

A LOOK AT THE RISK INDUSTRY
RESEARCH CENTER ON CLIMATE CHANGE IMPACTS
ROVIGO, 20 MARCH 2026

Natural Catastrophe Modelling for the Risk Industry: overview and perspectives from model development and insurance management

Simone Persiano

*Hydrologist – NatCat Modeller
Catastrophe Risk Modeling & Mitigation – Unipol S.p.A.*

Unipol as a primary insurer

Unipol S.p.A. is the leader company in **Non-Life** (Property & Casualty) business in **Italy**, with a network of ~2,000 agencies. Unipol is a domestic player (99% premiums collected in Italy) with a well diversified investment portfolio.

Primary Insurer: company that actually issues the policy to the end customer.



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Natural Catastrophe Risk Modelling and Mitigation

Main activities:

Use of **probabilistic models** to estimate **potential losses** from natural catastrophic events such as earthquakes, floods, hailstorms, windstorms, landslides, etc.

Aim:

Translate **physical phenomena** into **financial metrics** that Unipol uses to **stay solvent** and **price policies** accurately, as well as define its **reinsurance** strategy.



Earthquake, May 2012 (Clock Tower of Finale Emilia (MO) ([corrieredibologna](http://corrieredibologna.it)))



Bridge failure due to flood, May 2023 (Molinella di Budrio, BO) (rainews.it)



Solar panels damaged by hail (aviva.co.uk)

Catastrophe risk in Unipol

Context:

[Solvency II](#) (Directive **2009/138/EC** of the European Parliament): prudential risk-based framework for insurers to protect policyholders via three pillars:

- **Pillar I** (Quantitative): **Solvency Capital Requirement (SCR)**, i.e., amount of funds that (re)insurance companies are required to hold to have a **99.5% confidence** (return period **200 years**) they could survive the most extreme expected losses over the course of a year (**short-term**).
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 - **Calibrating** broad-scale **vendor models** (e.g., Moody's) to specific portfolio regions using the company's **historical claims**.
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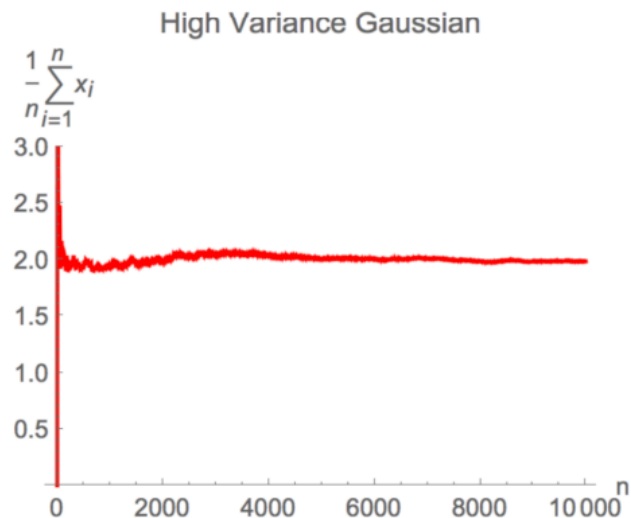
Forward-looking evaluations that should account for the changes in frequency and severity of natural extreme events. Useful for **climate change stress tests** included in the ORSA (Pillar II).



Catastrophe modelling: why?

If risks are **independent** and **similar** (high-frequency, low-severity risks; e.g., car accidents)

- **Law of Large Numbers** (i.e., how long it takes for the sample mean to stabilize):
More policies lead to less uncertainty.
- **Central Limit Theorem:**
As the portfolio grows, the distribution tends toward a bell curve (i.e., Gaussian).



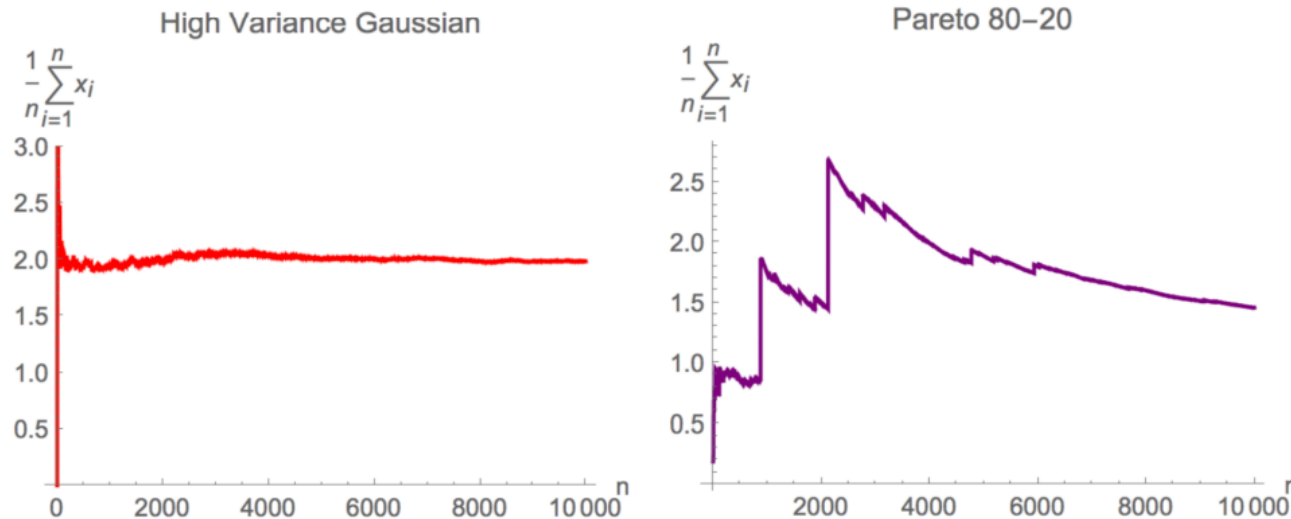
Source: Figure 3.5 in [Taleb \(2020; arXiv\)](#)

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The **law of large numbers** works much more slowly in “**Extremistan**” (e.g., Pareto distribution).
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Catastrophe modelling: why?

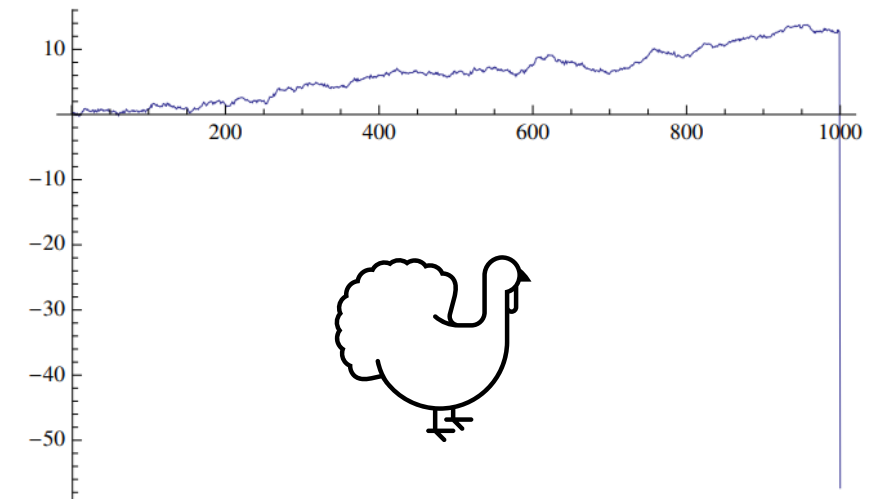
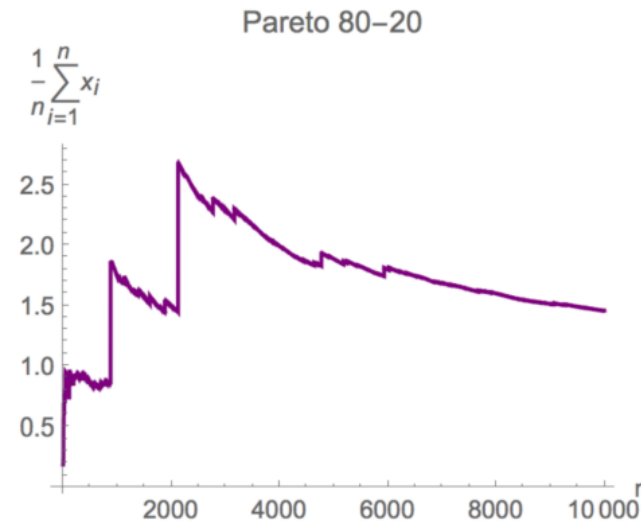
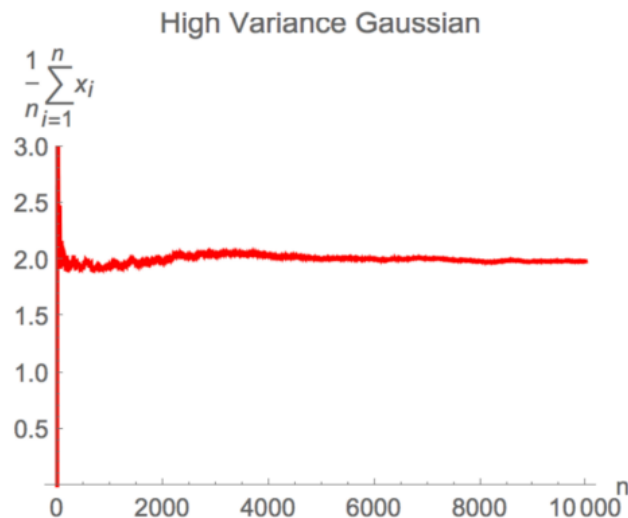
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Catastrophes (e.g., hurricanes, earthquakes, floods, windstorms) are different:

The **law of large numbers** works much more slowly in “**Extremistan**” (e.g., Pareto distribution).
([Taleb, 2020](#); [arXiv](#))

- **Heavy-tailed distributions** of losses.
- A single event can wipe out decades of profits.
- The **mean** is **unstable**: the Law of Large Numbers no longer saves you.
- The **Turkey Problem**: “The turkey fed for 1,000 days, then comes Thanksgiving.” ([Taleb, 2020](#); [arXiv](#)).



Source: Figure 3.5 in [Taleb \(2020; arXiv\)](#)

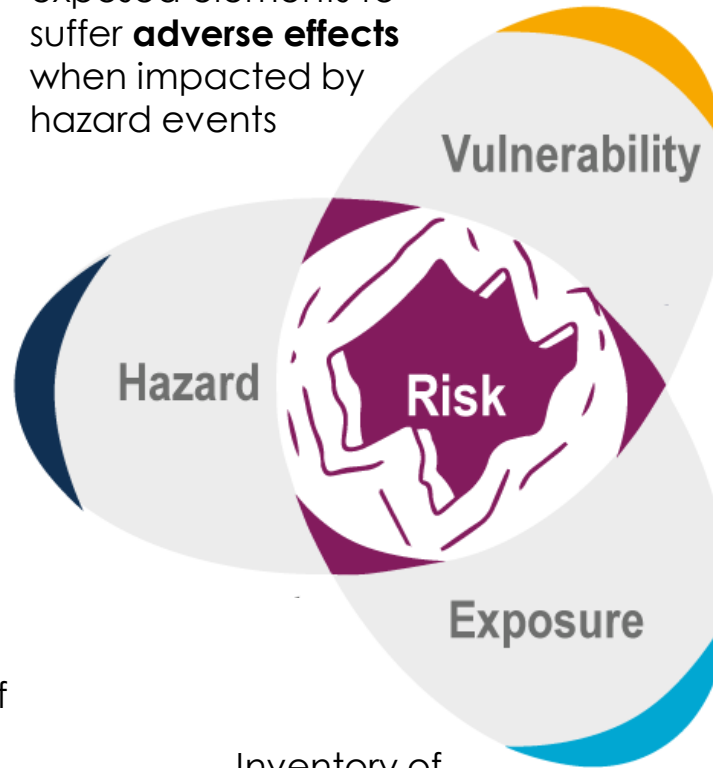
Source: Figure 5.5 in [Taleb \(2020; arXiv\)](#)

Catastrophe models

Definition of Risk

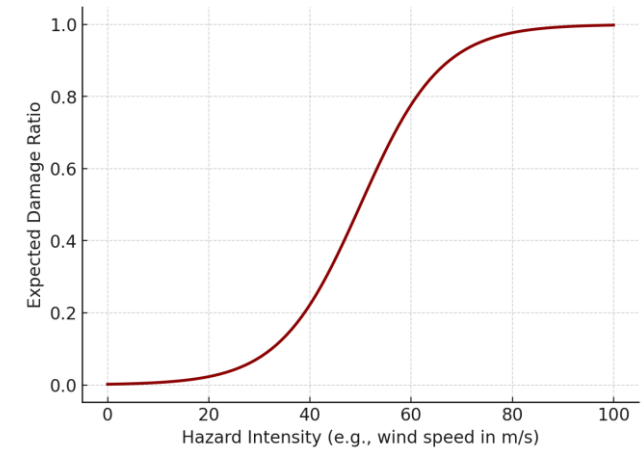


Propensity of exposed elements to suffer **adverse effects** when impacted by hazard events



Probabilistic analysis of the **frequency** and **intensity** of the physical phenomenon of interest

Inventory of **elements** in an area in which hazard events may occur



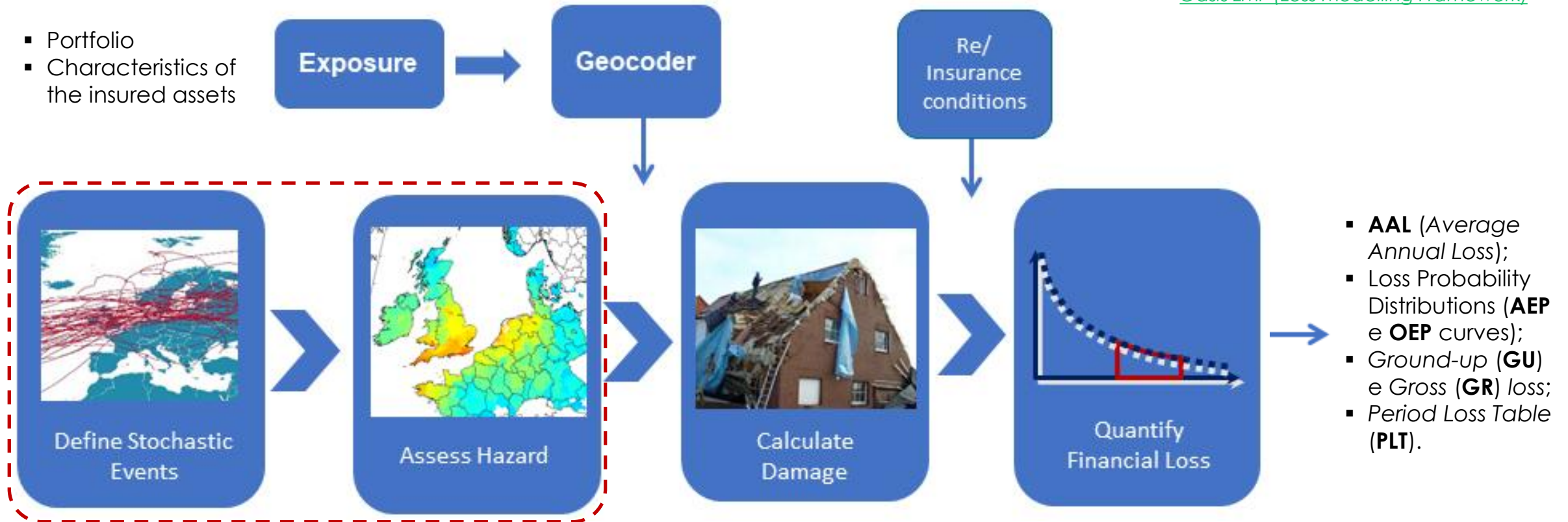
Source: Adaptation of [Figure MIGRATE.1](#) (General interactions between climatic and non-climatic processes, adaptation, potential migration outcomes and implications for future risk. Adapted from McLeman et al., 2021) in [Climate Change 2022 – Impacts, Adaptation and Vulnerability](#)

Catastrophe models

Structure of a fully-probabilistic catastrophe model

- Portfolio
- Characteristics of the insured assets

Source: Adaptation of figure from [Oasis LMF \(Loss Modelling Framework\)](#)



HAZARD

- **Stochastic Event Set (SES)**: Catalogue of $\sim 10^4 \div 10^5$ stochastic (synthetic) events.
- **Primary uncertainty**: Uncertainty linked to the natural variability of natural phenomena

VULNERABILITY

- Damage ratios by **peril**, **asset type** and items (**building/content**).
- **Secondary uncertainty**

FINANCIAL

- Evaluation of the effects of:
- **policy conditions**;
 - **territorial diversification** (spreading risks across different areas)

Catastrophe models

Relevant outputs

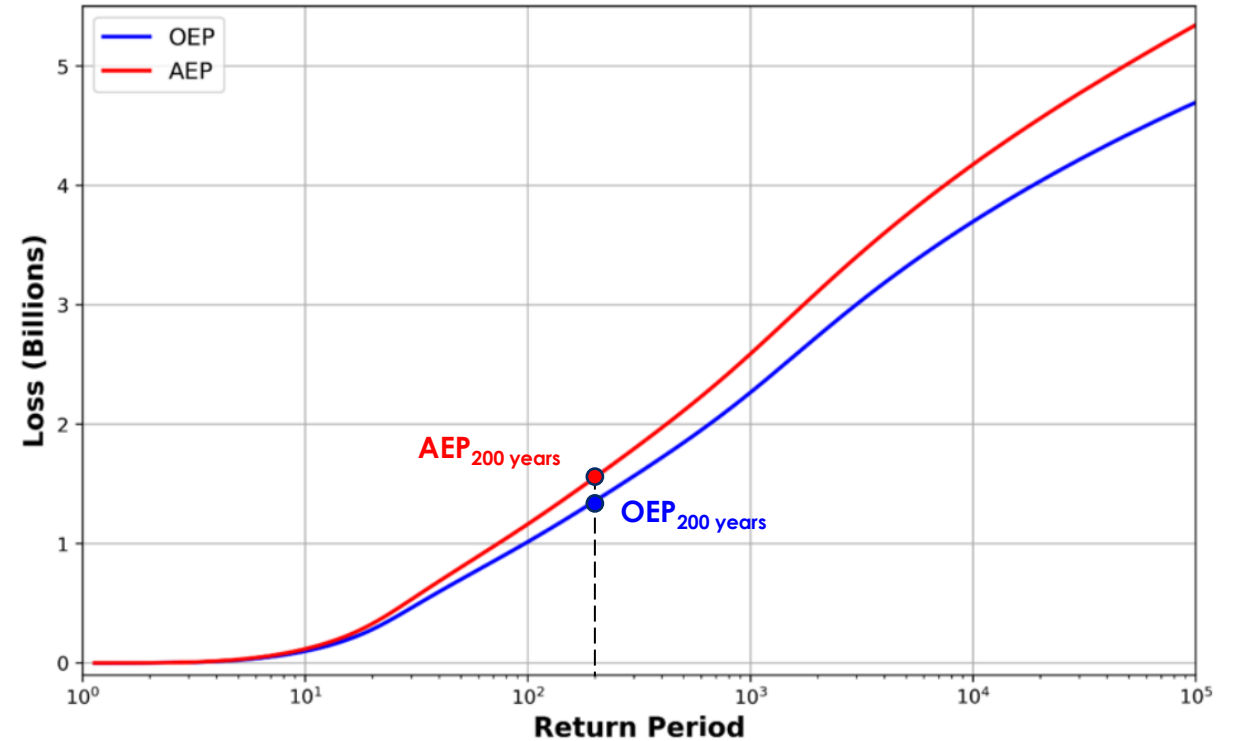
PLT (Period Loss Table)

Period (Year)	Event ID	Loss (€)	Event Date	Period Weight	Max. Loss (€)	Aggr. Loss (€)
1	100	64,128	04 Feb	$2 \cdot 10^{-5}$	64,128	85,776
	500	21,548	19 Mar	$2 \cdot 10^{-5}$		
2	300	84,521	29 Oct	$2 \cdot 10^{-5}$	84,521	84,521
3	-	0	-	-	0	0
4	700	6,489	01 Dec	$2 \cdot 10^{-5}$	26,451	32,940
	600	26,451	12 Dec	$2 \cdot 10^{-5}$		
5	400	31,244	15 Jan	$2 \cdot 10^{-5}$	64,845	98,404
	800	64,845	18 Feb	$2 \cdot 10^{-5}$		
	501	2,315	03 Nov	$2 \cdot 10^{-5}$		
6	-	0	-	-	0	0
...
49,999	200	9,954	30 Nov	$2 \cdot 10^{-5}$	9,954	9,954
50,000	900	64,887	27 Dec	$2 \cdot 10^{-5}$	64,887	64,887

↓
AAL

↓ ↓
OEP ≤ **AEP**

Source: [Jun & Li \(White Paper\)](#)



AAL (Average Annual Loss) → **Pricing**

OEP (Occurrence Exceedance Probability) → **Reinsurance**

AEP (Aggregate Exceedance Probability) → Overall capital solvency (**SCR**) and **Reinsurance**

Catastrophe models

Examples of catastrophe models available on the market

Proprietary models:

- [Moody's](#) (formerly RMS)
- [Verisk](#)
- [Cotality](#) (formerly CoreLogic)
- [RED](#) (*Risk Engineering + Development*)

MOODY'S

<https://www.moody.com/>

Verisk™

<https://www.verisk.com/>

cotality
Intelligence beyond bounds™

<https://www.cotality.com/>

RED
RISK
ENGINEERING+
DEVELOPMENT

<https://www.redrisk.com/>

Open-source solutions are progressively being made available:

- [Oasis LMF](#) (*Loss Modelling Framework*): open-source platform for NatCat models
- [CLIMADA](#) (*CLIMate ADaptation*): use of NatCat models even outside the (re)insurance context (e.g., climate adaptation studies)

OASIS

<https://oasislmf.org/>

CLIMADA
Economics of Climate Adaptation

<https://climada.ethz.ch/>



wcr.ethz.ch/research/climada.html

Weather-related events

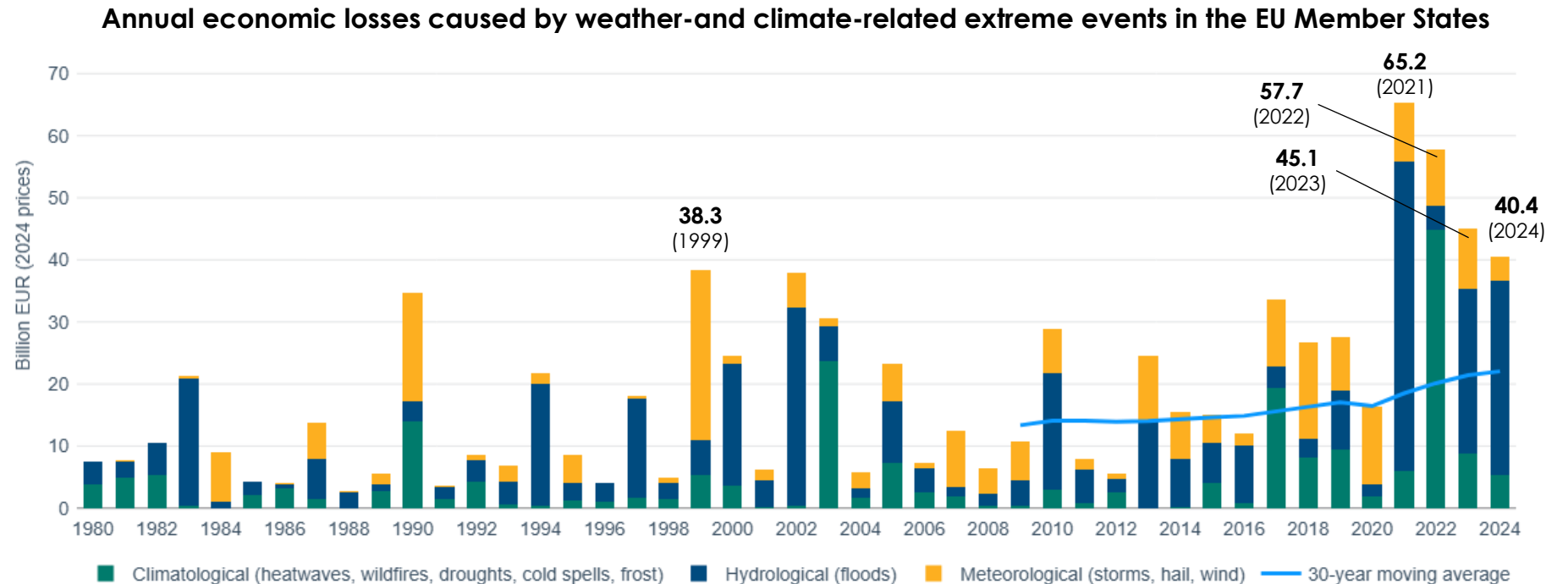
Economic losses in the EU Member States caused by **weather-** and **climate-related extremes** (EEA, 2025):

- **822 billion €** in **1980-2024** (45 years);
- **208 billion €** (~25%) in the last 4 years (**2021-2024**, all in the top-5 years of the highest annual economic losses since 1980);

As severe weather- and climate-related extreme events are **expected to intensify further**, associated economic losses will likely continue to **increase** (EEA, 2025).

Hazards associated with the **greatest contribution to economic losses**:

- **Hydrological (floods):** ~43%
- **Meteorological** (storms, including lightning and hail): ~27%
- **Climatological:**
 - ~18% heatwaves;
 - ~8% droughts, wildfires, cold spells and frost.



Source: *European Environment Agency (EEA), Economic losses from weather- and climate-related extremes in Europe (2025)*

Weather-related events

Economic losses and fatalities caused by weather- and climate-related extreme events (1980-2024) per EU country

- Highest economic losses in 1980-2024 recorded in Germany, Italy, France and Spain.
- **<20%** of total losses in 1980-2024 were **privately insured**:
 - >35%: meteorological events;
 - ~15%: hydrological events (floods);
 - ~10%: climatological events (heatwaves, wildfires, droughts, cold spells and frost).
- **Italy**:
 - ~145 billion € of total economic losses in 1980-2024;
 - Only ~ 4% (~ 6.3 billion €) covered by insurance.

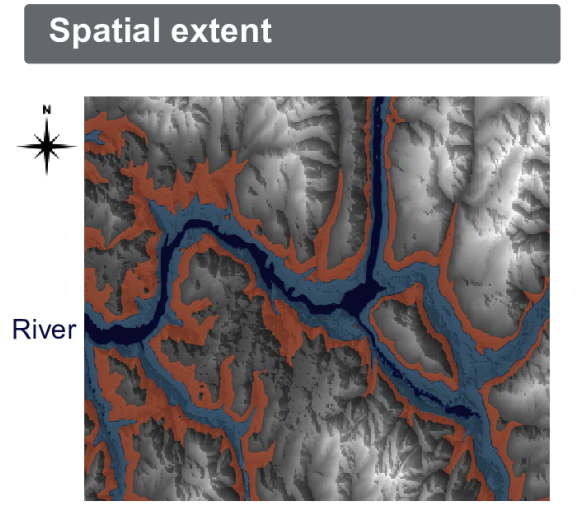
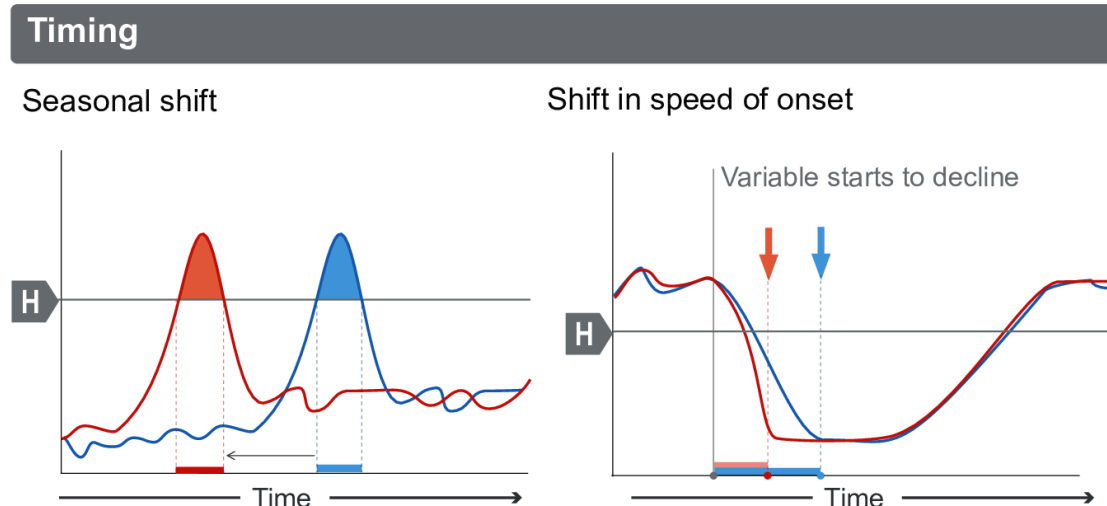
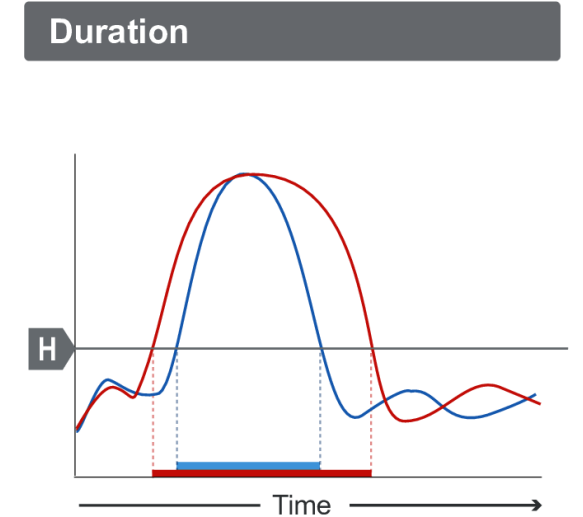
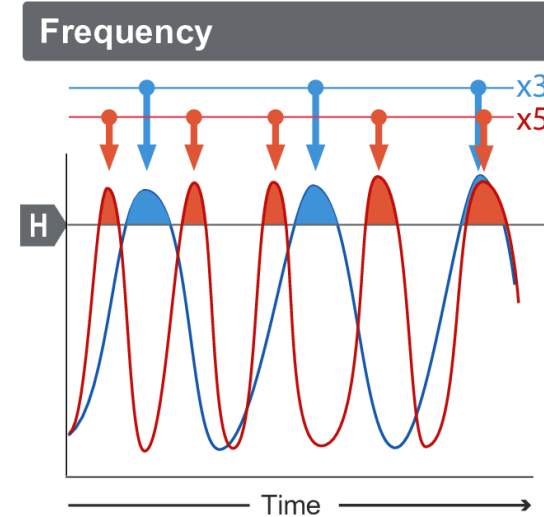
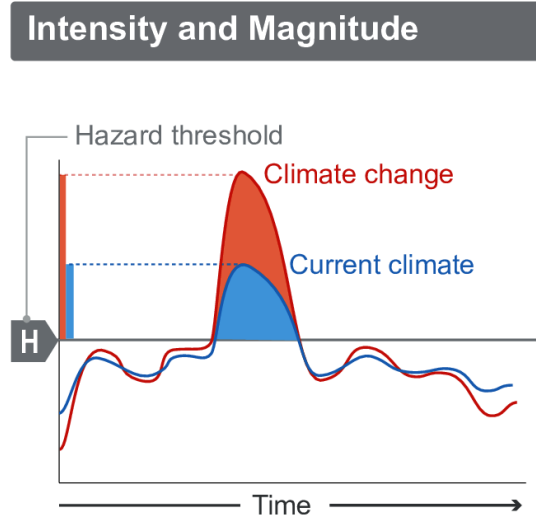
Country	Total losses million EUR	Loss per km ² EUR	Loss per capita EUR	Insured losses million EUR	Insured losses %	Fatalities
Austria	19,757	235,538	2,417	3,669	19	2,426
Belgium	18,404	600,130	1,742	7,610	41	14,827
Bulgaria	6,292	56,684	801	99	2	3,190
Croatia	4,742	83,796	1,083	110	2	2,146
Cyprus	459	49,607	635	8	2	253
Czechia	21,711	275,270	2,086	2,885	13	1,382
Denmark	9,347	217,750	1,724	5,690	61	1,036
Estonia	352	7,766	250	54	15	547
Finland	2,422	7,159	465	74	3	1,873
France	138,104	216,302	2,218	48,009	35	69,059
Germany	186,908	522,718	2,304	57,663	31	107,508
Greece	18,311	139,046	1,734	912	5	14,096
Hungary	12,813	137,755	1,261	617	5	8,453
Ireland	4,833	69,095	1,169	813	17	295
Italy	145,226	480,766	2,503	6,373	4	56,855
Latvia	1,302	20,153	570	90	7	251
Lithuania	2,968	45,467	899	70	2	731
Luxembourg	1,409	543,089	2,980	685	49	218
Malta	83	261,285	204	2	2	170
Netherlands	13,241	354,112	828	6,255	47	5,450
Poland	27,885	89,395	738	1,611	6	6,773
Portugal	17,653	191,412	1,721	617	3	20,339
Romania	23,964	100,521	1,121	334	1	6,495
Slovakia	2,549	51,989	478	106	4	1,281
Slovenia	18,480	911,559	9,176	642	3	861
Spain	119,577	236,326	2,804	14,415	12	113,627
Sweden	3,831	8,563	419	990	26	927
Total EU-27	822,624			160,403		441,069
Iceland	27	267	93	0	0	3
Liechtenstein	22	139,338	674	11	48	1
Norway	4,462	11,604	956	3,079	69	77
Switzerland	22,749	550,999	3,056	7,978	35	19,408
Türkiye	7,978	10,225	120	535	7	3,222

Source: European Environment Agency (EEA), Economic losses from weather- and climate-related extremes in Europe (2025)

Climate change: impacts

Types of changes to a region's hazard profile

Climate changes can alter intensity (or magnitude), frequency, duration, timing (by seasonality and speed of onset) and spatial extent of a given hazard in a certain region.



Source: [FAQ 12.3 Figure 1](#) (Types of changes to a region's hazard profile) in [IPCC \(2021\) Climate Change 2021 – The Physical Science Basis](#)

Climate change: impacts

International Panel on Climate Change (IPCC) – 6th Assessment Report (AR6)

Source: Table 12.7 in [IPCC \(2021\) Climate Change 2021 – The Physical Science Basis](#)

Region	Climatic Impact-driver																												
	Heat and Cold				Wet and Dry						Wind			Snow and Ice				Coastal and Oceanic				Other							
	Mean air temperature	Extreme heat	Cold spell	Frost	Mean precipitation	River flood	Heavy precipitation and pluvial flood	Landslide	Aridity	Hydrological drought	Agricultural and ecological drought	Fire weather	Mean wind speed	Severe wind storm	Tropical cyclone	Sand and dust storm	Snow, glacier and ice sheet	Permafrost	Lake, river and sea ice	Heavy snowfall and ice storm	Hail	Snow avalanche	Relative sea level	Coastal flood	Coastal erosion	Marine heatwave	Ocean acidity	Air pollution weather	Atmospheric CO ₂ at surface
Mediterranean (MED)	●	●	●	●	●	5						6	7			●	●	●				●	●	2	●	●	●	●	
Western and Central Europe (WCE)	●	●	●	●			4									●	●	●					●	2	●	●		●	
Eastern Europe (EEU)	●	●	●	●												●	●	●										●	
Northern Europe (NEU)	●	●	●	●	●	1		●				●				●	●	●				●	8	2,3	●	●		●	●

High confidence of decrease	Medium confidence of decrease
Low confidence in direction of change	Not broadly relevant
Medium confidence of increase	High confidence of increase

1. Excluding southern UK.
2. Along sandy coasts and in the absence of additional sediment sinks/sources or any physical barriers to shoreline retreat.
3. The Baltic Sea shoreline is projected to prograde if present-day ambient shoreline change rates continue.
4. For the Alps, conditions conducive to landslides are expected to increase.
5. Low confidence of decrease in the southernmost part of the region.
6. General decrease except in Aegean Sea.
7. Medium confidence of decrease in frequency and increase in intensities.
8. Except in the northern Baltic Sea region.

- Already emerged in the historical period (medium to high confidence)
- Emerging by 2050 at least in scenarios RCP8.5/SSP5-8.5 (medium to high confidence)
- Emerging after 2050 and by 2100 at least in scenarios RCP8.5/SSP5-8.5 (medium to high confidence)

FLOODS

An aerial photograph of a city square in Lugo di Romagna, Italy, completely inundated with muddy brown floodwater. The water reaches the second-story windows of the surrounding buildings. In the center, a large, circular stone tower with a crenellated top stands prominently. To its right is a large, lush green park area. The square is filled with cars and some small boats floating in the water. The overall scene depicts a severe flooding event.

Lugo di Romagna (RA), May 2023
Source: Avalon/Sintesi

Floods

NatCat modelling: the hazard component



Fluvial (riverine) flooding



Pluvial flooding



Flash flooding

Floods

NatCat modelling: the hazard component



Fluvial (riverine) flooding



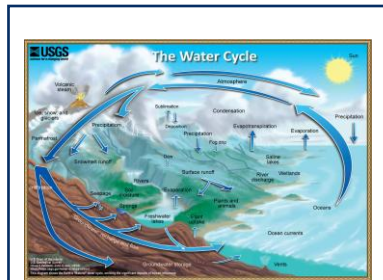
Pluvial flooding



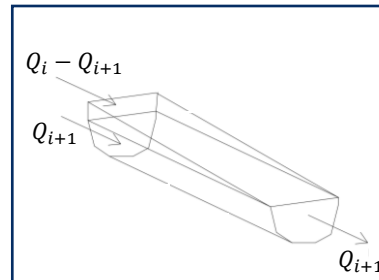
Flash flooding



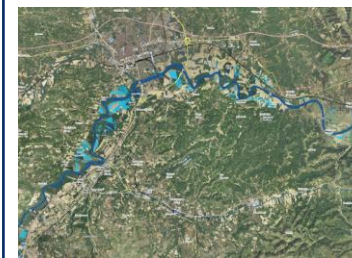
Stochastic
Precipitation Events



Rainfall-runoff
model



River routing



Flooding module

Period (Year)	Event ID	Event Date	Period Weight
1	100	04 Feb	$2 \cdot 10^{-5}$
	500	19 Mar	$2 \cdot 10^{-5}$
2	300	29 Oct	$2 \cdot 10^{-5}$
	-	-	-
...
49,999	200	30 Nov	$2 \cdot 10^{-5}$
	900	27 Dec	$2 \cdot 10^{-5}$

Period Event
Table (PET)

$\sim 10^4 \div 10^5$ **stochastic realizations** of the **next year** in terms of **rainfall events**

$\sim 10^4 \div 10^5$ **stochastic realizations** of the **next year** in terms of **flood events**

Floods

NatCat modelling: the hazard component



Fluvial (riverine) flooding



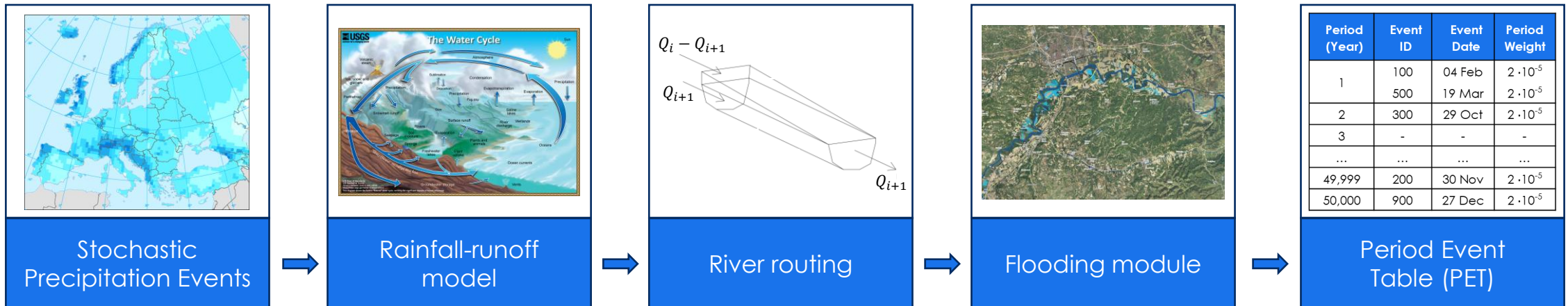
Pluvial flooding



Flash flooding

Main activities:

- **Methodological review** of vendor models
- **Calibration** of vendor models with **internal claims**
- Model **extensions** to perform forward-looking analysis across different **climate-change scenarios**.
- Development of **model integrations**:
 - **Precipitation**
 - **Digital Elevation Model (DEM)**



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Floods

Precipitation

Issue:

NatCat models are calibrated on a **continental scale**, frequently referencing **dated datasets**.

Activities:

- 1 Bridge the gap between **commercial release cycles** and the **rapid evolution** of:
 - availability of **new/updated datasets**
 - **scientific literature**.
- 2 Analyze forward-looking **climate scenarios** (i.e., CMIP5 and CMIP6).

Floods

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ANALYSIS OF RAIFALL DATASETS

OBSERVATIONAL DATASETS

- **POINT**;
- **GRIDDED** (from proper **spatial interpolations**).

REANALYSIS (GRIDDED)

- **GLOBAL**;
- **REGIONAL** (**convection-permitting**).

Floods

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 - **scientific literature**.



ANALYSIS OF RAIFALL DATASETS

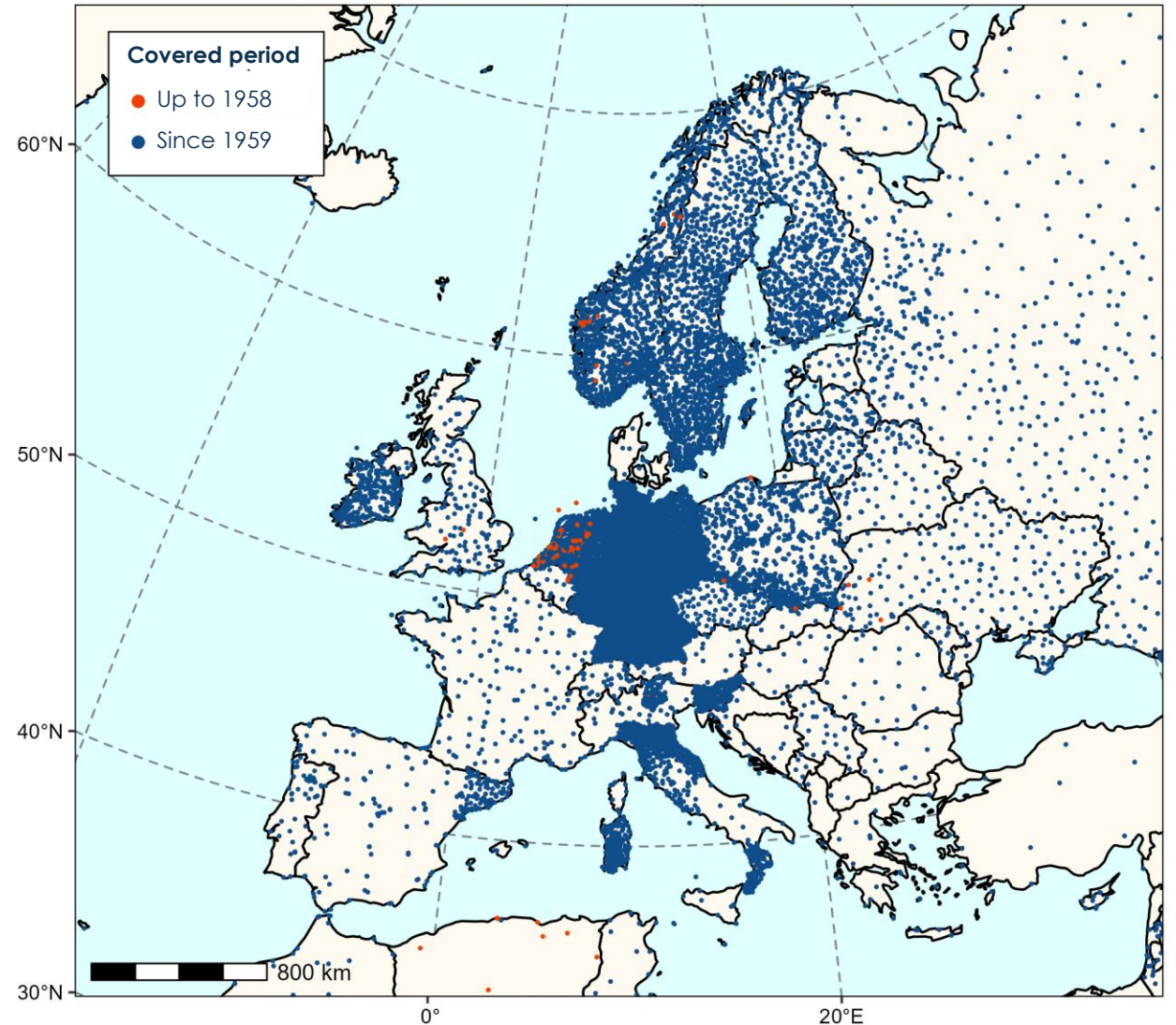
OBSERVATIONAL DATASETS

- **POINT**;
- **GRIDDED** (from proper **spatial interpolations**).

E-OBS Copernicus Climate Change Service

- **Daily** precipitation
- **Gridded**, resolution:
 - 0.25° (~27 km)
 - 0.1° (~11 km)
- **1950-2025** (v32.0e)
- **Publicly available**

Spatial distribution of rainfall gauging stations E-OBS v21.0e



Source: Analysis of **E-OBS** dataset performed by Unipol

Floods

Precipitation

Issue:

NatCat models are calibrated on a **continental scale**, frequently referencing **dated datasets**.

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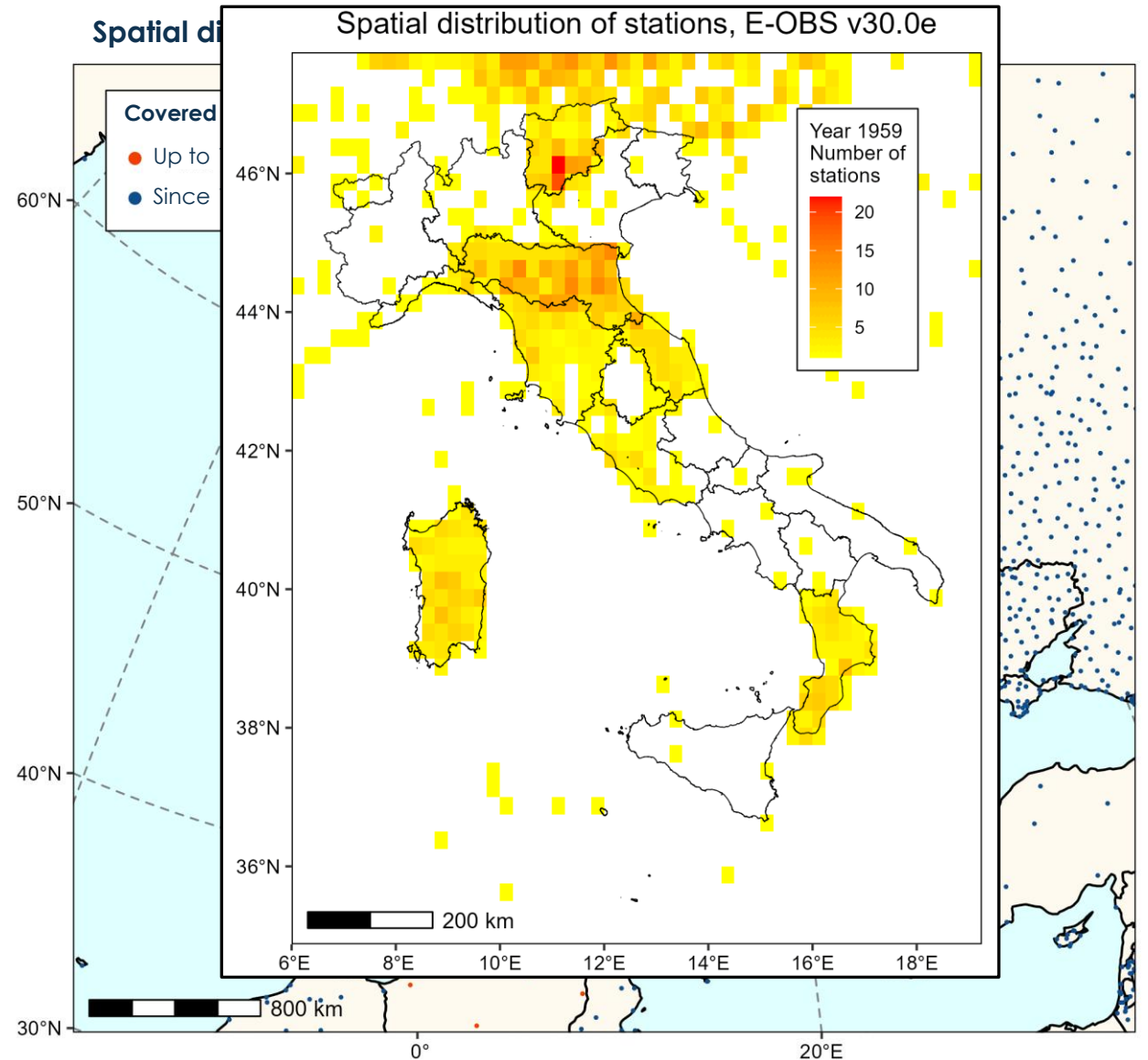
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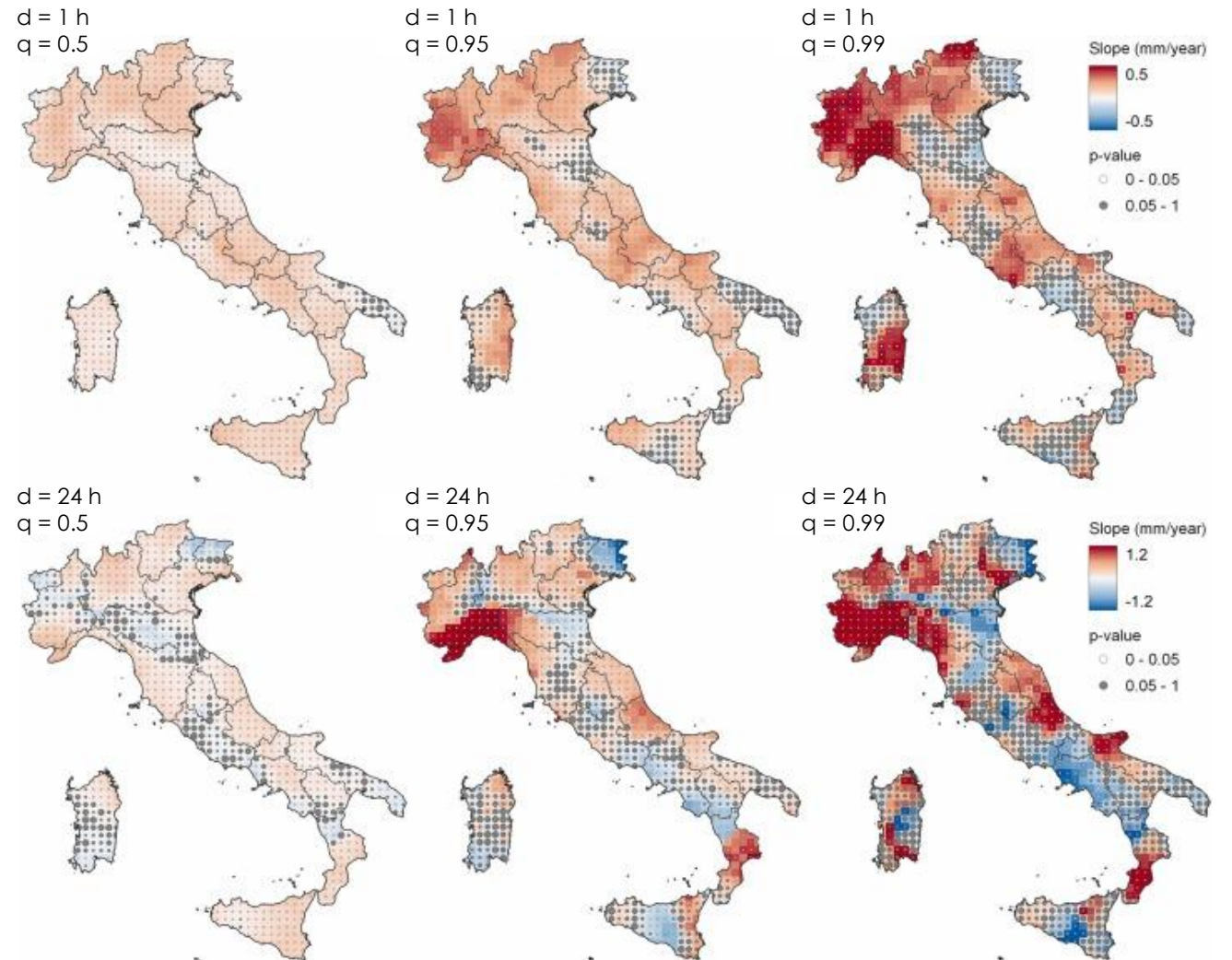
OBSERVATIONAL DATASETS

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I²-RED (Improved Italian - Rainfall Extreme Dataset)
([Mazzoglio et al., 2020](#); [Water MDPI](#))

- AMS, d = 1, 3, 6, 12, 24 h
- 1916-2022
- **Restricted access**

Slopes of the quantile regressions



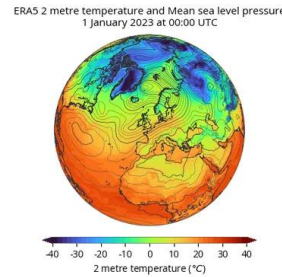
Source: [Mazzoglio et al. \(2025; J. Hydrol. Reg. Stud.\)](#)

Precipitation

CLIMATE REANALYSIS

Datasets combining past observations with models to generate consistent time series of multiple climate variables.

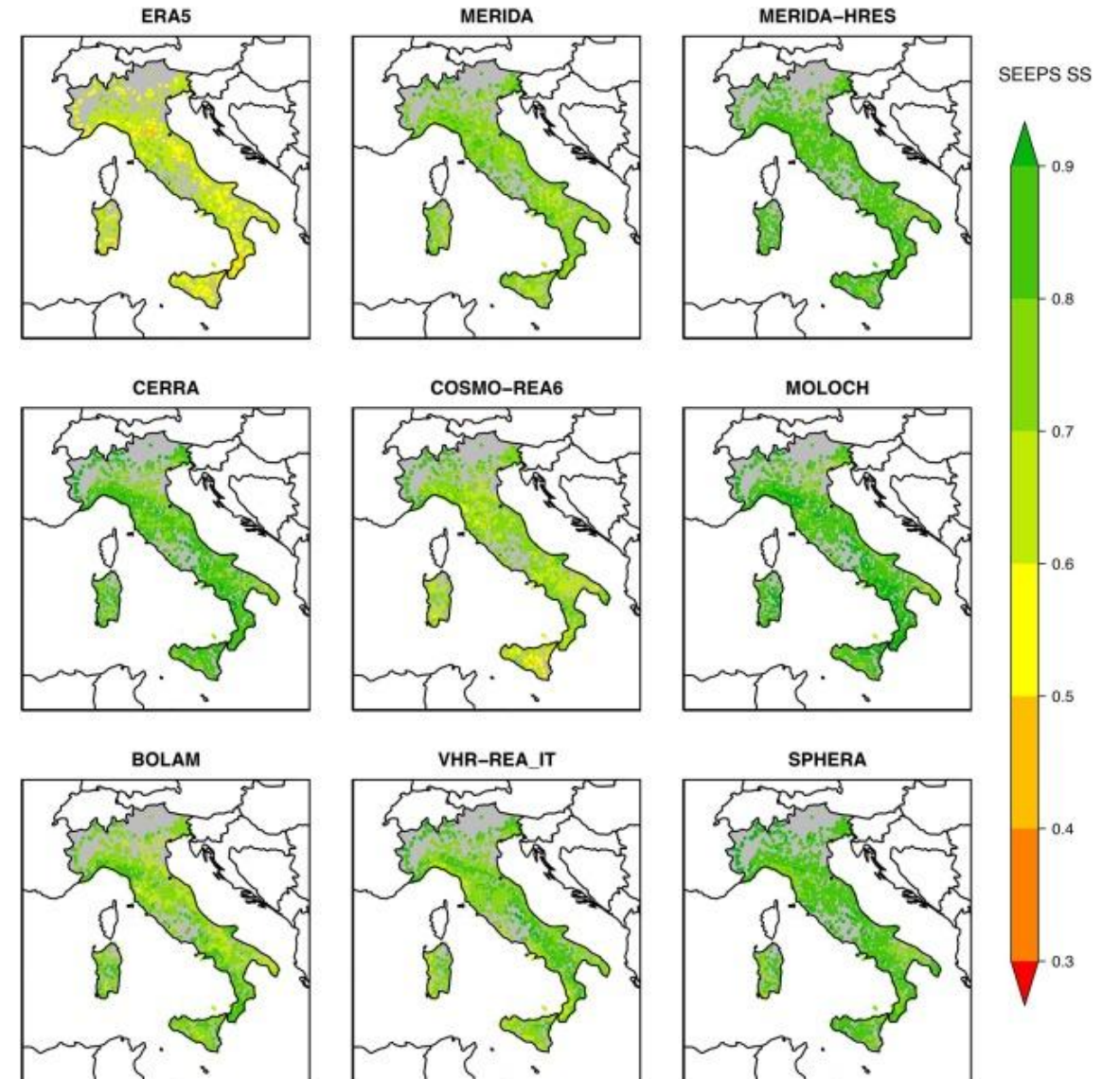
GLOBAL
(e.g., ERA5)



REGIONAL

Details of the reanalysis products considered in [Cavalleri et al. \(2024\)](#)

Name	Devel. group	NWP Model	I.C. and B. C.	Horiz. grid	Conv- perm.
ERA5	ECMWF	IFS CY41R2	/	0.25°	No
CERRA	ECMWF	ALADIN	ERA5	5.5 km	No
COSMO- REA6	DWD	COSMO	ERA- Interim	6 km	No
MERIDA	RSE	WRF-ARW v3.9	ERA5	0.07°	No
BOLAM	LaMMA	BOLAM	ERA5	0.07°	No
MERIDA- HRES	RSE	WRF	ERA5	0.04°	Yes
MOLOCH	LaMMA	MOLOCH	BOLAM	0.0247°	Yes
VHR-REA_IT	CMCC	COSMO-CLM v5.0	ERA5	0.02°	Yes
SPHERA	ARPAE	COSMO v5.05	ERA5	0.02°	Yes



Source: Extract of Table 1 from [Cavalleri et al. \(2024; Atmos. Res.\)](#)

Source: [Cavalleri et al. \(2024; Atmos. Res.\)](#)

Precipitation

FORWARD-LOOKING CLIMATE SCENARIOS (CMIP5, CMIP6)

By providing a more realistic description of convective precipitation and complex topography, **Convection-Permitting Models (CPMs)** offer a superior framework for capturing **sub-daily rainfall extremes**.

Earth's Future

[Dallan et al. \(2024; Earth's Future\)](#)

Research Article | [Open Access](#) | [CC](#) | [i](#)

Dynamical Factors Heavily Modulate the Future Increase of Sub-Daily Extreme Precipitation in the Alpine-Mediterranean Region

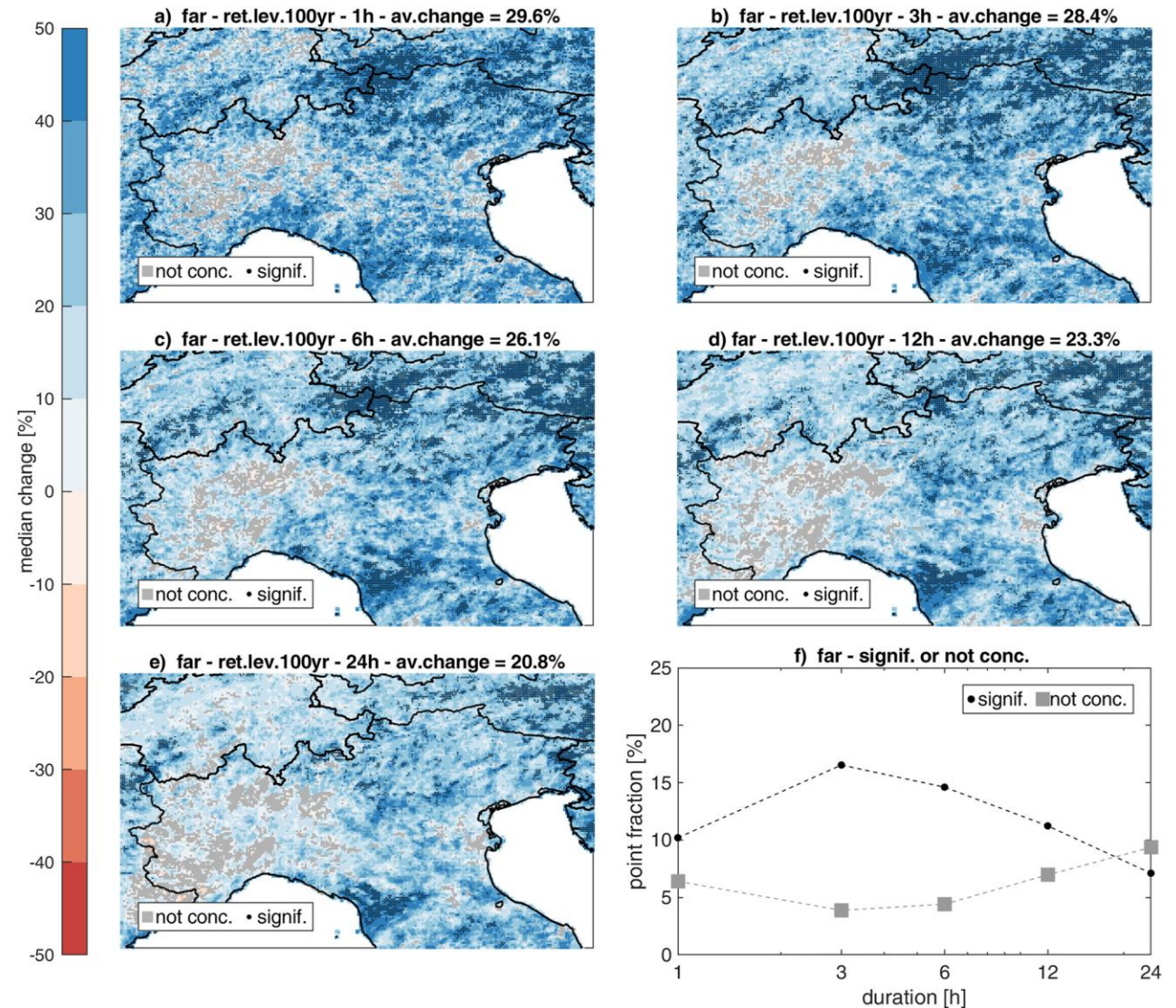
[Eleonora Dallan](#) | [Francesco Marra](#) | [Giorgia Fosser](#) | [Marco Marani](#) | [Marco Borga](#)

First published: 28 November 2024 | <https://doi.org/10.1029/2024EF005185> | [VIEW METRICS](#)

Dataset: 9 CPMs produced within the FPS Convection (CORDEX Flagship Pilot Study on Convective Phenomena over Europe and the Mediterranean; [Coppola et al., 2020; Clim. Dyn; Fosser et al., 2024; npj Clim. Atmos. Sci.](#)).

Highlights: General intensification of extremes across all durations (1-24 hours), stronger at **shorter durations** and rarer probabilities (**higher RP**).

RCP8.5, 2090–2099 - Ensemble-median changes for RP = 100 years



Source: [Dallan et al. \(2024; Earth's Future\)](#)

Digital Elevation Model (DEM)

Issue:

NatCat models are calibrated on a **continental scale**, frequently referencing **dated DEMs**.

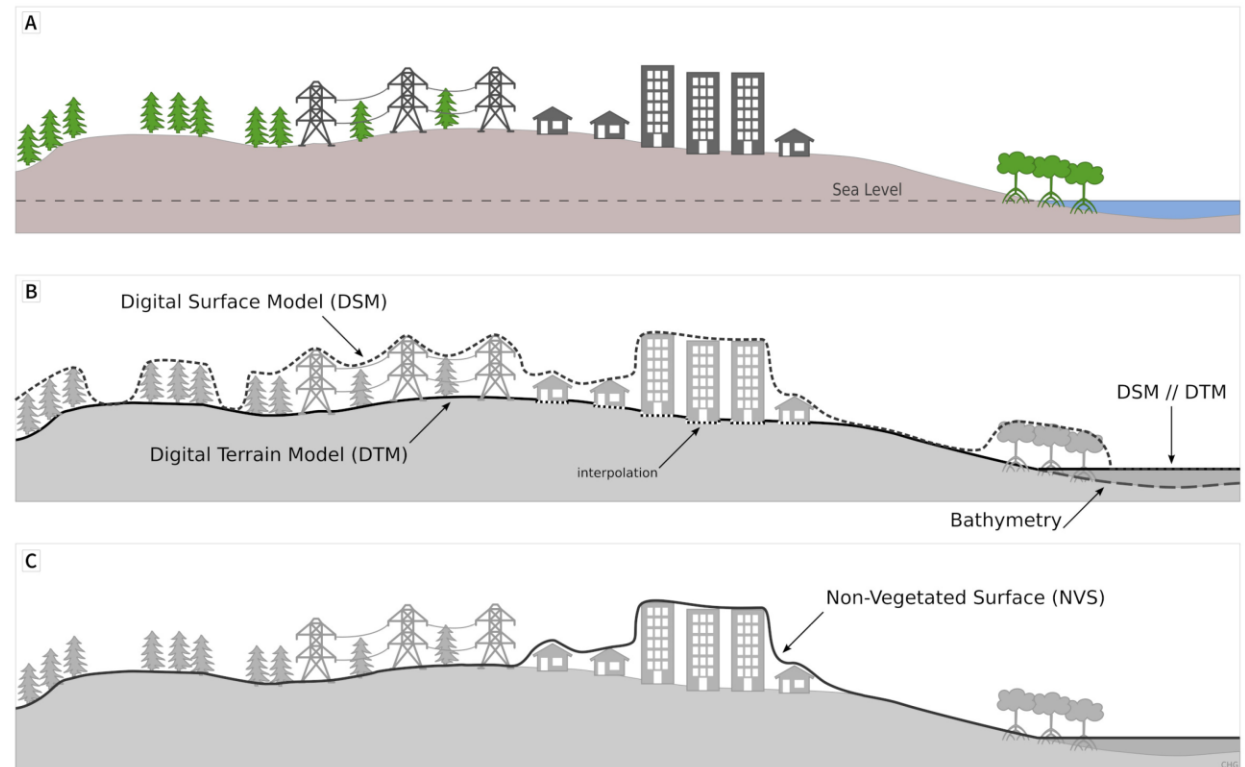
Activities:

1 **Validation** of vendor models' flood hazard maps with **reference flood hazard maps**:

- [PGRA](#) maps by ISPRA (Italian Institute for Environmental Protection and Research)
- JRC (Joint Research Center) ([Baugh et al., 2026](#))

2 **Complementing** vendor models with **flood susceptibility** estimated based on available DEMs (useful also for **pricing** purposes):

- High-Resolution regional **LiDAR** (Light Detection and Ranging; **0.5÷5 m**)
- [TINITALY](#) (provided by [INGV](#)) (**10 m**)
- **Quasi-global DEMs (1 arc-sec, ~30m)** (e.g., [Meadows et al. \(2024; Int. J. Digit. Earth\)](#))



Source: [Guth et al. \(2021; Remote Sensing MDPI\)](#)

Table 1. Overview of freely-available, 1 arc-second global DEM products.

Global DEM	Spatial coverage	Data acquisition	Primary data source
SRTM (v3)	56°S–60°N	2000 (11 days)	C-band radar
ASTER (v3)	83°S–83°N	2000–2013	Stereo NIR imagery
AW3D30 (v3.2)	82°S–82°N	2006–2011	Stereo pan imagery
NASADEM (v1)	56°S–61°N	2000 (11 days)	Reprocessed C-band radar
Copernicus DEM (v2022)	Global	2011–2015	Reprocessed X-band radar
FABDEM (v1.2)	Global	2011–2015	Copernicus DEM

Source: [Meadows et al. \(2024; Int. J. Digit. Earth\)](#)

Floods

Quasi-global DEMs

Spatial resolutions necessary for regional-scale flood modelling: variously estimated at ~5÷50 m ([Savage et al., 2016; Hydrol. Process.; Winsemius et al., 2019; Front. Earth Sci.](#)).



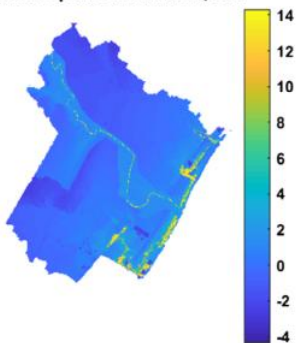
IDENTIFICATION OF APPROPRIATE DEMs



DEM-BASED APPROACHES FOR FLOOD-PRONE AREAS DELINEATION

GEOMORPHIC CLASSIFIERS

Geomorphic Flood Index, GFI



[Manfreda et al. \(2014; J. Hydrol.\)](#)

[Samela et al. \(2017; Adv. Water Resour.\)](#)

[Manfreda & Samela \(2019; J. Flood Risk Manag.\)](#)

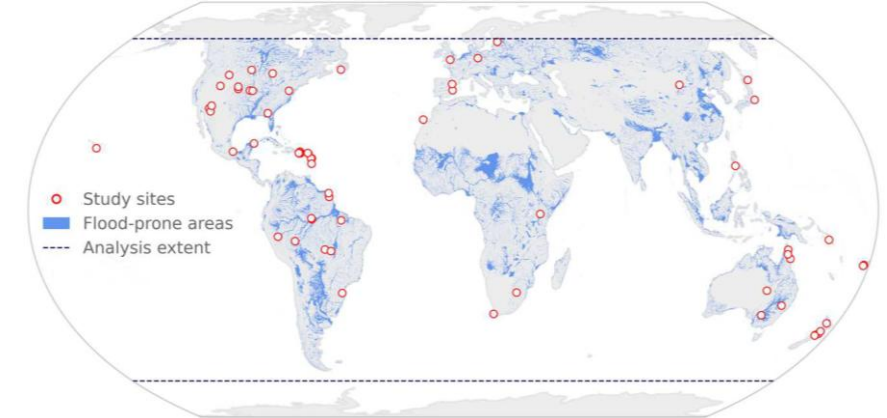
[Magnini et al. \(2022; NHSS\)](#)

[Magnini et al. \(2023; HSJ\)](#)

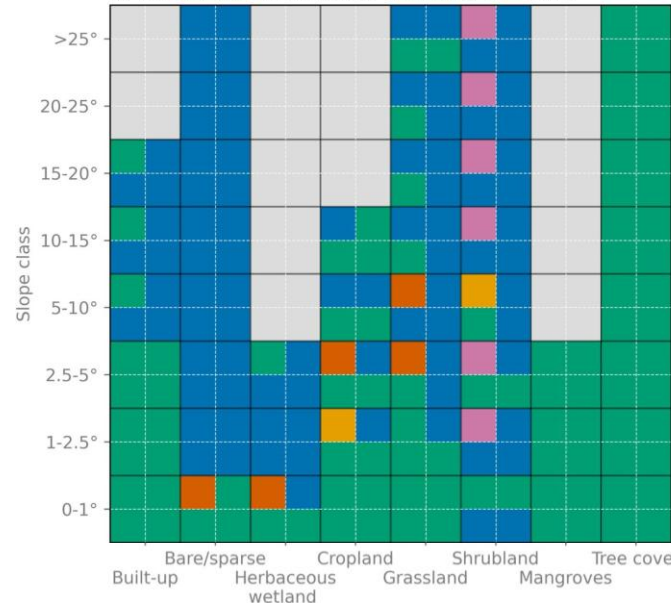
Best-performing DEM by land cover and slope class, considering (a) all DEMs, and (b) excluding FABDEM (licensing fee for commercial applications).

Source: [Meadows et al. \(2024; Int. J. Digit. Earth\)](#)

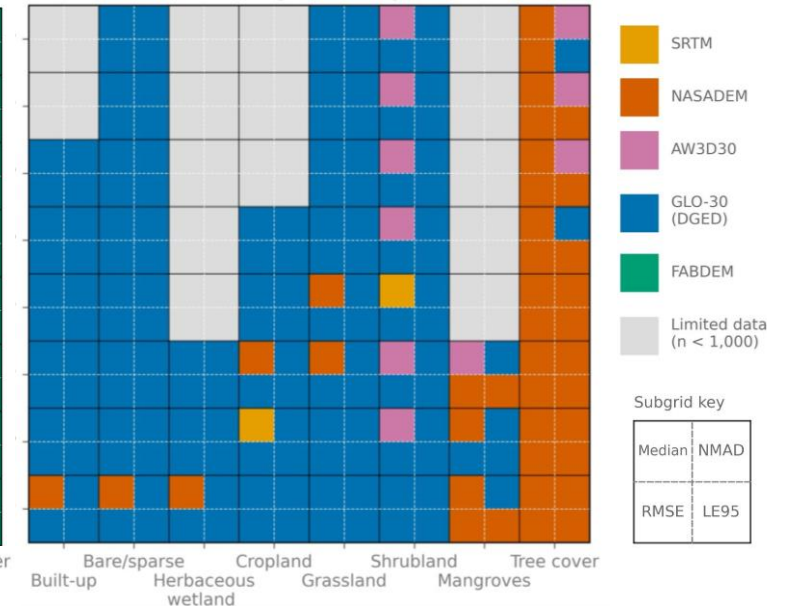
a) Location of 65 study sites with reference to flood-prone areas globally



a) Performance summary, including all DEMs



b) Performance summary, excluding FABDEM





SEVERE CONVECTIVE STORMS

Thunderstorm bringing thunder and lightning, along with hail, heavy rain and strong winds.

Source: FloodFlash

Severe Convective Storms

Convective storms (or **thunderstorms**): “severe local storms associated with lightning, heavy rain, hail, strong winds and sudden temperature changes. They can occur all year round but are most common during **summer**”.
([Royal Meteorological Society](#))

Modelling of **severe thunderstorm perils** within NatCat models:

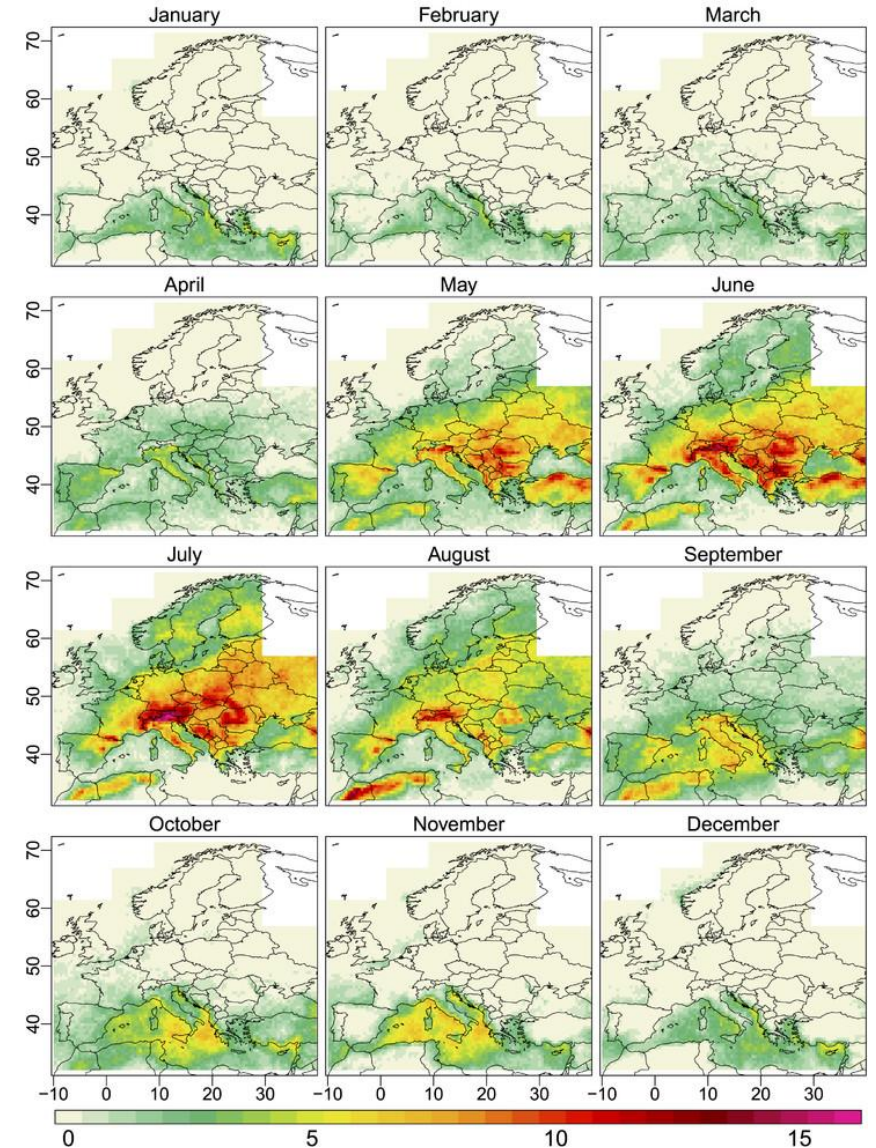


A thunderstorm is classified as “**severe**” if it produces:

- **hail ≥ 2 cm**, or
- convective **wind gusts ≥ 25 m/s**.

There is no real physical difference around these thresholds, but they are **useful markers** as the likelihood of damage increases sharply beyond them
([Doswell, 2001; Meteorol. Monogr.](#))

Mean annual number of days with thunderstorm within months (lightning data)



Source: [Taszarek et al. \(2019; J. Clim.\)](#)

Severe Convective Storms

Hailstorms: July 2023 Events

Exceptional storm phenomena in **Northern Italy** in terms of intensity and frequency:

- 4 consecutive days of **hail >10 cm** in Lombardy, Emilia-Romagna, Veneto, and Friuli-Venezia Giulia.
- New **European record** for hailstone size (~19 cm).

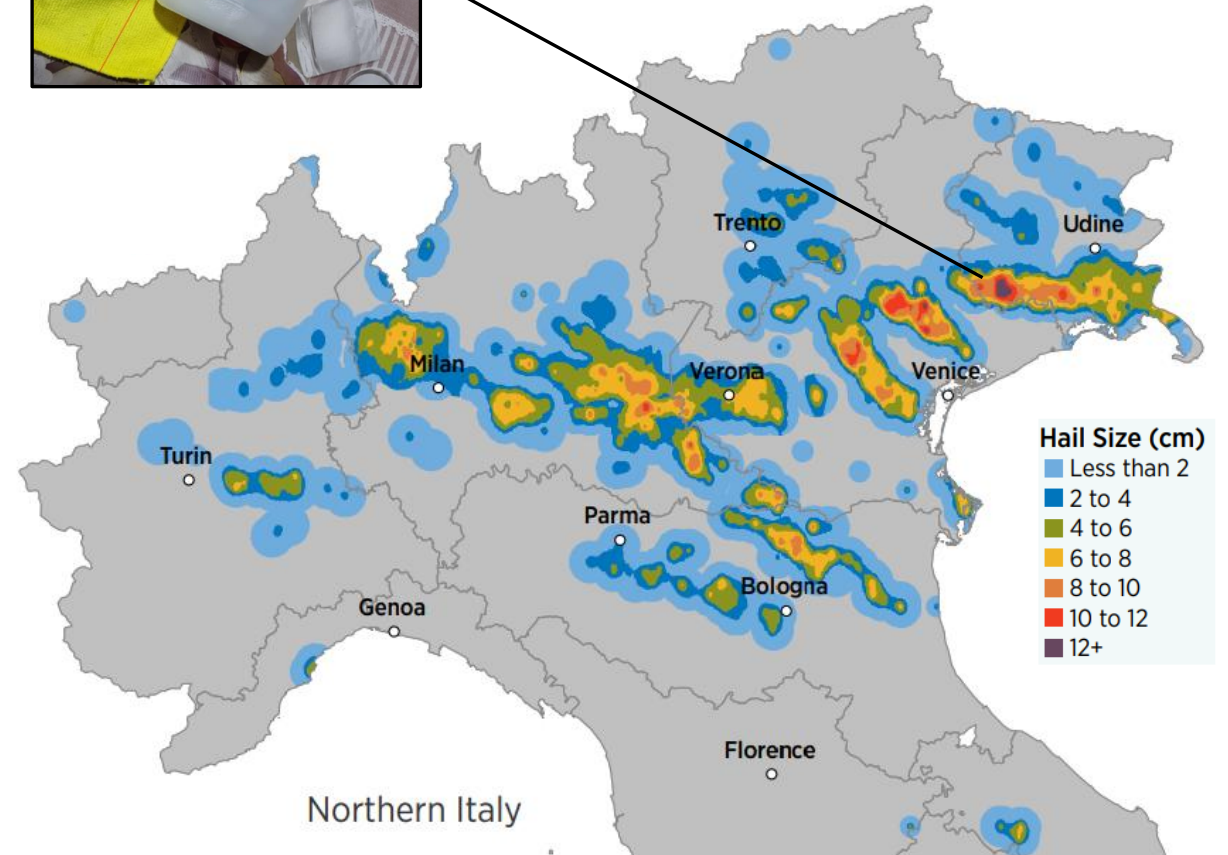


**Hail size record, 24 July 2023
Azzano Decimo (PN)**

Fonte: Tornado in Italia - Marilena Tonin

Estimated Hail Footprints, 18-25 July 2023

Source: [Gallagher Re \(2023, Q3\)](#) based on data by [ESWD \(European Severe Weather Database\)](#)



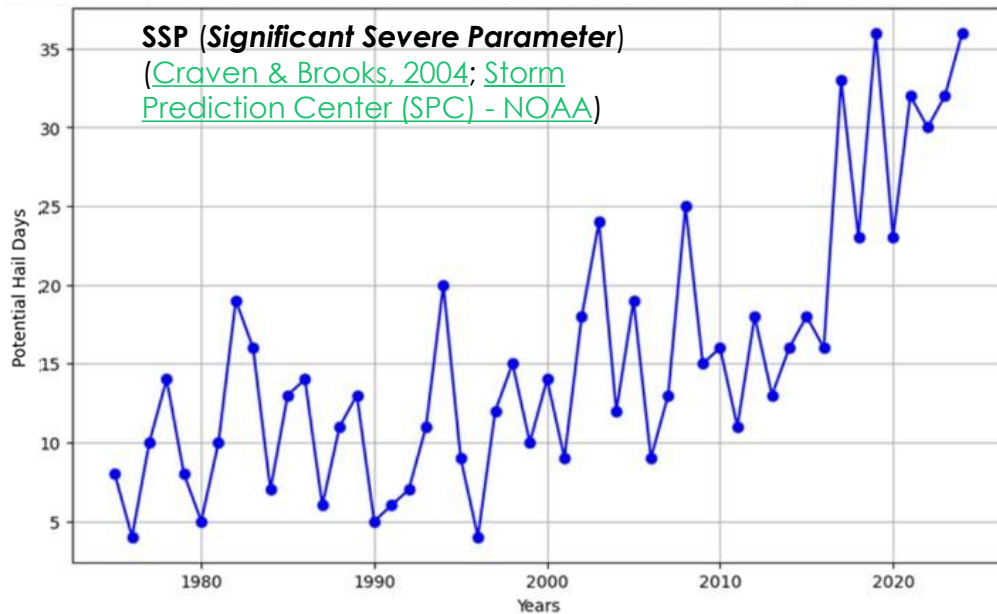
Severe Convective Storms

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Potential Hail Days (SSP > 10⁴ m³/s³) in summer (JJA) 1975-2024, Po Valley (Italy)



Source: Analysis performed by Unipol based on [ERA5](#)

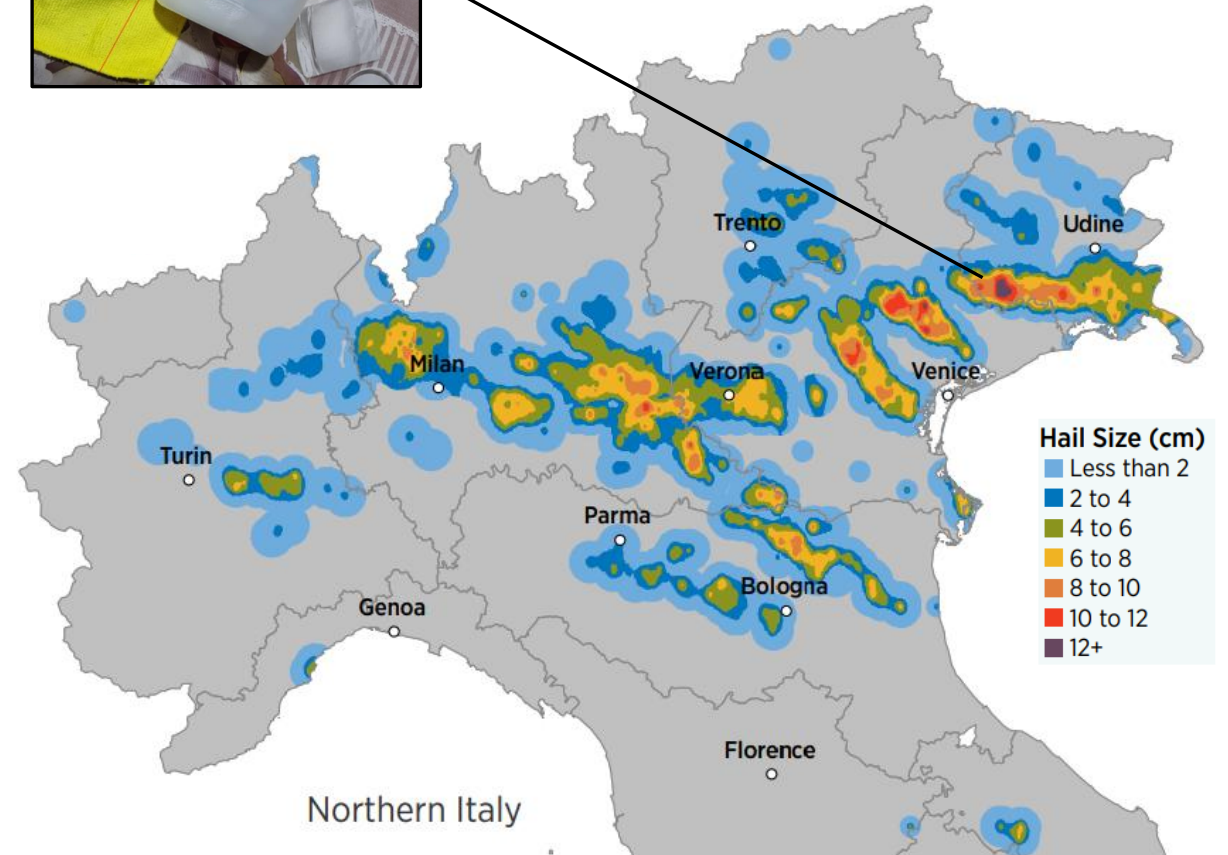


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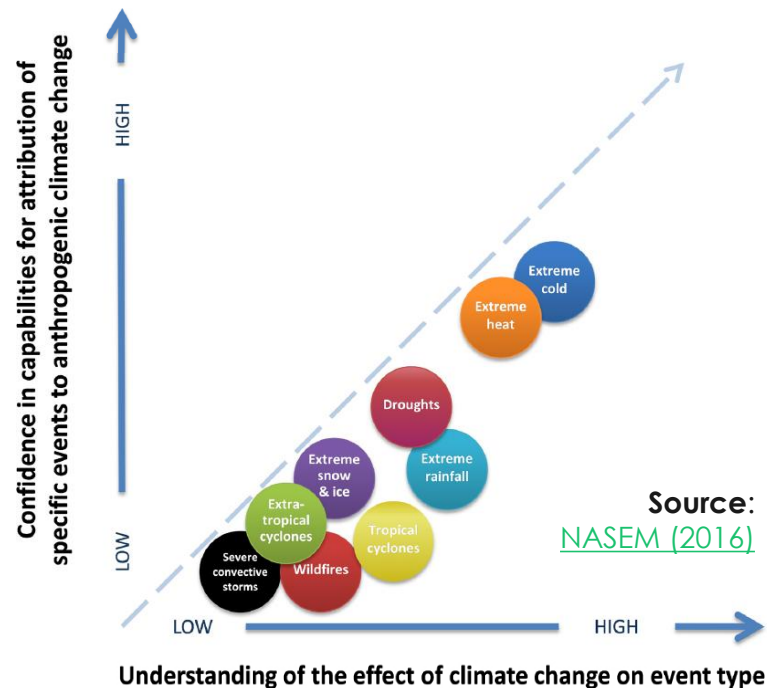


Severe Convective Storms

Impacts of climate change

AR6 ([IPCC, 2021](#)): increase in **hail reports** in Europe, but low confidence in attributing this to climate change, as it may reflect **increased reporting** (e.g., [ESWD](#) by [ESSL](#)).

Thermodynamic: atmospheric warming increases specific humidity, providing more potential energy for intense storms; however, **regional dynamics** are **complex**.

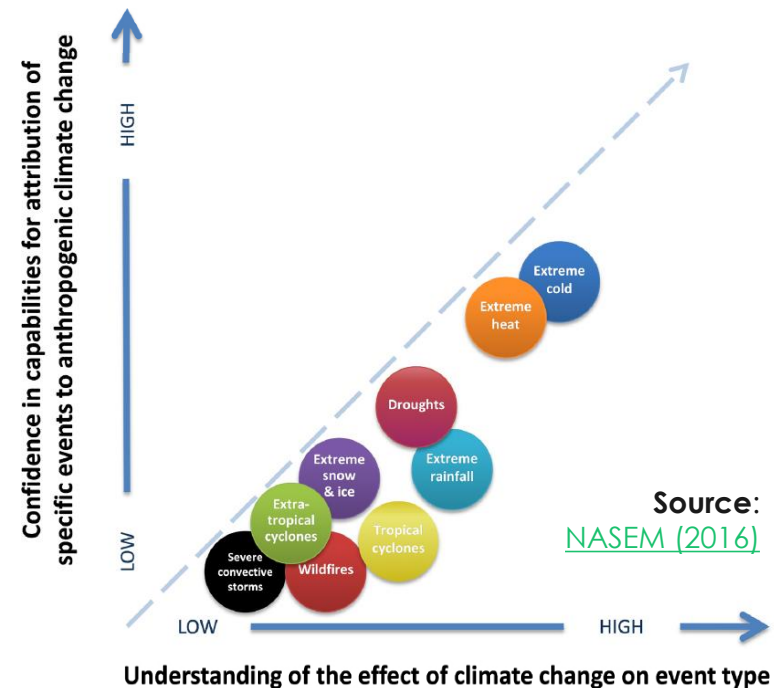


Severe Convective Storms

Impacts of climate change

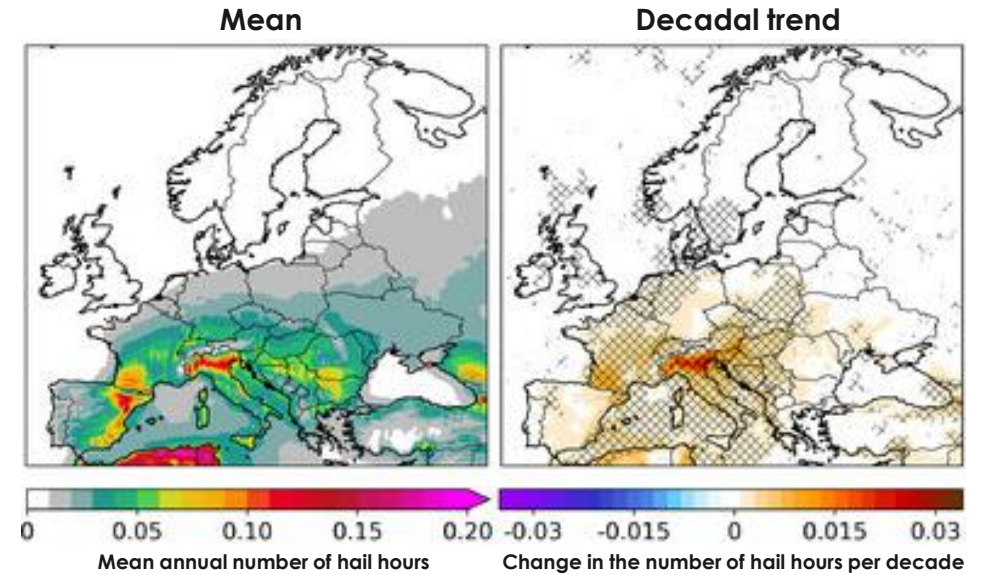
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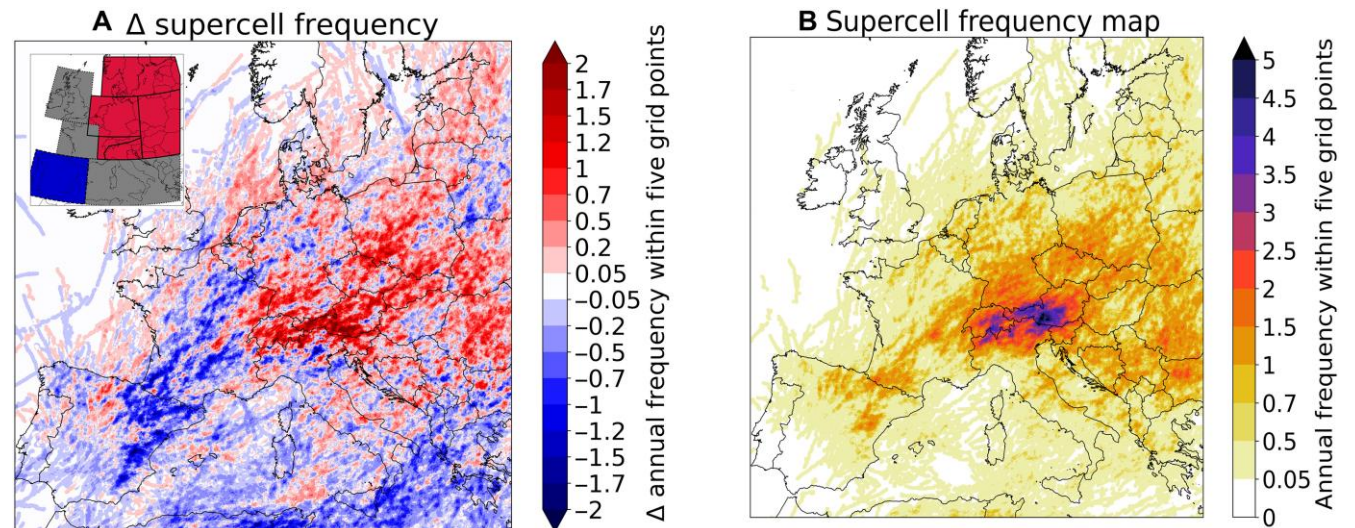


Mean annual number of hail hours (hail ≥ 5 cm) and decadal trend in the period 1950-2021 across Europe.

Source: [Battaglioli et al. \(2023; JAMC\)](#)




Supercell tracks in future climate: (A) annual average difference in supercell track frequency [future – present]; (B) Annual average supercell track frequency at +3°C.



Source: [Feldmann et al. \(2025; Sci. Adv.\)](#)

WINDSTORM



Damage caused by an uprooted tree on Oxford Street in Burnham-on-Sea (UK).

Source: BBC

A Windstorm NatCat model for Italy

Windstorm: an [extratropical cyclone](#) (low-pressure system) that **brings high-speed winds** and significant damage to European infrastructure, most commonly in **winter**.

- Modeling windstorms in **Italy** is challenging because they are frequently associated with convective activity.
- **Italy:** one of the most affected countries in Europe (estimated annual losses > 0.5 billion €; [Spinoni et al., 2020; JRC](#)).



Catastrophic forest blowdown caused by the Vaia Storm (October 2018) in the Italian Dolomites (Northern Italy)

Source: [guidedolomiti.com](https://www.guidedolomiti.com)

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Development of a comprehensive NatCat model to assess windstorm-related financial losses in **Italy**.

Hazard component: calibration of a stochastic windstorm event set based on historical event footprints extracted from the **open-access reanalysis dataset CERRA**.



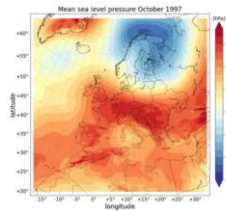
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A Windstorm NatCat model for Italy

	CERRA
Spatial domain	Europe
Spatial resolution	5.5 km
Temp. domain	1984 - 2021
Temp. resolution	1 hour
Data assimilation	3D-Var (8 runs/day)
IC/BC	ERA5
Variables	Wind gust
Expected updates	✓ (end 2024)
Provider	Copernicus CDS

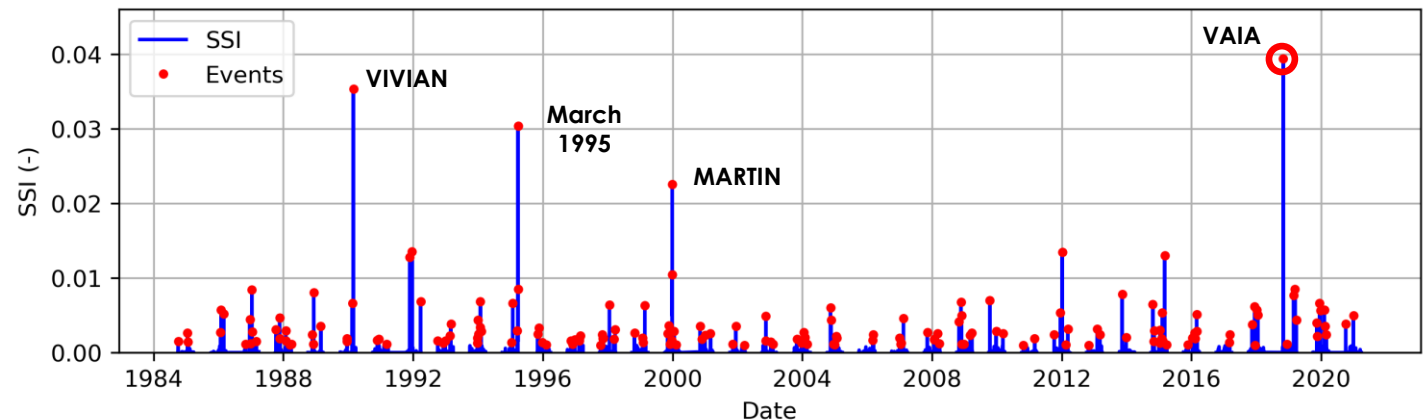
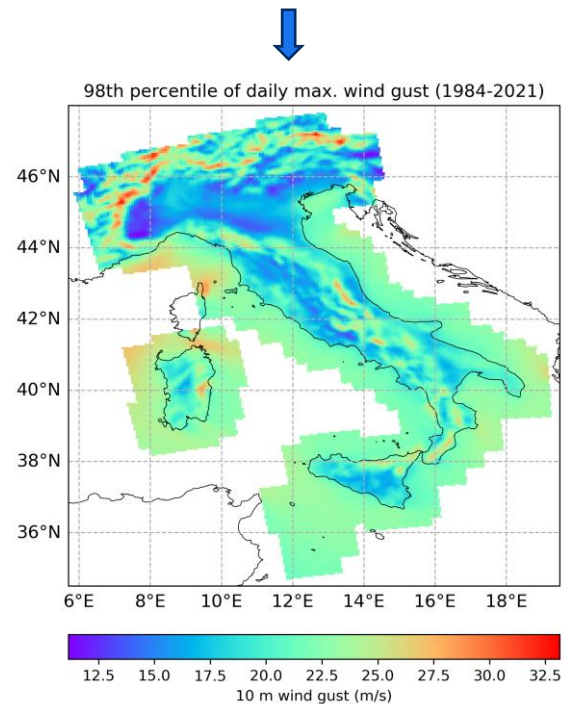
Copernicus
European
Regional
ReAnalysis
(**CERRA**)



A catastrophe model for Windstorm in Italy: developing a stochastic windstorm event set adjusted with open-access reanalysis datasets

Lorenzo Aiazzi¹, Simone Persiano¹, Michele Bottazzi², Glauco Gallotti², Antonio Petrucci², Farid Ait-Chaalal³, and Giovanni Leoncini³
¹UnipolSai Assicurazioni S.p.A., Catastrophe Risk Modeling & Mitigation, Bologna, Italy (lorenzo.aiazzi@unipolsai.it)
²Leithà S.r.l., Unipol Gruppo S.p.A., Bologna, Italy
³Moody's Risk Management Solutions, London, United Kingdom / Zürich, Switzerland

Source: [Aiazzi et al. \(2024; EGU24\)](#)



Summarizing...

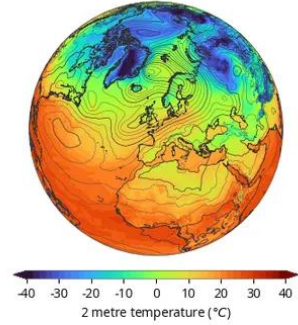


FLOOD



SEVERE CONVECTIVE STORM

ERA5 2 metre temperature and Mean sea level pressure
1 January 2023 at 00:00 UTC



WINDSTORM



A LOOK AT THE RISK INDUSTRY
RESEARCH CENTER ON CLIMATE CHANGE IMPACTS
ROVIGO, 20 MARCH 2026

Thanks!

Simone Persiano

simone.persiano@unipol.it



[LinkedIn profile](#)

