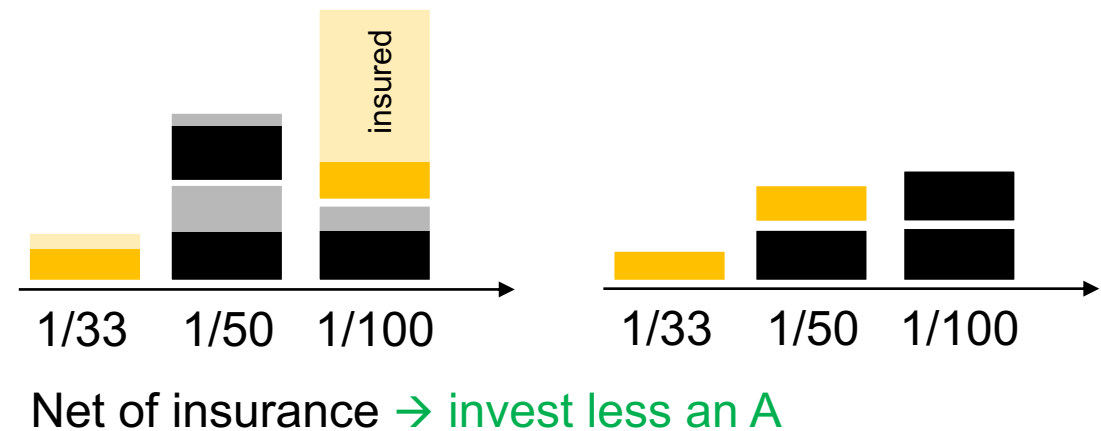
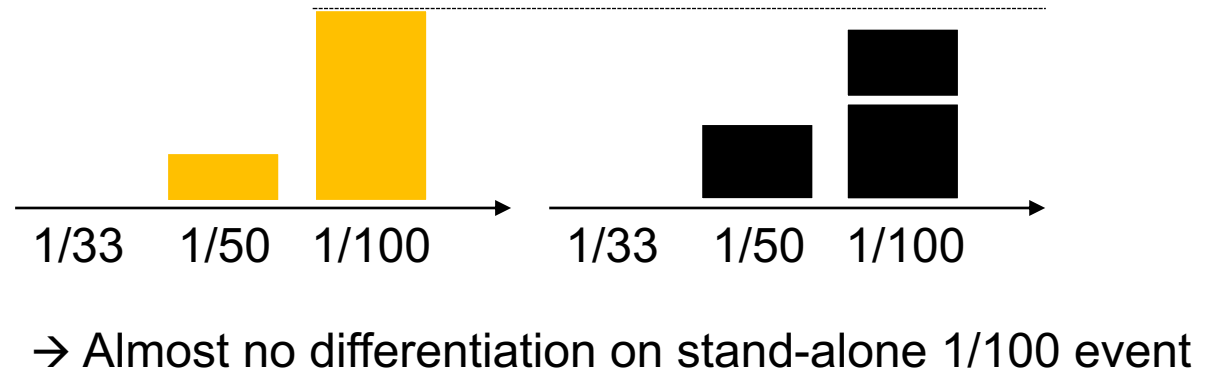
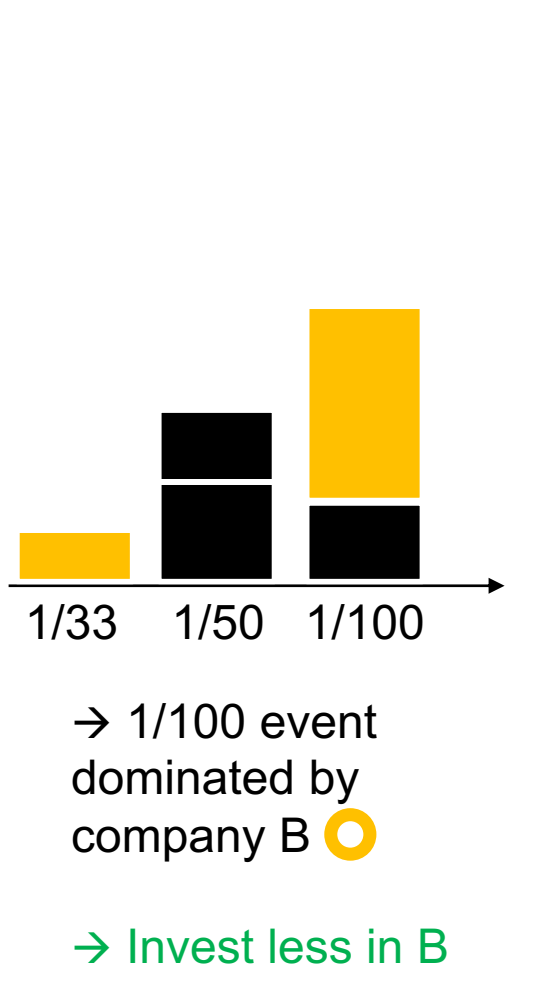
company A  
 company B





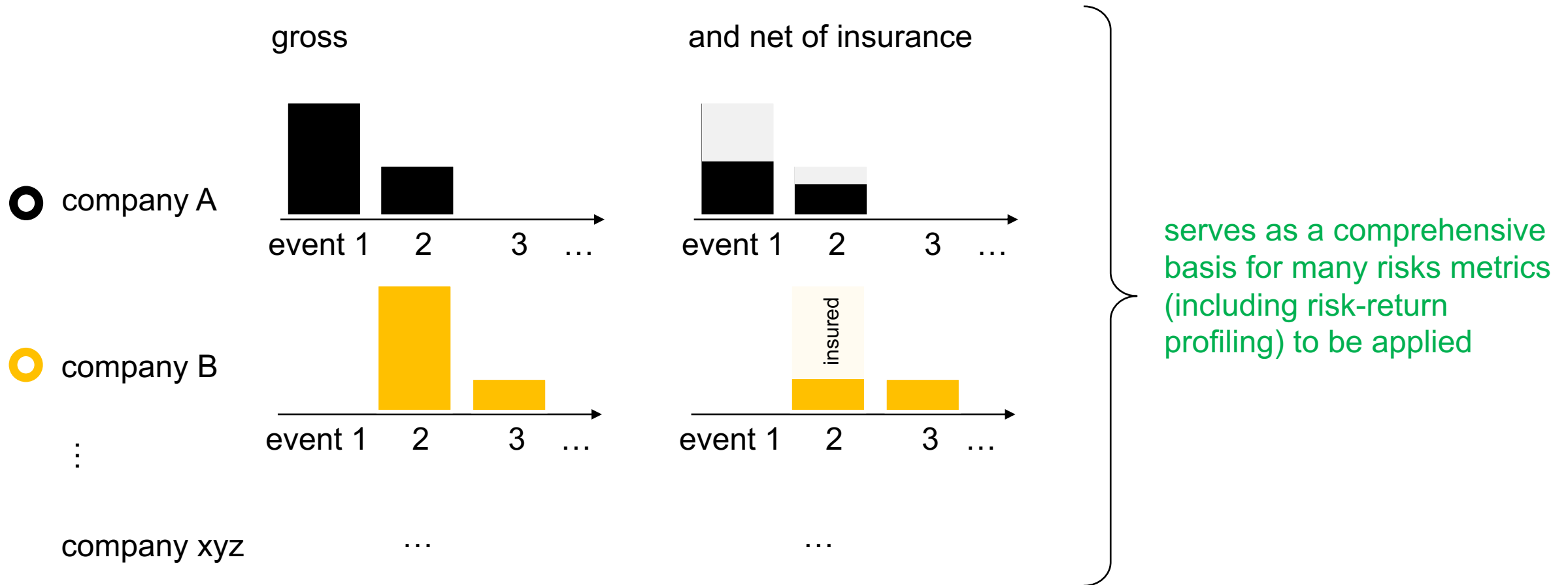
# Event-based risk assessment – risk differentiation (cntd)

company A  
 company B



# Aggregate-ability – a suggested methodology for inter-comparison

Each company to report modeled impact on a per-event basis of a reference hazard set, gross and net





# Event-based physical climate risk reporting

## Prerequisites

- globally consistent **reference hazard event sets** for main perils both under current and future climate conditions (tropical cyclones, floods, droughts, wildfires to start with)
- globally consistent, **interoperable open-source and -access models**

## Pros

- modeled impact on a per-event basis of a reference hazard set, gross and net serves as a comprehensive basis for many risks metrics (including risk-return profiling) to be applied
- companies need to disclose neither asset locations, nor supply chain structure, nor vulnerabilities
- allows for true transparency and **enables risk-aware long-term investment strategies** to be enacted

## Cons

- Looks like quite some data volume, but a ridiculous argument in the era of big data

This presents a tremendous opportunity for the academic community to work towards **interoperable models** and **reference hazard event sets** both under current and future climate conditions.

# Poster session<sup>1</sup>

- **Event-Loss Table Framework**  
Maps hazard events to company impacts, stored in a centralized database
- **Versatile Approach**  
Streamlines risk assessment across portfolios, enabling customizable metrics.
- **Call to the Community**  
Promotes the standardization of hazards and financial impact models.

<sup>1</sup> [victor.wattinhakansson@usys.ethz.ch](mailto:victor.wattinhakansson@usys.ethz.ch),  
<https://meetingorganizer.copernicus.org/EGU24/session/50334>

Wattin Håkansson, V., Hülsen, S., Meiler, S., Villiger, L., Kropf, C. M., McCaughey, J. W., and Bresch, D. N.: Beyond Single Company Risk Disclosure – Exploring the Efficient Frontier in Physical Risk Reporting, EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-11080, <https://doi.org/10.5194/egusphere-egu24-11080>, 2024.

## BEYOND SINGLE COMPANY RISK DISCLOSURE -

### EXPLORING THE EFFICIENT FRONTIER IN PHYSICAL RISK REPORTING

Victor Wattin Håkansson<sup>1,2</sup>, Simona Meiler<sup>1,2</sup>, Sarah Hülsen<sup>1,2</sup>, Leonie Villiger<sup>1,2</sup>, Jamie W. McCaughey<sup>1,2</sup>, Chahan M. Kropf<sup>1,2</sup>, and David N. Bresch<sup>1,2</sup>

<sup>1</sup>Institute for Environmental Decisions (IED), ETH Zurich, Switzerland  
<sup>2</sup>Federal Office of Meteorology and Climatology MeteoSwiss, Switzerland

#### Introduction

The escalating concerns over investment and systemic risks due to climate change, resulting in increased occurrences of hazardous weather events such as tropical cyclones and floods, have led to a demand for enhanced disclosure of physical risks by individual companies. This prompt led the G20 ministries to establish the Task Force on Climate-related Financial Disclosures (TCFD)[3] in 2017, which offers guidelines for transparent reporting.

The TCFD has significantly influenced corporate behavior, with a notable percentage of companies adopting its recommendations and a surge in service providers offering tools for risk disclosure, creating a competitive landscape [5, 4].

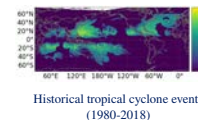
However, the effectiveness of the TCFD's initiatives is hindered by the varied and proprietary nature of climate risk assessments provided by different entities [5, 4], challenging the overall **transparency**, **comparability**, **aggregability**, and **accessibility**, of disclosed information.

#### Event-Loss Table Framework

**Event-Loss Table:** Matrix that maps hazard events, defined by intensity and geographical footprints, against the modeled financial losses incurred by companies. Event frequencies are integrated annually to enable statistical financial risk assessments.

Event Id	Frequency	CLIMATE PHENOMENON (GLOBES)	CLIMATE PHENOMENON (NETS)	SWP SERVICIOS (GLOBES TRANSFER)	SWP SERVICIOS (NETS)
341	1/1000	-100	-50	-10	-10
342	1/1200	0	-20	-20	-20
343	1/1120	-140	-30	0	0

Event loss table showing estimated property damage (Mn \$) per company and event ID.



**Hazard Sets and Loss Models:** Detailed available hazard event sets, including historical and synthetic ones, along with a financial loss model (e.g., property damage).

**Centralized Database:** A centralized database facilitates the assessment of diverse portfolios, i.e., different combinations of companies, enabling efficient and wide-ranging risk analysis.

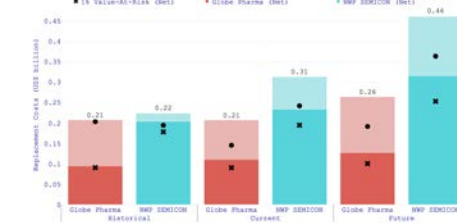


#### Comprehensive TCFD-Aligned Risk Assessment



#### Company Risk Comparison

Leveraging the open-source platform CLIMADA [1] with the STORM model [2], generate event-loss tables by simulating annual losses over 10,000 years for two fictional companies and quantifying property damage replacement costs for historical (1980-2018), current and future climate (SSP585; 2015-2050).

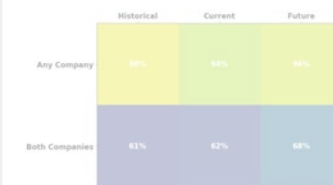


Risk metrics are expressed through a 1% annual Expected Shortfall (ES) and a 1% annual Value at Risk (VaR), equivalent to a 100-year return period, detailing both gross and net risks, with the latter incorporating insurance coverage.

#### Portfolio Analysis & Optimization



Comparison of investment



Annual probability of either or both companies being impacted

Optimal portfolio allocation given gross and netto risk



# CLIMADA – Collaborations (logo style, size arbitrary)



Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich



Federal Department of Home Affairs FDHA  
Federal Office of Meteorology and Climatology  
MeteoSwiss



UNIVERSITÄT  
BERN



THE WORLD BANK



POTS DAM-INSTITUT FÜR  
KLIMAFOLGENFORSCHUNG



United Nations University



InsuResilience

Solutions Fund





Accelerating the global mindset towards anticipating climate impact and adaptation

Supporting a global client base in climate adaptation and resilience with decision-critical insights

THE CLIMATE ADAPTATION  
TECHNOLOGY COMPANY