

Physical Climate Risks at the Intersection of Global and Regional Perspectives

Translating Global & Regional Signals into Asset-Level Decisions

Climate & Finance Round Table

Frankfurt, June 19

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01 Global Drivers vs Regional Patterns

02 Major Climate Events in Germany

What has actually happened?.

03 The Scale Mismatch & Translation Framework

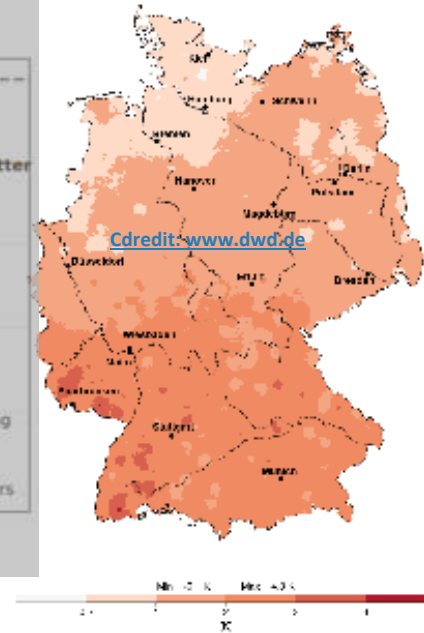
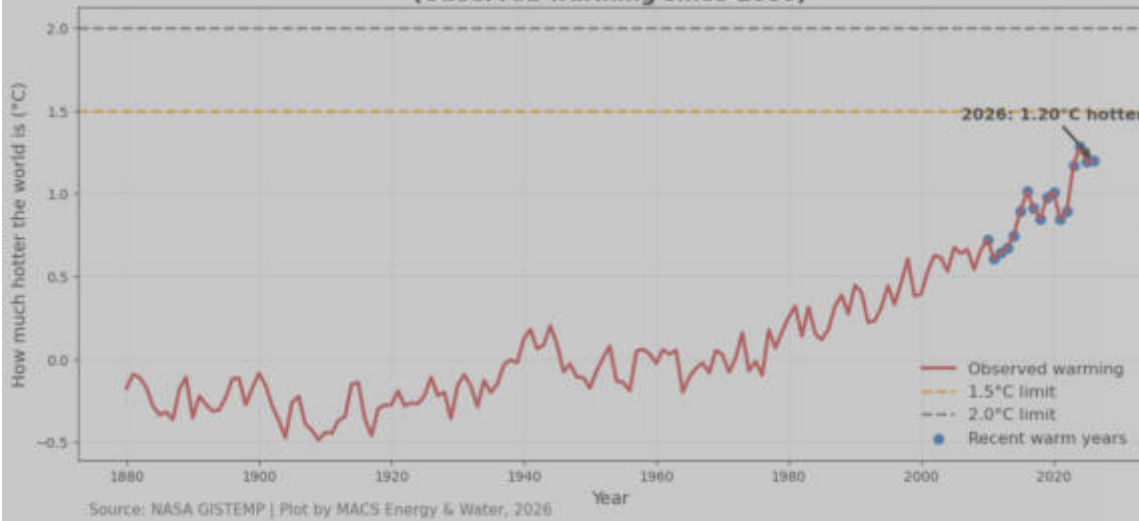
04 MACS Physical Climate Risk Approach

Spatial granularity, uncertainty, multi-hazard thinking, and strategic relevance.

05 Some Outputs & Summary

01 Global Drivers vs Regional Patterns

The World is Now -1.2°C Hotter Than the Old Climate
(Observed warming since 1880)



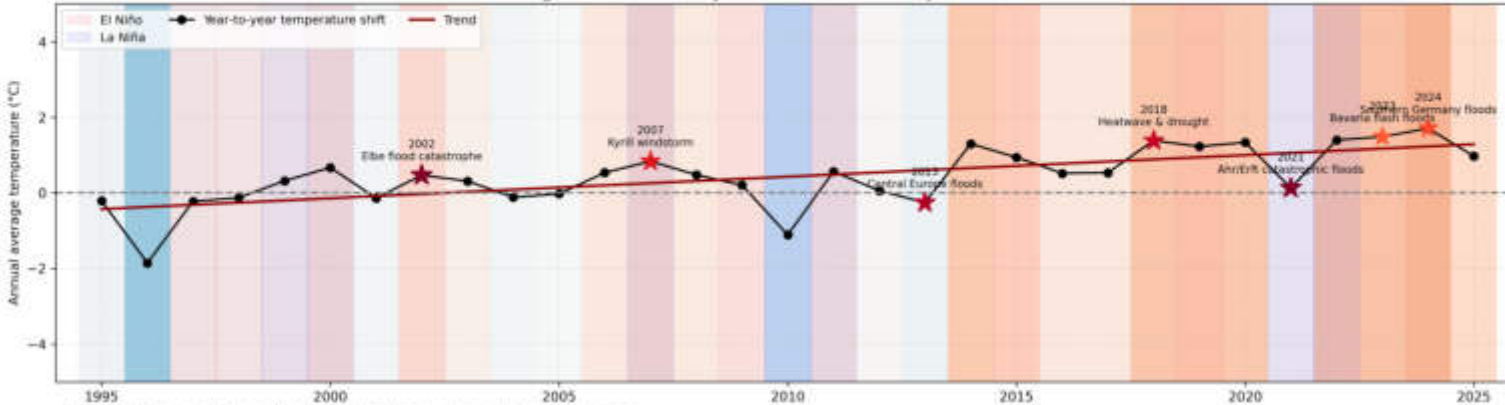
Do global warming trends show up in Germany?

- Global warming is now $+1.2^{\circ}\text{C}$ - the highest in human history
- Germany shows a similar warming pattern, but with strong regional and local variations in temperature and climate extremes



Germany's Major Climate-Related Events: What Has Actually Happened?

How Germany's Temperature Has Changed (1995-2025)
Red shading shows warmer years. Stars mark major weather disasters.



Note: El Niño and La Niña are global climate patterns that can shift weather systems. They influence storms, rainfall, heatwaves, and other extremes, so major events can occur even when Germany's temperature shift is small.

- Germany has experienced repeated high-impact events across floods, storms, heatwaves, and droughts
- Several events align with global climate variability (ENSO), but their magnitude is shaped by regional and local factors
- Local hazards do not scale linearly with global and regional warming, they depend on circulation, soil moisture, topography, and exposure

Year	Month	Severity	Description	ENSO Phase
1990	Feb	3.5	Vivian & Wiebke windstorms	Neutral
2002	Aug	5.0	Elbe flood catastrophe	El Niño
2007	Jan	3.8	Kyrill windstorm	La Niña
2013	Jun	4.5	Central Europe floods	Neutral
2018	Jul	4.2	Heatwave & drought	Neutral
2021	Jul	5.0	Ahr/Erfk catastrophic floods	La Niña
2023	Aug	3.0	Bavaria flash floods	Neutral
2024	Jun	3.2	Southern Germany floods	Neutral

Only climate models, regional downscaling, and exposure analysis can quantify how these events impact financial losses, insurance volatility, and infrastructure resilience.

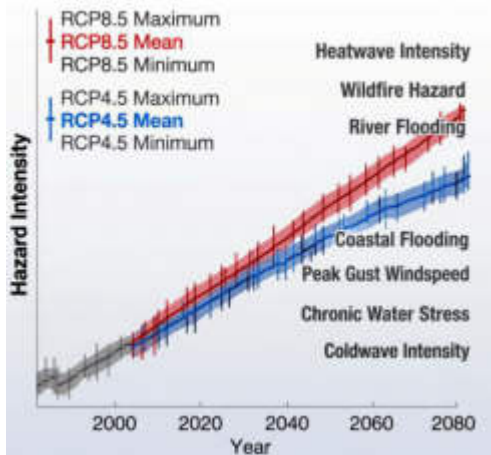
The Scale Mismatch: Why We Need a Translation Framework

Global climate signals \neq local hazard intensity \neq asset-level losses

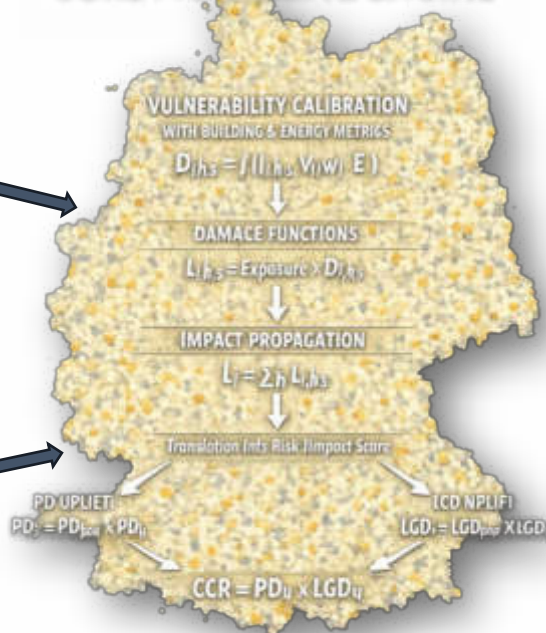
- **Global warming tells us the direction of change**, but not where or how hazards intensify Different hazards respond differently to warming:
- **Regional climate variability shapes local hazard intensity** (floods, storms, heatwaves, droughts)
- **Assets experience risk only through hyper-local conditions** (soil, elevation, drainage, exposure, vulnerability)
- **Climate risk must be translated across scales from global models \rightarrow regional downscaling \rightarrow local hazard \rightarrow asset exposure \rightarrow asset risk scoring /climate-credit-risk**



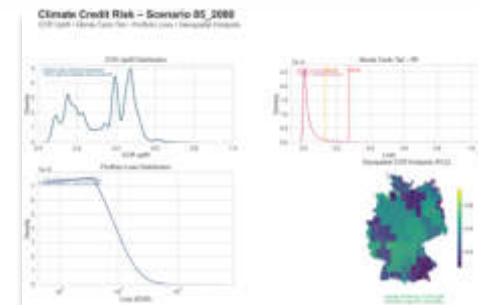
IPCC CMIP Models



CORE MODELLING ENGINE



SECONDARY LAYER - TAIL-RISK & SCENARIO DIAGNOSTICS



- This framework aligns with **ECB, EBA, ESRB** and **NGFS** expectations by using IPCC-based climate scenarios, asset-level vulnerability data, and forward-looking loss estimation to assess physical climate risk in a transparent and science-based manner

- UNEP FI and ECB / European Systemic Risk Board guidance underpin the methodological structure, ensuring transparency, scenario consistency, and supervisory alignment.
- IPCC future climate scenarios are represented through a middle-emission-risk path (RCP4.5) and a high-emission-risk path (RCP8.5), reflecting diverging climate trajectories.
- Open-source, state-of-the-art climate model data (e.g., Copernicus, CMIP6) provide multi-hazard projections for Germany across heat, wildfire, flooding, wind, water stress, and cold extremes.
- Forward-looking climate scenarios are translated into hazard-specific risk levels, forming a consistent scientific basis for physical-risk quantification.
- Building-level vulnerability metrics (e.g., typology, height class, energy system, structural characteristics) are integrated to calibrate hazard-to-damage relationships, in line with ECB expectations for asset-level granularity and UNEP FI guidance on physical-risk modelling.
- These hazard and vulnerability layers feed into the MACS Physical Climate Risk Score, enabling transparent, reproducible, and science-based assessment of climate-related physical risk across assets and portfolios.

Physical Climate Risks Translated into Climate-Credit Risk for Individual Buildings (Frankfurt Region, RCP8.5, 2080)








Legend

Building Types

 Multi-Family House	 Single-Family House
 Non-Residential Building	 Terraced House
 Large Multi-Family House	 Other Residential

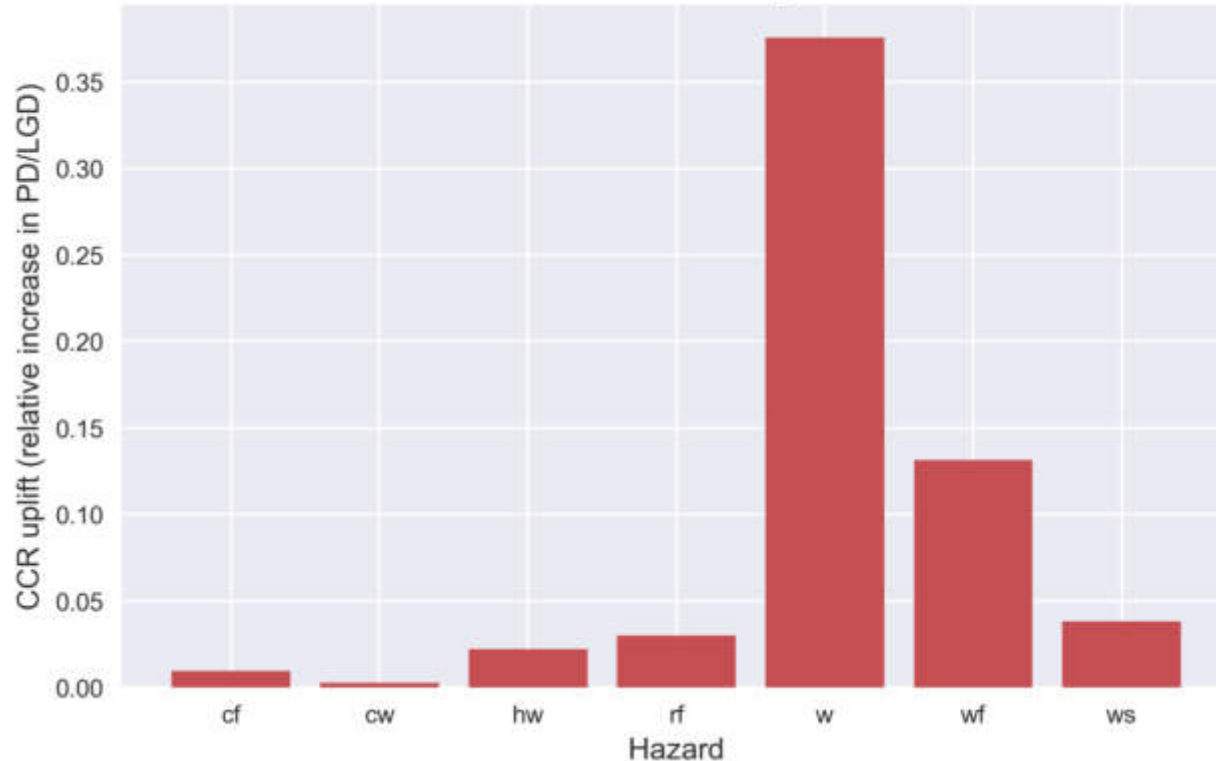
Climate-Credit Risk Score (RCP8.5, 2080)

	0.046126 - 0.073283
	0.073284 - 0.100440
	0.100441 - 0.127598
	0.127599 - 0.154755
	0.018966 - 0.046125

Higher values indicate stronger climate-driven credit risk; meaning a higher chance that the borrower defaults (PD), and higher losses for the bank if that default happens (LGD)

- **Climate-Credit-Risks (CCR)** based on individual building-metrics & Physical climate scenarios
- **Physical hazards** (heat, flood, wind, drought) are translated into **credit-risk drivers** (PD & LGD)
- **Risk scores** reveal spatial clusters where climate impacts materially affect borrower resilience.
- The framework enables **portfolio-wide repricing, risk-based lending, and forward-looking supervision.**

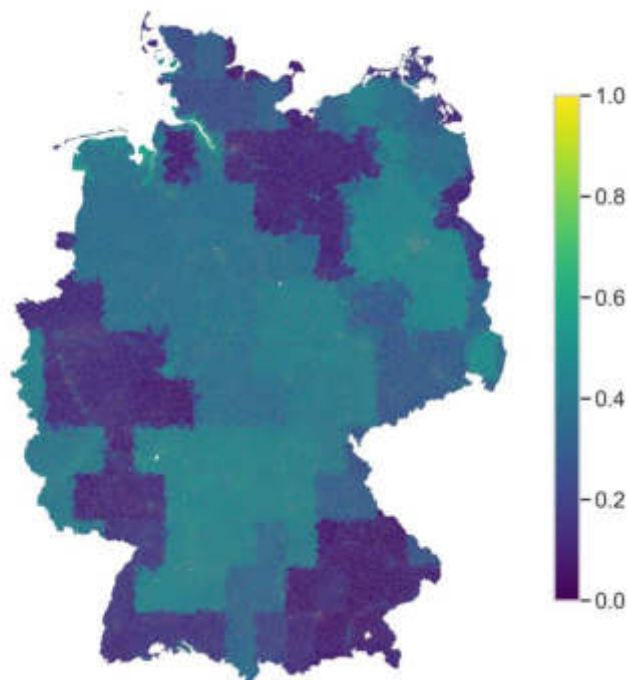
Climate Credit Risk by Hazard



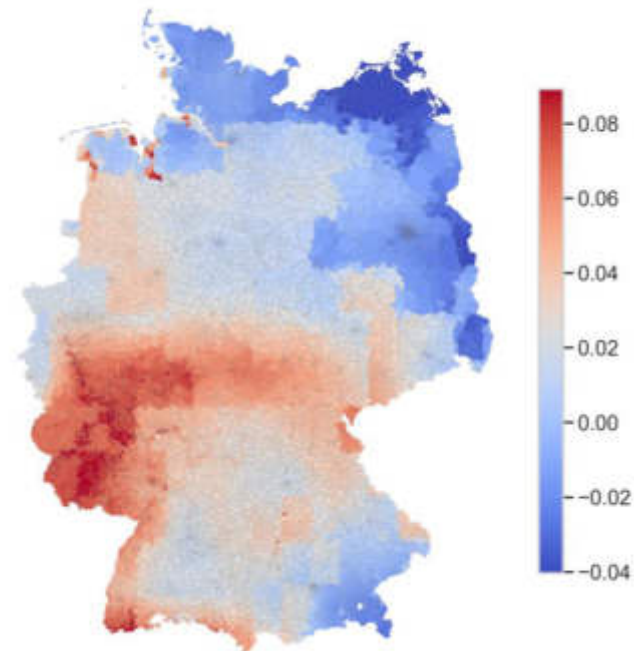
- ~550k addresses analysed, **Wind peaks** emerge as the dominant **Climate Credit Risk** drivers
- Wind-related hazards generate the largest PD/LGD uplifts, consistent with their structural-damage potential and non-linear damage scaling
- Other hazards (coastal flood, river flood, heat wave, cold wave, water stress) show only marginal overall CCR impact but can have localized impact esp. river flood

mv= Coastal Flooding || n2 = Cold Wave || < 2 = Heat Wave || sv= River Flood || 2 = Wind || 2v= Wildfire || 2¶= Water Stress

PLZ – CCR (Climate Credit Risk Index) – 85_2050

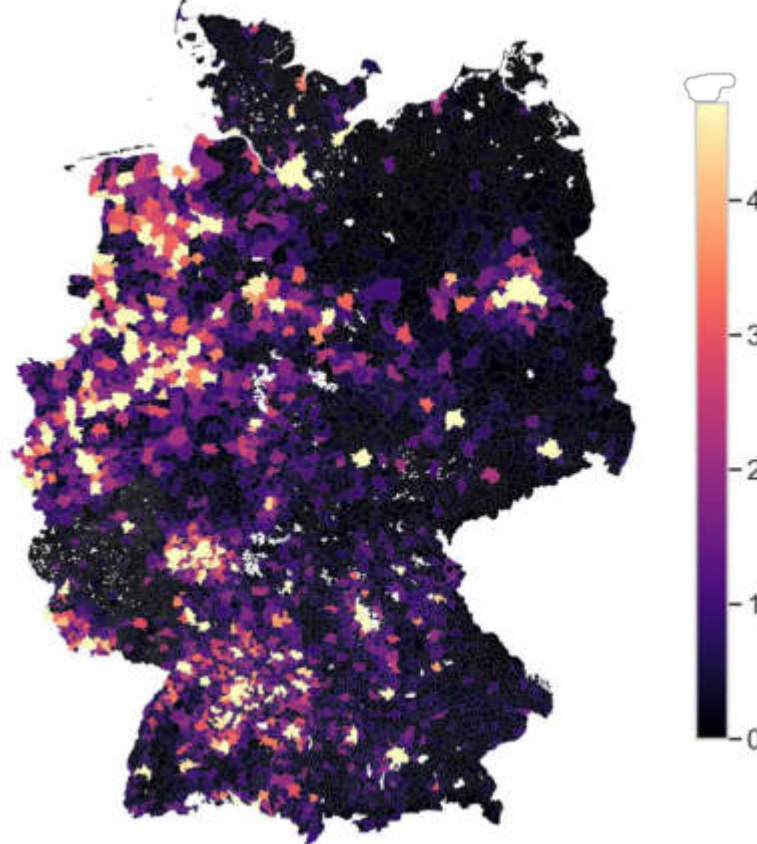


- PLZ –level CCR index under scenario stress
- Higher CCR= stronger PD/LGD amplification
- Useful for spatial scenario benchmarking.

PLZ – Δ CCR (85_2080 – 85_2050)

- Change in CCR uplift between 2050 and 2080
- Positive values = higher CCR in 2080
- Highlights long-term climate stress intensification

Normalized Monetary Loss(Euro) Potential by 2080 under RCP 8.5 (aggregated at community level)



- Aggregated losses represent climate-driven monetary damage scaled per community, allowing direct comparison across regions regardless of population or asset density
- Based on our sampled locations **K&U** in western and southern Germany indicate areas where hazard severity and economic value combine to drive elevated loss potential.
- Spatial patterns highlight regions with elevated exposure to climate hazards, especially areas where hazard intensity and asset concentration coincide
- **CE2** appear in darker tones, reflecting either lower hazard intensity, lower asset exposure, or both

- Assets experience risk only through hyper-local conditions
- MACS Framework is aligned with ECB, EBA, NGFS, and CSRD expectations is strong: forward-looking, scenario-based, asset-level, and hazard-specific
- Model transparency and traceability ensure the approach is defensible to internal model risk, auditors, and supervisors
- The model estimates borrower-level default risk and captures how climate-related losses translate into elevated PD/LGD and portfolio-level risk for financial institutions
- Spatial loss patterns reveal concentrated long-term monetary loss potential under RCP 8.5, highlighting regional hotspots relevant for underwriting and portfolio steering
- Spatial patterns highlight regions with elevated exposure to climate hazards, especially areas where hazard intensity and asset concentration coincide



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