Quantification of climate change risk in insurance

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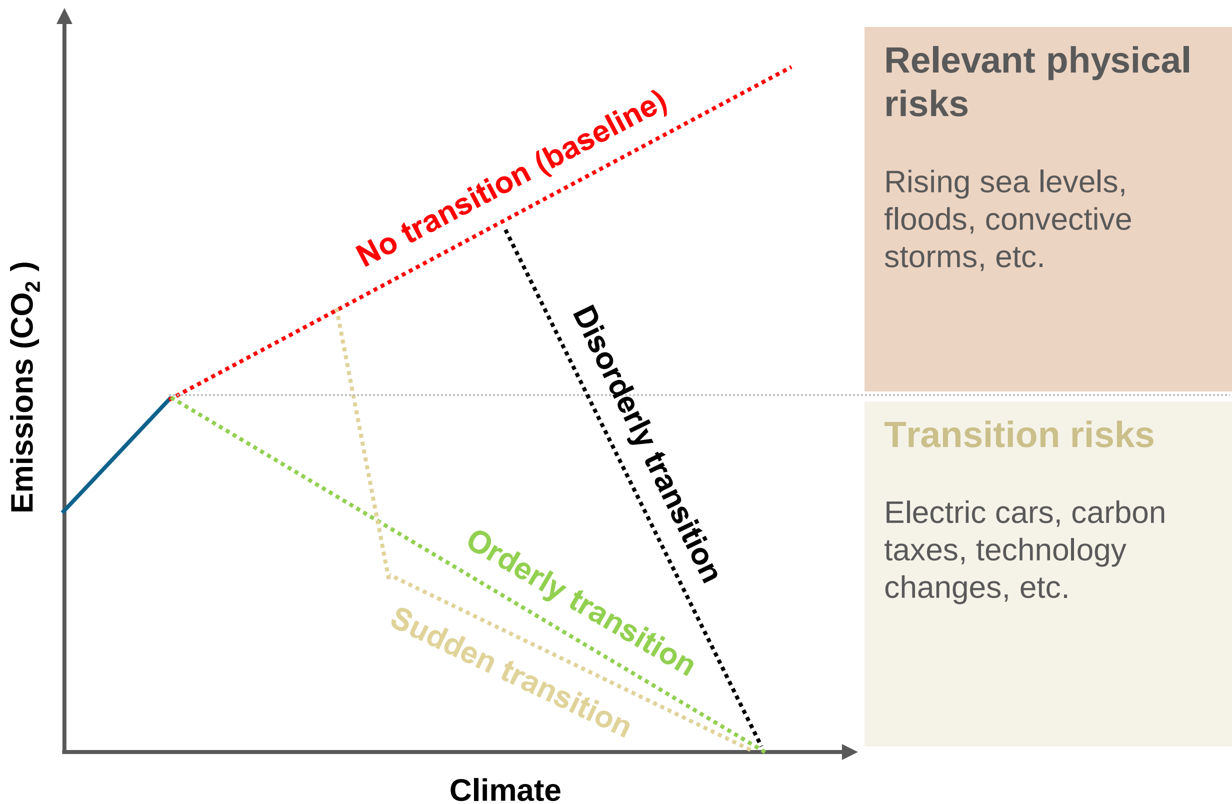
17/06/2024

Management Solutions
Making things happen

1 Scenarios to derive the impact of climate change risk

Given the uncertainty in the ambition of climate policies and greenhouse gas emissions, it is necessary to make use of climate scenarios to stimate the impacts in insurance portfolios:

Trajectories of climate risk policy [1]



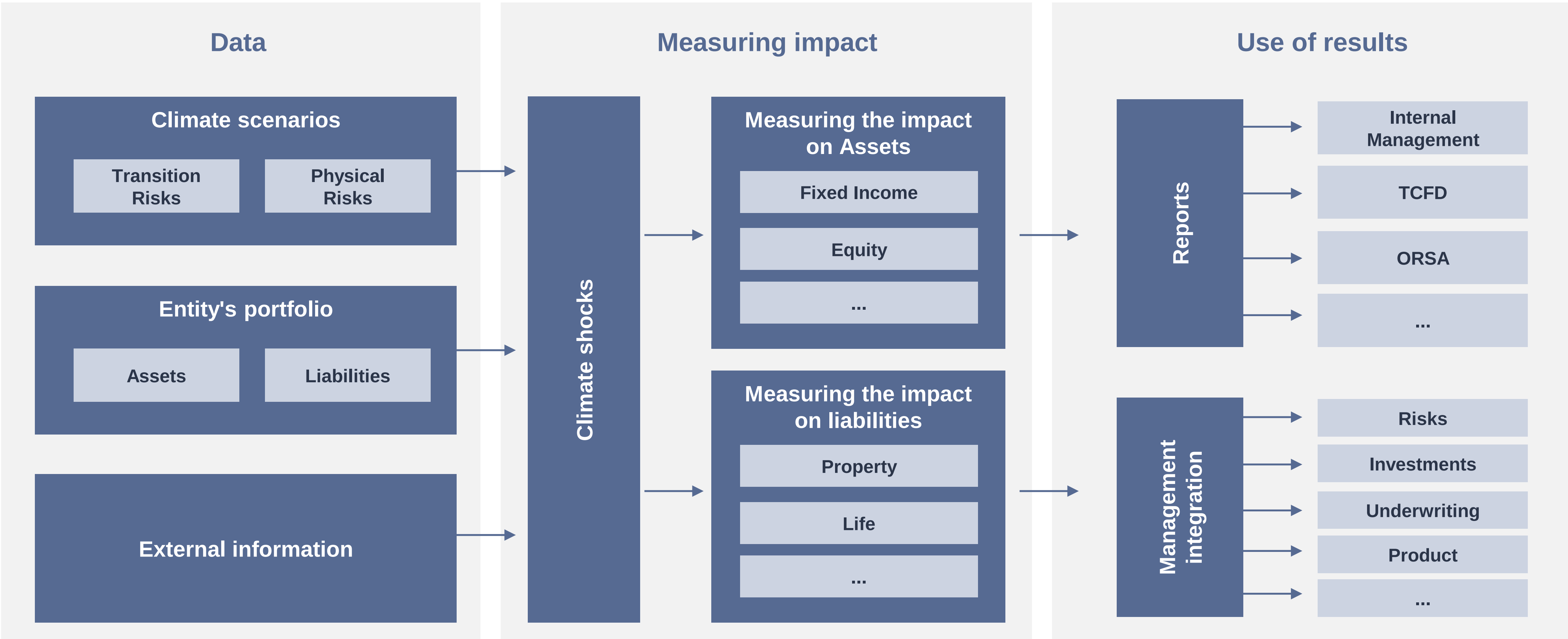
- **Without** significant **policy action**, **levels of physical risks will increase substantially**, especially over longer time horizons.
- **A climate policy** that seeks to **mitigate these physical risks** may have **significant economic impacts on certain sectors of activity and thus a high transition risk.**
- The **time horizon, stringency and anticipation of climate policies** determine the level of disruption to the economy.
- From a **risk management perspective,** climate policies can be understood as a **trade-off between long-term physical risk and short-term transient risk.**

The literature is converging on the use of **NGFS scenarios** for projecting transition risks, and **IPCC scenarios** for physical risks.

*EIOPA requires for climate risk assessment in ORSA at least one scenario with a projected temperature of +2°C, and one scenario below this threshold (preferably a temperature increase of no more than 1.5°C).

2 General framework of measurement

The following methodological scheme has been taken into account for the measurement of both transition and physical climate risk impact:



3 Link between scenarios and variables

In order to measure the impact of climate change risk, economic, energy and climate information is needed in a forward looking perspective in different scenarios to obtain the CLIMATE SHOCK.

TRANSITION

NGFS SCENARIOS

- Net Zero 2050
- Below 2ºC
- Delayed Transition
- Divergent
- NDC
- Current Policies

IAMs →

KEY PROJECTIONS

- Fossil energy production
- Electricity consumption
- Energy prices
- CO2 price
- Demand for agriculture
- GDP
- Etc.

ASSET SECTOR → CLIMATE SECTOR (CPRS) → MACROECONOMIC / ENERGY VARIABLE

PHYSICAL

IPCC SCENARIOS

- SSP1-1.9
- SSP1.2.6
- SSP2-4.5
- SSP3-7.0
- SSP5-8.5

CGMs/ RCMs →

KEY PROJECTIONS

- Precipitation
- Maximum daily temperature
- Daily minimum temperature
- Wind speed
- Evaporation
- Fire Weather Index
- Etc.

LOCATION OF THE ASSET → CLIMATE VARIABLE → PERILS

4 Rationale for each methodology

Depending on the type of portfolio, the measurement of the impact of physical risks and transition risks applies a different methodology, commonly differentiating between the investment portfolio, real estate and insurance portfolio.

	Investment Portfolio	Real estate	Non-life insurance portfolio	Life insurance portfolio
Physical risks	Measuring the impact of risks associated with weather events affecting the properties of issuers in which we hold financial instruments. **Metric:** Impact on market value of financial instruments	Measurement of the impact of risks associated with weather events affecting property owned by the insurer. **Metric:** Impact on market value of properties	Measurement of the impact of the risks associated with climatic events affecting claims in the different lines of business of the entity. **Metric:** Impact on claims incurred	Measuring the impact of temperature change on human health and hence mortality **Metric:** Impact on reserves (mortality table shock)
Transition risks	Measuring the impact of risks associated with economic and social changes that may affect the issuers in which we hold financial instruments. **Metric:** Impact on market value of financial instruments	Measuring the impact of risks associated with economic and social changes that may affect the value of the insurer's real estate. **Metric:** Impact on market value of properties	Measuring the impact of risks associated with economic and social changes that may affect the premiums of the insurance portfolio. **Metric:** Revenue impact per premiums	Measuring the impact of risks associated with PM2.5 particles affecting human health and hence mortality. **Metric:** Impact on reserves (mortality table shock)

5 Transition Scenarios - NGFS

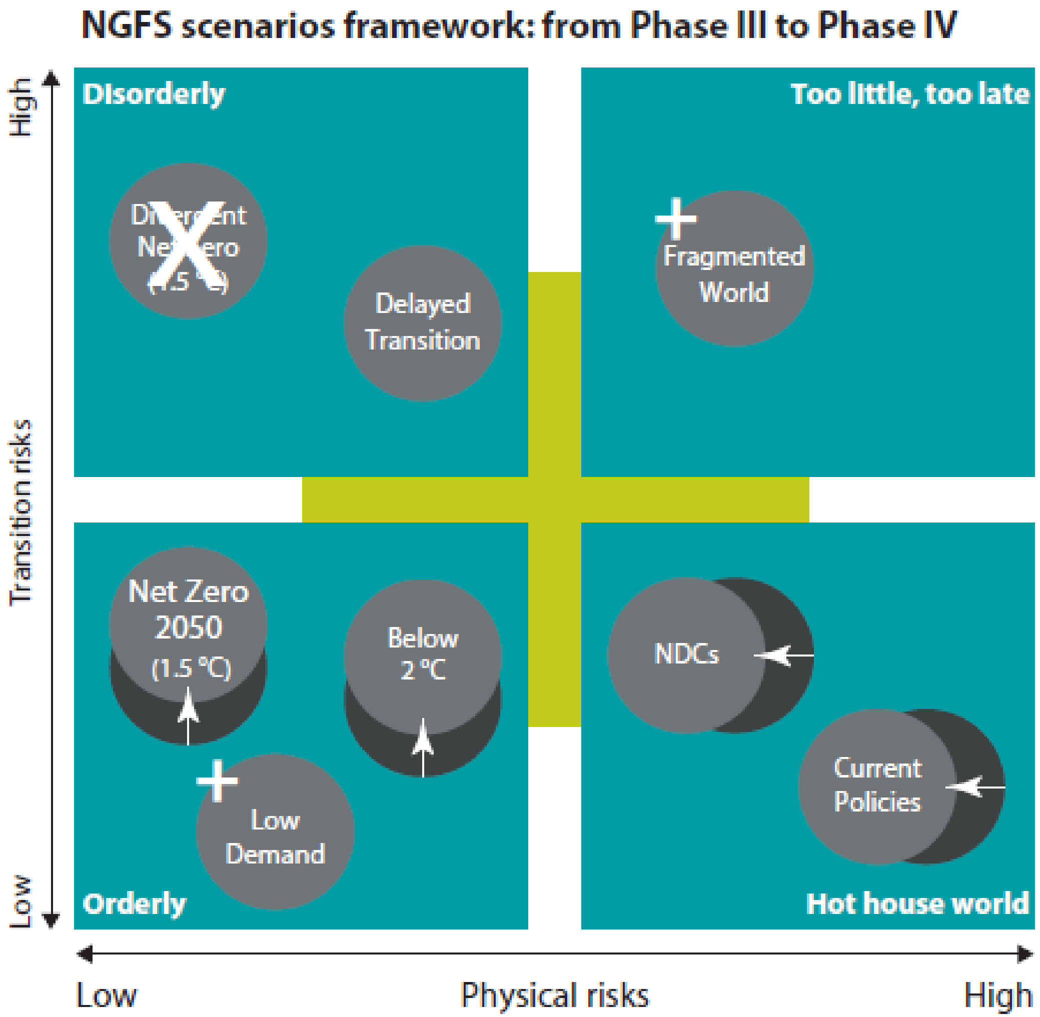


Image source: NGS: ngfs_climate_scenarios_for_central_banks_and_supervisors_phase_iv

- **Net Zero 2050:** limit global warming to 1.5°C through stringent climate policies and innovation, achieving net zero global CO2 emissions by 2050 (US, EU, UK, Canada, Australia and Japan achieve net zero emissions for all greenhouse gases).
- **Delayed Transition:** assumes that annual emissions do not decrease until 2030. Strong policies are needed to limit warming to below °2C.
- **NDCs**: includes all promised targets, even if they are not yet backed by effective policies.

5 Physical Risk Scenarios - IPCC

The IPCC, the leading authority on climate issues, regularly provides assessments of climate change, its impacts, future risks and options for mitigation and adaptation.

RCP

Representative concentration pathways (RCPs) describe different **greenhouse gas** (GHG) **emission and concentration trajectories over** the 21st century for climate modelling and impact and adaptation assessment.

The **IPCC Fifth Assessment Report** used **4** emission **scenarios** with a total radiative forcing (RF) for the year 2100 ranging from 2.6 to 8.5 W/m^2 .

	RF	RF trend	CO_2 in 2100
RCP 2.6	2.6 W/m2	Decreasing in 2100	421 ppm
RCP 4.5	4.5 W/m2	Stable in 2100	538 ppm
RCP 6.0	6.0 W/m2	Growing in 2100	670 ppm
RCP 8.5	8.5 W/m2	Growing in 2100	936 ppm

SSP

Shared socio-economic trajectories (SSPs) describe **alternative futures of socio-economic development** throughout the 21st century and what challenges these changes pose for mitigation and adaptation.

The **Sixth IPCC Report** uses the **5 SSP narratives,** with different socio-economic mitigation and adaptation challenges, in combination with the RCPs

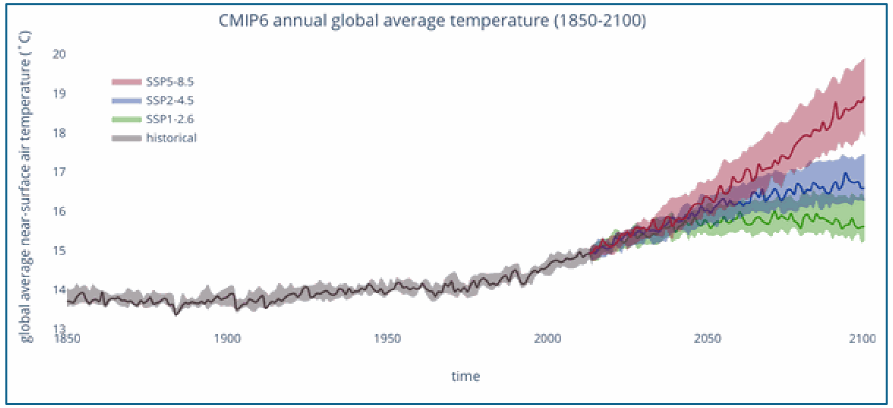
	Mitigation challenges	Adaptation challenges
SSP 1	Low	Low
SSP 2	Medium	Medium
SSP 3	High	High
SSP 4	Low	High
SSP 5	Low	High

The combination of the different socio-economic futures (SSPs) and the different emission and concentration futures (RCPs) gives rise to the new scenarios used in the IPCC Sixth Assessment Report.

Multiple SSP scenarios have been generated, combining socio-economic narratives and greenhouse gas emissions, but the following **5 scenarios** are the **most commonly used**:

SCENARIOS IN THE SIXTH ANNUAL REPORT IPCC

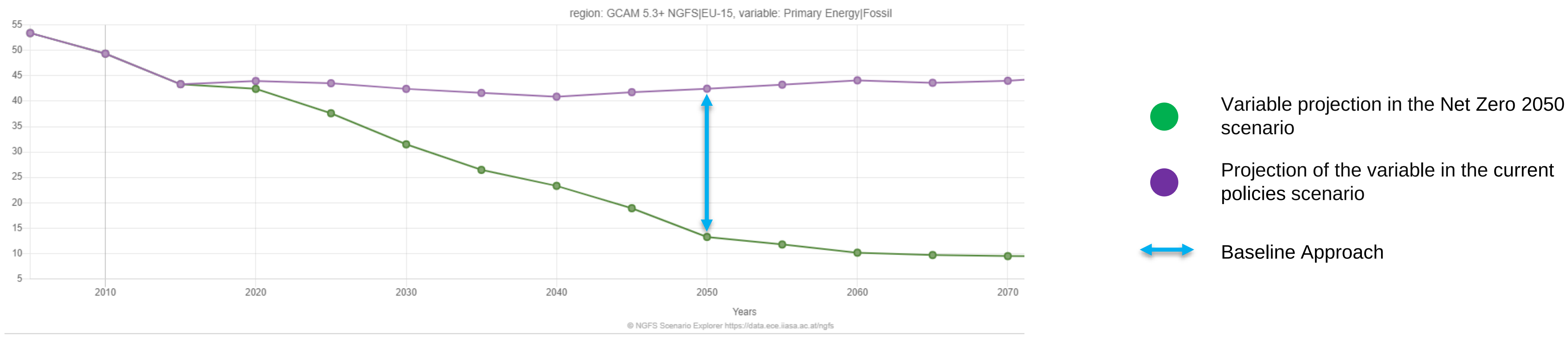
SSP1-1.9 | **SSP1-2.6** | **SSP2-4.5** | **SSP3-7.0** | **SSP5-8.5**



Physical data repository: Copernicus Climate Change Service

6 Climate shock

The approach applied to calculate the shocks is to calculate them against a baseline scenario (using current policies), a methodology widely used by the industry and referred to by regulators such as EIOPA[7].



The shock with baseline for the scenario in year "y" to be assessed is as follows:

$$Shock_{Baseline\ y} = \frac{Shock_{Projected\ scenario\ y}}{Shock_{Current\ policies\ y}} - 1$$

[7] Sensitivity analysis of climate-change related transition risks (europa.eu)

7 Data - climate-loss databases

Understanding and accurately modeling climate change requires comprehensive climate catastrophe data, as it provides crucial insights into the frequency, intensity, and impacts of extreme weather events, enabling more precise predictions

EM-DAT contains data on the occurrence and impacts of over 26,000 mass disasters worldwide from 1900 to the present day. The database is compiled from various sources, including UN agencies, non-governmental organizations, reinsurance companies, research institutes, and press agencies. The **Centre for Research on the Epidemiology of Disasters (CRED)** distributes the data in **open access** for non-commercial use.

The DRMKC Risk Data Hub is a multi-hazard Geo-portal designed to bridge science and policy across different scales, facilitating collaboration between scientists and end-users.

The project is comprised by potential data sources modules:

- **Disaster Loss Data**
- **Vulnerability to disasters**
- **Disaster Risk** - Curated European-wide risk data

The Catastrophe Data Hub brings together data related to natural catastrophes. It presents the data in two different views:

- **Insured exposure view**: it indicates the insured exposure to flood and windstorm of residential and commercial buildings
- **Insured losses view**: it shows the incurred for buildings reported by the insurance undertakings or groups in the sample. It covers three types of events: a flood event, a wildfire and a windstorm.

7 Data – climate projections

The Climate Data Store from Copernicus is freely available and functions as a one-stop shop to explore climate data.

- CMIP6 Climate projections
- Agroclimatic indicators from 1951 to 2099
- Water level change indicators (WLCI)
- Fire danger indicators for Europe (FWI)
- Climatic suitability for the presence and seasonal activity of the Aedes albopictus mosquito for Europe derived from climate projections
- (…)

The Joint Research Centre (JRC) aims to develop knowledge and tools in support of the EU Climate Change Policy.

- High resolution SPEI monthly projection for the globe (1975-2100)
- Rate of change of frost-free period map for Europe 1975-2010
- Bias corrected high resolution temperature and precipitation projection for Europe

EEA's Datahub contains quality-assure and quality-check data on a wide set of topics and legislation related to the environment, climate and sustainability:

- Pollution
- Soil
- Land use
- Health
- Climate
- Water
- Climate change adaptation
- Climate change mitigsation
- (…)

WRI's Data Lab uses advances in data and technology to help researchers improve lives, protect nature and ensure just transitions.

- Global Forest Watch
- Aqueduct
- Climate Watch
- Ocean Watch
- (…)

The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships.

- CORDEX-CMIP5 data
- CORDEX-CMIP6 data

Data presented on CCKP is disseminated by the World Bank under its Open Data Policy.

- CCKP Data Catalog

7 Data – climate projections

COPERNICUS Climate Data Store – Example data sources

CMIP — The World Climate Research Programme's Coupled Model Intercomparison Project

ISIMIP — Inter-Sectoral Impact Model Intercomparison Project

Climate Change Service

Climate Change Service

CMIP6 Climate projections

DATA DESCRIPTION	
Data type	Gridded
Projection	Regular latitude-longitude grid, ocean grid
Horizontal coverage	Global
Horizontal resolution	Varies between models
Vertical coverage	Single levels, pressure levels (1 - 1000 hPa)
Temporary coverage	1850-2300 (shorter for some experiments)
Temporary resolution	Monthly, daily, fixed (no temporal resolution)
File format	NetCDF4
Conventions	Climate and Forecast (CF) Metadata Convention v1.6
Versions	Latest version of the data is provided

Agroclimatic indicators from 1951 to 2099

DATA DESCRIPTION	
Data type	Gridded
Projection	Regular latitude-longitude grid
Horizontal coverage	Global
Horizontal resolution	0.5° x 0.5°
Vertical coverage	Surface
Vertical resolution	Single level
Temporary coverage	1951 to 2099
Temporary resolution	Variable dependent: 10-day, seasonal or annual
File format	NetCDF-4
Conventions	Climate and Forecast (CF) Metadata Convention v1.7

Water level change indicators (WLCI)

DATA DESCRIPTION	
Data type	Time-series for a vector of point locations
Horizontal coverage	Europe
Horizontal resolution	Coastal grid points: 0.1° Coastal grid points: 0.1° Coastal grid points: 0.1° Coastal grid points: 0.1 Ocean grid points: 0.25°, 0.5°, and 1° within 100 km, 500 km, and >500 km of the coastline, respectively
Vertical coverage	Surface
Vertical resolution	Single level
Temporary coverage	Statistics for ERA5 reanalysis: from 1979 to 2100
Temporary resolution	NA
File format	NetCDF-4

Fire danger indicators for Europe (FWI)

DATA DESCRIPTION	
Data type	Gridded
Horizontal coverage	Europe
Horizontal resolution	0.11° x 0.11°
Vertical coverage	Surface
Vertical resolution	Single level
Temporary coverage	1970-2098
Temporary resolution	Daily, seasonal and annual
File format	NetCDF-4
Versions	1.0 (deprecated), 2.0
Update frequency	No updates expected

8 Main challenges

Limitations and considerations

Dati

- **Granularity of** internal data lower than required by the models, e.g., for underwriting portfolio.
- Necessity of **extensive internal data**: e.g. information on investments, look through details for the funds, energy characteristics and emissions of the real estate portfolio…
- Integration of **external data**, complexity in source selection, data costs and standardisation
- **Data gaps**, **quality** and **consistency** of data and use of proxy to fill information gaps
- Management and **processing** of **large volumes of data** (physical climate scenarios, ISIN level calculation)

Scenari

- Continuous **updating** of **scenarios** and consequent re-calibration of models.
- **New and removed scenarios, difficulties in comparisons.**

Results

- **Anchoring points limited**, often incoherent, lack of reliable historical data.
- **Results not comparable** between different companies, methodologies and hypotheses.

Examples – physical risk methodology for underwriting

Which scenarios?

- The company has established that within its strategic alignments and the possible trajectories it manages, scenarios SSP1-2.6, SSP2-4.5 and SSP3-8.5 are the ones it selects for analysis.

SSP 1-1.9 | SSP 1-2.6 | SSP 2-4.5 | SSP 3-7.0 | SSP 5-8.5

What risk?

- Among the risks to which the entity is exposed, given the history of claims and the countries where it operates, flooding is considered the most important risk for the Motor line.

How do I assess risk?

- The company has established that the risk of flooding will be assessed on the basis of daily rain.
- For the country where it operates, given the historical information on events and correlation with the variable, the threshold of 20mm is defined.

What information do I have?

- In this case, the company does not have granular data, i.e. it only has claims information at the regional level and without insurance characteristics. Therefore, LitPop information is used to distribute geographically.

Frequency and intensity projections

2020	2025	2030	2050
5.14	5.74	6.96	9.83

Number of times the 20mm precipitation **threshold is exceeded in** each year

Variations in frequency

2025	2030	2050
11.7%	35,4%	91.2%

2020	2025	2030	2050
25.49	25.84	26.38	27.86

Average intensity when the threshold of 20mm of precipitation is exceeded in each year.

↓

2020	2025	2030	2050
0.0204%	0.0211%	0.0214%	0.0231%

Average damage when threshold is exceeded (obtained from projected intensity and vulnerability curve).

Variations in damage

2025	2030	2050
3.4%	4.9%	13.2%

Climate Shock

(1+var. freq) x (1+var. damage) -1

2025	2030	2050
15.5%	42.0%	116.6%

ILUSTRATIVE EXAMPLE

Examples – Reports on physical risk for underwriting

GEOGRAPHY	ssp126 Convective storm	ssp245 Convective storm	ssp585 Convective storm	ssp126 Wildfire	ssp245 Wildfire	ssp585 Wildfire	ssp126 Drought	ssp245 Drought	ssp585 Drought	ssp126 Flood	ssp245 Flood	ssp585 Flood
Spain	1,76%	8,10%	18,26%	30,92%	53,39%	75,31%	20,43%	76,15%	167,52%	12,78%	45,35%	88,27%
Portugal	3,73%	11,99%	19,43%	20,65%	46,38%	74,70%	11,95%	65,97%	105,21%	4,24%	47,13%	83,10%
Italy	1,30%	9,33%	12,50%	17,06%	27,95%	48,55%	4,64%	39,73%	64,20%	7,72%	30,80%	43,35%
Mexico	-0,30%	23,62%	46,02%	26,25%	81,34%	93,62%	3,92%	66,60%	84,02%	12,12%	138,74%	268,06%
Colombia	5,67%	19,49%	46,28%	0,66%	44,52%	110,19%	7,85%	81,92%	83,51%	46,81%	129,19%	303,42%
Brazil	0,00%	8,78%	51,12%	17,37%	57,73%	77,84%	-2,27%	55,25%	82,19%	9,93%	71,22%	400,72%
Chile	6,29%	18,75%	45,49%	-1,83%	55,11%	87,98%	11,77%	88,99%	89,62%	50,24%	130,68%	309,73%
Hungary	-0,39%	29,38%	37,89%	4,98%	21,40%	30,70%	10,22%	35,34%	45,47%	19,83%	126,73%	189,77%
Ireland	21,79%	29,48%	49,59%	3,02%	52,41%	71,95%	-0,01%	39,43%	70,92%	25,68%	96,18%	122,17%
Malta	3,68%	22,60%	33,06%	7,62%	34,21%	59,56%	8,47%	35,58%	64,81%	17,89%	62,14%	105,27%
...	2,97%	18,19%	50,80%	8,01%	54,40%	83,33%	13,01%	96,89%	96,40%	44,18%	127,32%	326,80%

CITY	FREQUENCY FLOODING - SSP585 2022	2025	2030	2050	FLOOD INTENSITY - SSP585 2022	2025	2030	2050	VAR ACCIDENT RATE FLOODS - SSP585 2025	2030	2050
Hidalgo	9.01	10.33	12.95	32.09	27.83	27.84	27.86	28.04	14.67%	43.92%	258.76%
Querétaro	8.09	9.71	12.42	32.07	27.14	27.23	27.27	27.38	20.44%	54.20%	299.91%
Mexico City	9.01	10.33	12.95	32.09	27.83	27.84	27.86	28.04	14.67%	43.92%	258.76%
Coahuila De Zaragoza	5.80	6.65	8.35	20.76	30.01	30.09	30.21	30.53	14.98%	44.97%	264.21%
Oaxaca	8.71	10.03	12.62	32.04	28.43	28.45	28.48	28.59	15.23%	45.13%	270.01%
Jalisco	13.53	15.56	19.56	48.58	30.58	30.97	31.19	31.74	16.51%	47.47%	272.81%
Michoacán	18.73	21.45	26.89	66.42	28.97	29.07	29.14	29.46	14.92%	44.42%	260.68%
San Luis Potosí	8.09	9.71	12.42	32.07	27.14	27.23	27.27	27.38	20.44%	54.20%	299.91%
Chihuahua	0.89	1.07	1.41	3.94	25.16	25.23	25.38	26.45	19.40%	58.79%	363.13%
Sinaloa	11.91	13.66	17.17	43.03	35.89	36.16	36.29	36.95	15.52%	45.75%	271.80%
Puebla	9.01	10.33	12.95	32.09	27.83	27.84	27.86	28.04	14.67%	43.92%	258.76%
Veracruz	9.01	10.33	12.95	32.09	27.83	27.84	27.86	28.04	14.67%	43.92%	258.76%
Sonora	6.41	7.35	9.26	23.66	33.63	33.88	34.18	35.40	15.61%	46.86%	288.74%
Tamaulipas	7.20	8.25	10.34	25.56	32.75	33.11	33.27	33.87	15.81%	45.89%	266.93%
Guanajuato	12.04	14.13	17.92	45.44	27.62	27.70	27.75	27.91	17.70%	49.47%	281.27%
Quintana Roo	4.92	5.64	7.07	17.61	30.32	30.44	30.62	31.12	15.01%	45.09%	267.41%
Yucatan	3.60	4.13	5.18	12.98	31.15	31.79	32.26	33.38	16.91%	48.91%	285.80%
Nuevo León	5.80	6.65	8.35	20.76	30.01	30.09	30.21	30.53	14.98%	44.97%	264.21%
Colima	11.39	13.09	16.48	41.10	33.63	33.80	34.04	34.59	15.44%	46.35%	271.00%
State Of Mexico	9.01	10.33	12.95	32.09	27.83	27.84	27.86	28.04	14.67%	43.92%	258.76%
Morelos	12.50	14.32	17.95	44.46	27.42	27.51	27.62	28.17	14.88%	44.62%	265.25%
Guerrero	15.19	17.61	22.48	58.11	28.12	28.12	28.12	28.15	15.95%	47.99%	283.00%
Chiapas	10.94	12.66	16.04	41.85	28.72	28.73	28.76	29.05	15.74%	46.80%	286.88%
Nayarit	13.21	15.13	18.97	46.85	37.61	38.08	38.74	40.32	15.94%	47.87%	280.23%
MEXICO									15.32%	45.53%	268.06%

ILUSTRATIVE EXAMPLE

Examples – Reports on transition risk for investments

Net Zero 2050 - Year 2050

GEOGRAPHY	Fossil-fuel	Utility	Energy-intensive	Finance
Italy				
France		23,830%	-8,877%	1,182%
Spain	-44,754%	28,170%		1,106%
United States			-7,283%	0,512%
Germany		30,697%	-8,964%	
Belgium				
China				0,883%
Netherlands				
United Kingdom		35,157%		
Austria				
Switzerland			-5,938%	
Portugal		24,902%		
Ireland				
Rest of countries	-15,636%	27,494%	-2,345%	0,858%

NDCs - Year 2050

GEOGRAPHY	Fossil-fuel	Utility	Energy-intensive	Finance
Italy				
France		14,774%	-4,948%	0,145%
Spain	-25,655%	19,139%		0,124%
United States			-4,279%	0,093%
Germany		20,274%	-4,997%	
Belgium				
China				0,076%
Netherlands				
United Kingdom		23,885%		
Austria				
Switzerland			-1,801%	
Portugal		15,246%		
Ireland				
Rest of countries	4,546%	18,679%	-1,463%	0,197%

SUMMARY OF IMPACTS ON TOTAL INVESTMENT

Scenario	Horizon	GOVIES	CORP	EQUITY	% TOTAL	TOTAL € €
Net Zero 2050	2025	-0,07%	0,09%	-0,20%	-0,18%	-508.676
Below 2 C	2025	-0,05%	0,03%	-0,07%	-0,09%	-251.481
Delayed transition	2025	-0,01%	0,03%	0,02%	0,05%	133.134
Divergent Net Zero	2025	-0,09%	-0,04%	-0,30%	-0,45%	-1.237.790
Nationally Determined Contributions (NDCs)	2025	-0,04%	0,01%	-0,09%	-0,12%	-335.313
Net Zero 2050	2030	-0,09%	0,19%	-0,32%	-0,24%	-660.473
Below 2 C	2030	-0,06%	0,10%	-0,14%	-0,11%	-310.509
Delayed transition	2030	0,00%	0,11%	0,07%	0,18%	504.744
Divergent Net Zero	2030	-0,11%	-0,02%	-0,41%	-0,56%	-1.538.508
Nationally Determined Contributions (NDCs)	2030	-0,04%	0,09%	-0,12%	-0,08%	-209.579
Net Zero 2050	2050	-0,07%	0,47%	-0,79%	-0,40%	-1.090.126
Below 2 C	2050	-0,09%	0,24%	-0,66%	-0,52%	-1.431.044
Delayed transition	2050	-0,14%	0,29%	-0,93%	-0,80%	-2.217.891
Divergent Net Zero	2050	-0,12%	0,10%	-0,90%	-0,94%	-2.579.310
Nationally Determined Contributions (NDCs)	2050	-0,05%	0,31%	-0,45%	-0,19%	-525.775

ILUSTRATIVE EXAMPLE

Making things happen

International *One Firm*

Multiscope Team

Best Practice *Know-How*

Proven Experience

Maximum Commitment

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