Sustainability

Physical Risk

Methodology & Research Process

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Version 1.0
PUBLIC DISCLOSURE ON THE METHODOLOGY, MODELS, AND KEY RATING ASSUMPTIONS USED IN ESG RATING ACTIVITIES

ISS STOXX

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Terms/Acronyms

TERMS/ACRONYMS	DEFINITION
AR5	5th Assessment Report (of the IPCC)
CAPEX	Capital Expenditure
CDP	Carbon Disclosure Project
CIR	Climate Impact Report
CMIP5	Coupled Model Intercomparison Project 5
COGS	Costs of Goods Sold
EBA	European Banking Authority
EM-DAT	Emergency Events Database
EPA	Environmental Protection Agency
EVA	Economic Value Added
GDP	Gross Domestic Product
GeoRev	Geographical Revenue (dataset from FactSet)
GHG	Greenhouse Gas
GICS	Global Industry Classification Standard
GMT	Global Mean Temperature
GPW	Gridded Population of the World
GTAP-INT	Global Trade Analysis Project - Integrated
GTSR	Global Tide and Surge Reanalysis
IAM	Integrated Assessment Model
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
OECD	Organisation for Economic Co-operation and Development

TERMS/ACRONYMS	DEFINITION
PP&E	Property, Plant & Equipment
RCP	Representative Concentration Pathway
SG&A	Selling, General & Administrative expenses
SSP	Shared Socioeconomic Pathway
TCFD	Task Force on Climate-related Financial Disclosures
VaR	Value at Risk
WRI	World Resources Institute

Regulation (EU) 2024/3005: Public Disclosure on the Methodology, Models, and Key Rating Assumptions Used in ESG Rating Activities

This disclosure is published to meet the relevant requirements of the EU ESG Ratings Regulation (EU2024/3005) and related regulatory technical standards. The following index cross-references to the relevant information are made available within the Physical Risk Methodology Document and on our website.

Within this disclosure, the Regulation (EU) 2024/3005 of the European Parliament and of the Council of 27 November 2024 on the transparency and integrity of Environmental, Social and Governance (ESG) rating activities is referred to as "**Regulation (EU) 2024/3005**".

Within this disclosure, the Commission Delegated Regulation (EU) of 21 04 2026 supplementing Regulation (EU) 2024/3005 of the European Parliament and of the Council with regard to regulatory technical standards specifying the elements of ESG rating products to be disclosed to the public and to users of ESG ratings, rated items and issuers of rated items is referred to as "**Delegated Regulation**".

REGULATION (EU) 2024/3005	DELEGATED REGULATION	REQUIRED INFORMATION	ISS GERMANY AG DISCLOSURE
Rating Product Disclosures			
ANNEX III.1.f	Article 3(1)	ESG rating providers shall disclose information on the ESG rating's clearly defined objective and marking whether the rating is assessing risks, impacts, or both, according to the double materiality principle, or any other dimensions, and in the case of double materiality the proportion of the risk and impact materiality. ESG rating providers shall disclose at the level of each ESG rating product: a) a description of the risks covered, where the ESG rating is assessing risks; b) a description of the impacts covered, where the ESG rating is assessing impacts; c) information on how the risk and impact materiality are taken into account according to the double materiality principle, where applicable; d) where the ESG rating is based on other materiality dimensions, a description of those dimensions.	Please refer to: • Summary • Introduction
ANNEX III.1.g	Article 3(2)	ESG rating providers shall disclose the ESG rating's scope, namely, whether it covers an individual E, S, or G factor or whether it is an aggregated rating aggregating E, S and G factors, or whether it covers specific issues such as transition risks. ESG rating providers shall disclose at the level of each ESG rating product: a) a description of what is covered under the E, S or G factors and which factors are aggregated, where applicable; b) a description of the specific issues that the ESG rating covers.	Please refer to: • Summary • Operational Risks • Market Risks • Financial Risk and Financial Risk Ratio • Value at Risk

REGULATION (EU) 2024/3005	DELEGATED REGULATION	REQUIRED INFORMATION	ISS GERMANY AG DISCLOSURE
ANNEX III.1.h	N/A	ESG rating providers shall disclose in the case of an aggregated ESG rating, the weighting of the three overarching E, S and G categories of factors (for example 33 % for the E factor, 33 % for the S factor, 33 % for the G factor), and the explanation of the weighting method, including weight per individual E, S and G category.	• This requirement is not applicable to the Physical Risk as it is not an aggregated rating.
ANNEX III.1.i	N/A	ESG rating providers shall disclose within the E, S or G factors, specification of the topics covered by the ESG rating, and whether they correspond to the topics from the sustainability reporting standards developed pursuant to Article 29b of Directive 2013/34/EU.	Please refer to: • Introduction
ANNEX III.1.j	N/A	ESG rating providers shall disclose information on whether the rating is expressed in absolute or relative value.	Please refer to: • Summary
ANNEX III.1.o **ANNEX III.1.p**	Article 3(3) Article 3(4)	ESG rating providers shall disclose if an ESG rating of a rated item covers the E factor, information on whether that rating takes into account the targets and objectives of the Paris Agreement or any other relevant international agreements. ESG rating providers shall disclose if an ESG rating of a rated item covers the S and G factors, information on whether that rating takes into account any relevant international agreements. ESG rating providers shall at the level of each ESG rating product: a) include an indication of whether the ESG rating takes into account the targets and objectives of the Paris Agreement and which other international agreements are considered, with reference to basic identifying information on these agreements together with an explanation of their relevance to the ESG rating;	Please refer to: • Scientific Foundations of the Methodology

REGULATION (EU) 2024/3005	DELEGATED REGULATION	REQUIRED INFORMATION	ISS GERMANY AG DISCLOSURE
		b) specify whether the ESG rating is assessing alignment of commitments against the objectives of the agreements referred to in point (a).	
Basic Methodological Disclosures			
ANNEX III.1.a	Article 4(1)	ESG rating providers shall disclose an overview of the rating methodologies used and changes thereto, including whether analysis is backward-looking or forward-looking and the time horizon covered. ESG rating providers shall disclose: a) the title of the rating methodology used; b) a description of the types of rated items in relation to which the methodology referred to in point (a) applies; c) the time horizon over which the ESG rating is considered valid, where applicable d) a list and overview of the relevant supporting models and key rating assumptions, where applicable; information on measures and procedures to ensure the quality and reliability of data used; e) a description of the defined ranking system of rating categories used, with reference to: i. the meaning of each rating category for absolute and relative values and how the ranking system should be interpreted;	Please refer to: Points a) and f) • Appendix F: Version Control Points b) to e) • b) Introduction • c) Introduction, Update Cycle • d) Appendix E: Relevant Supporting Models and Key Rating Assumptions, Quality Assurance • e) Main Metrics

REGULATION (EU) 2024/3005	DELEGATED REGULATION	REQUIRED INFORMATION	ISS GERMANY AG DISCLOSURE
		ii. in the case of relative values, an explanation as to whether they are relative to a specific industry, geographical area, peer groups or other comparative references and their respective description. f) the dates of the most recent update of the methodology and a description of the changes introduced to the previous version.	
ANNEX III.1.b	Article 4(2)	ESG rating providers shall disclose the industry classification used. ESG rating providers shall provide: a) the name of the issuing body of the industry classification used; b) the name and version of the industry classification used; c) any publicly available link to the official documentation of the industry classification system.	Please refer to: • Industry Classifications
ANNEX III.1.c	Article 4(3)	ESG rating providers shall disclose an overview of data sources, including whether data is sourced from sustainability statements required under Directive 2013/34/EU or from information disclosed under Regulation (EU) 2019/2088 and whether sources are public or non-public, and an overview of data processes, estimation of input data in case of unavailability and frequency of data updates. ESG rating providers shall include a description of the engagement process with rated items or issuers of rated items, including how the input from such engagement is taken into account.	Please refer to: • Data Sources: Sources/Input • Data Processes: Data Collection • Estimation of Input Data: Estimation of Data • Frequency of Data Updates: Update Cycle • Engagement with rated items or issuers of rated items is not part of the Physical Risk's process.
ANNEX III.1.e	Article 4(4)	ESG rating providers shall disclose information on whether and how the rating methodologies are based on scientific evidence.	Please refer to:

REGULATION (EU) 2024/3005	DELEGATED REGULATION	REQUIRED INFORMATION	ISS GERMANY AG DISCLOSURE
		ESG rating providers shall where applicable, describe the process for identifying relevant scientific evidence.	• Scientific Foundations of the Methodology
ANNEX III.1.k	N/A	ESG rating providers shall disclose where applicable, reference to the use of artificial intelligence in the data collection or rating process including information about current limitations and risks of using artificial intelligence.	• This requirement is not applicable to the Physical Risk.
Limitations in data sources, methodologies and information			
ANNEX III.1.m	Article 5	ESG rating providers shall disclose any limitation in data sources and methodologies used for the construction of ESG ratings.	Please refer to: • Limitations • Limitations to Methodologies & Data
ANNEX III.1.q	Article 5	ESG rating providers shall disclose any limitation on the information available to ESG rating providers. ESG rating providers shall explain any limitations in respect of the following: a) the availability or consistency of data used in the rating process; b) the completeness, timeliness and accuracy of information; c) the use of assumptions, proxy reference points and data estimation.	
Organisational Disclosures			
ANNEX III.1.d	Article 6(2)	ESG rating providers shall disclose the ownership structure of the ESG rating provider. ESG rating providers shall disclose: a) a chart illustrating their ownership links with any parent undertaking and subsidiaries. The chart shall indicate, where applicable, whether any of those entities perform any of the activities listed in Article 16 (1) or services referred to in Article 16(6) of Regulation (EU) 2024/3005.	Please refer to: • Ownership Structure

REGULATION (EU) 2024/3005	DELEGATED REGULATION	REQUIRED INFORMATION	ISS GERMANY AG DISCLOSURE
ANNEX III.1.l	Article 6(3)	ESG rating providers shall disclose general information on criteria used for establishing fees charged to clients, specifying the various elements taken into consideration, and general information on the business/payment model. ESG rating providers shall disclose the following: a) how the criteria they apply for establishing fees ensure that fees are fair, reasonable, transparent and non-discriminatory in accordance with Article 27 of Regulation (EU) 2024/3005; b) whether the ESG rating provider operates a subscription-paid model, an issuer-paid model, a combination of those models, or another model; c) a description of the relevant business model, and the proportion of total annual revenue derived from each model; d) where applicable, the impact of fees charged for services other than ESG rating activities on the determination of fees for ESG ratings, together with a description of those other services.	Please refer to: • Pricing Policy
ANNEX III.1.n	Article 6(1)	ESG rating providers shall disclose the main risks of conflicts of interest and the steps take to mitigate them. ESG rating providers shall indicate the areas of the ESG rating provider's activities, services or organisational structure from which the main risks of conflicts of interest may arise.	Please refer to: • Conflict of Interest Policy

Summary

- The ISS STOXX climate physical risk assessment gives the investor a holistic overview of their exposure to physical climate risks.
- The assessment covers an extensive universe of listed corporations and is tailored to evaluating climate physical risk exposure of equity and corporate operations. It is a comprehensive solution with 500+ metrics per issuer.
- The assessment covers current and future risk exposure to six of the most costly physical climate hazards: tropical cyclones, river floods, coastal floods, wildfires, heat stress and droughts. The analysis provides metrics for both acute physical risks and chronic physical risks.
- Physical risk exposure is assessed for reporting year and future risk levels, under a likely and a worst-case emission scenario as well as 7 NGFS scenarios.
- The analysis uses granular corporate data, including asset-level information, to assess an issuer's geographical footprint and its risk exposure profile.
- The analysis provides current and future financial risk metrics as annual averages that include operational financial risks and market financial risks.
- The analysis uses a proprietary financial valuation model to assess the issuer's Value at Risk from considering physical risks.
- The analysis provides absolute scores and qualitative risk categories that evaluate an issuer’s physical risks on an absolute scale of financial costs and losses.
- The analysis provides also sector-relative scores that evaluate physical risks at a particular time, as well as their change over time, relative to issuers in the same GICS sector.
- The assessment evaluates the robustness of an issuer's risk-management strategy via a Management Score. The resilience of an issuer to climate physical risks relative to its sector is estimated as a Relative Resilience Score.
- The analysis provides aggregate metrics for acute and chronic physical risks as well as for operational and market financial risks.
- The output data generated by the assessment is suitable for reporting according to the TCFD, EBA Pillar 3 (Template 5) and other reporting frameworks.
- This solution addresses the Environmental (E) pillar by assessing climate physical risks and their financial impacts at issuer and portfolio level. The Social (S) pillar is not covered in this methodology. The Governance (G) pillar is reflected through a Management Score, which evaluates the extent to which companies identify, assess, and manage physical climate risks within their risk management frameworks.

Introduction

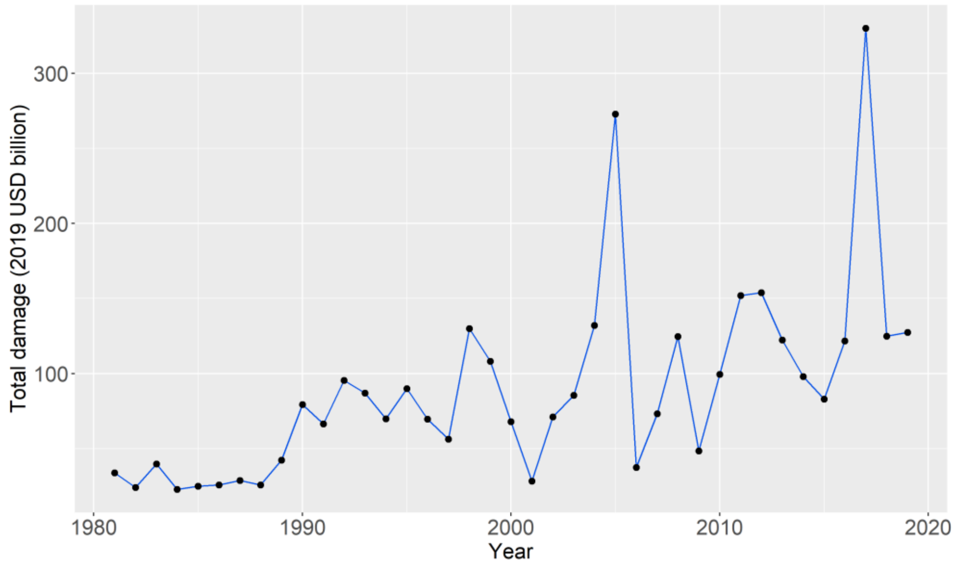
A climate physical risk analysis aims to understand a company's financial exposure to climate change, specifically to acute and chronic climate hazards such as wildfires, coastal floods, river floods, tropical cyclones, drought and heat stress. The assessment performed by ISS STOXX informs the investor of the company's climate physical risk impacts and awareness.

Exposure to physical risks is directly linked with a company's financial stability, as physical risks can result in abrupt value losses in operations as well as more gradual losses, e.g., productivity losses caused by temperature increases. As shown in Figure 1, costs associated with natural catastrophes have increased significantly in past years. For investors, it is vital to understand these risks and their holdings' exposure and management strategies.

The ISS STOXX forward-looking climate physical risk solution represents a model-based analytical opinion derived from a quantitative assessment of company exposure to physical climate hazard by simulating the impact of hazards such as tropical cyclones or wildfires on company operations and sales. The analysis is based on information on a company's geographical footprint, e.g., where a company has production facilities or generates revenue. The assessment then estimates the current and future financial risks and Value at Risk of companies due to climate hazard exposure. The future evaluation is performed for climatic conditions imposed by IPCC scenarios RCP4.5 and RCP8.5 (referred to herein as the likely and the worst-case scenarios respectively), as well as seven NGFS scenarios as described in "Scenario Analysis" section. Finally, the analysis evaluates to what extent issuers have strategies in place to manage physical climate risks and assesses the robustness of those strategies.

The content of the topics within the Physical Risk correspond to ESRS E1 (Climate Change) from the sustainability reporting standards developed pursuant to Article 29B of Directive 2012/34/EU.

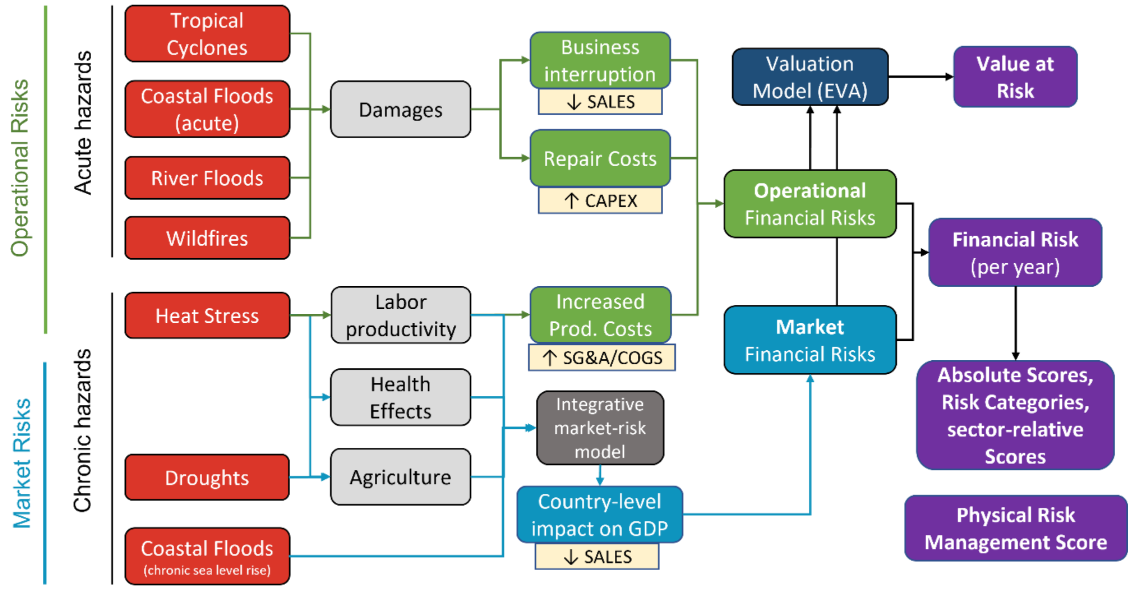
Figure 1: Total global damage in USD billions from 1981 to 2019 for all physical climate risks.
Values are presented in 2019 USD and are not corrected for exposure, socioeconomic factors, or vulnerability. Source: EM-DAT (2020) version 2020-07-01.



Methodology Overview

Physical risk levels may vary depending on the issuer's financial profile, including where the company operates, the total value of its assets, and in which countries the issuer generates its revenue. Physical risks can have a financial impact on a company at both the operational and the market level. The present analysis quantifies the current and anticipated future financial impacts emerging from the exposure of individual issuers to operational and market risks. Figure 2 shows a schematic overview of the hazards, operational and market risks, and related metrics in the analysis.

Figure 2: Schematic detailing the hazards and impacts considered in the assessment of operational and market risks.
The schematic indicates how operational and market risks relate to key output metrics (purple boxes).



Operational Risks

Operational risks (see Figure 2) are quantified by considering the costs of repairing assets damaged and the loss of income generated by business interruptions caused by the following acute physical hazards:

- Tropical Cyclones,
- Coastal Floods,
- River Floods,
- Wildfires.

Operational Risks also include the costs associated with the impact of Heat Stress on labor productivity. The analysis assumes that a decrease in productivity will generate an equivalent increase in production costs.

More details about how these impacts are calculated can be found in the "Financial Impacts Deep Dive" section.

Market Risks

Market risks quantify the revenue at risk due to the nation-wide effects of physical risks on the Gross Domestic Product (GDP) of countries. Annual relative changes in GDP due to climate change are calculated by a model that considers the impact of the chronic component of coastal floods, droughts and heat stress, including:

- the chronic effects of sea-level rise,
- the combined impact of Droughts and Heat Stress on agricultural productivity,
- the temperature-induced decrease in labor productivity,
- the effect of extreme temperatures on human health.

The ISS STOXX physical risk assessment assumes a one-to-one relation between the model's country GDP change and the changes in country-level company revenues. For example, if the model estimates that India's GDP will be reduced by 3.2% due to physical risks by 2050 in a likely emission scenario, if a company generates revenues in India, it is assumed that the 2050 revenues raised in India will be 3.2% lower than they would in the absence of physical risks.

Refer to the "Financial Impacts Deep Dive" section for more details on the market-risk model.

Main Metrics

Several metrics are provided as factors to offer insights on the physical risk exposure of individual issuers and the portfolio, as detailed below. All factor names and descriptions can be found in tables within the "Factor Dictionary" which is available to clients.

The metrics corresponding to the likely scenario (by 2050) are considered the most relevant ones in the first instance. A table collecting the names and descriptions of these **key summary factors** can be found in the "Factor Dictionary – Key Metrics" which is available to clients.

Financial Risk and Financial Risk Ratio

The Total Financial Risk measures the expected average annual financial impact of physical risks on an issuer for current risk levels or for future risk levels by 2050 following a likely, worst-case or seven NGFS scenarios. It reflects all the costs and losses incurred by a company as a result of all the climate physical hazards combined, and, as such, it is the sum of all operational and market risks:

$$\text{Total Financial Risk} = \text{Operational Risks} + \text{Market Risks}.$$

The Total Financial Risk can therefore be expressed as the sum of the average annual costs associated with repairing damaged assets and reduced labor productivity, as well as the average annual loss of income due to business interruptions and market risks:

$$\text{Total Financial Risk} = \text{Cost}_{\text{repairs}} + \text{Cost}_{\text{productivity}} + \text{Loss}_{\text{business interruption}} + \text{Loss}_{\text{market risk}}.$$

Financial Risk metrics are available as absolute values in Million USD (average costs and losses per year) as well as **Financial Risk Ratios** relative to issuer revenue (values in the range 0 to 1).

Apart from the Total Financial Risk, the analysis provides Financial Risk metrics corresponding to each of the six individual hazards considered. For a detailed list of Financial Risk factors available on DataDesk, clients may refer to the "Factor Dictionary - Financial Risk Metrics". The calculation of these factors is explained in detail in Appendix A: Calculation of Financial Risk Metrics.

The Financial Risk Ratio factors are used as a basis to calculate the Absolute Physical Risk Scores and Physical Risk Categories, as well as the Sector-Percentile Relative Scores. The change over time (from the current time to the future) in Financial Risk Ratio is used as a basis to derive a Physical Risk Change sector-relative Score metric. For more details on financial risks refer to the Financial Impact Deep Dive section.

Value at Risk

The Value at Risk (VaR) of an issuer estimates the change in equity value that would result from the financial impact of physical risks from all hazards. The VaR is computed using a valuation model based on the Economic Value Added (EVA) framework. Issuers are first valued without the consideration of physical risks to calibrate the model and are then re-evaluated accounting for financial changes due to physical risks. The resulting shift in equity value is the Value at Risk, that is, the value that can be lost to climate physical risks. The valuation model considers the following financial risks (see Figure 2):

- Damages: repair costs to damaged assets are treated as investments in Capital Expenditure (CAPEX) and as reductions in capital value via Property, Plant and Equipment (PP&E).
- Production costs: increases in production costs are modeled via changes in Selling, General and Administrative Expenses (SG&A) or Cost of Goods Sold (COGS).
- Revenue: changes are modeled via reductions in SALES.

The VaR is provided as a ratio (in the range 0 to 1) that can be converted to a percentage value at risk by multiplying by 100. Absolute VaR metrics are also provided in Million USD. The total VaR can be broken down into a current-risk contribution coming from physical risks up to the present time, and a future-risk contribution coming from physical risks to the year 2050 in a likely, worst-case or a NGFS scenario.

See the EVA Valuation Model section for more details on the valuation model and how the Value at Risk is estimated. For a detailed list of Value-at-Risk factors available on DataDesk, refer to the "Factor Dictionary – Value at Risk Metrics" which is available to clients.

Absolute Physical Risk Scores and Risk Categories

The Absolute Physical Risk Scores and Physical Risk Categories measure the level of a company's exposure to physical risks on an absolute basis at a particular time. There are 21 numerical Absolute Physical Risk Score factors and 21 associated qualitative Absolute Physical Risk Category factors. Overall (total) factors representing the overall risk from all hazards are provided, as well as hazard-specific factors representing the risk corresponding to each of the individual physical hazards covered. Factors are provided for both the current time and future time (2050), and for 9 future scenarios (likely, worst-case, seven NGFS scenarios). Tables with all the absolute scores and category factors available can be found in the "Factor Dictionary" which is available to clients.

These factors measure a company's level of financial risk as a fraction of issuer revenue on an absolute, sector-independent scale based on the Financial Risk Ratio factors. The Absolute Physical Risk Scores reflect the order of magnitude of the Financial Risk Ratio on a scale 0 - 100, where 0 corresponds to the highest risk and 100 to the lowest risk. The Absolute Scores are calculated using a simple formula based on the base-10 logarithm:

$$\text{Absolute Physical Risk Score} = -20\ Log_{10}(\text{Financial Risk Ratio}).$$

The Financial Risk Ratios for most of the public companies covered are in the range 0.00001 – 1, covering five orders of magnitude, and are skewed towards low values (most values are below 0.01, i.e., a risk below 1 % of issuer revenue). The logarithm in the above formula generates a distribution of absolute scores that is close to a normal distribution (less skewed), with scores adequately spread out over several well-defined risk categories. The factor of minus 20 in the formula spreads values over a scale 0 – 100. When the Financial Risk Ratio is below a 0.00001 threshold (fraction of issuer revenue), an absolute score of 100 is assigned. The expressions used to calculate the total and individual-hazard absolute scores for all time frames can be found in Appendix II: Calculation of Absolute Physical Risk Score Metrics.

Each numerical absolute score is accompanied by a qualitative Absolute Physical Risk Category to help users easily identify the level of physical risks for each issuer. There are five different physical risk categories: "very low risk", "low risk", "moderate risk", "high risk" and "very high risk". These risk categories are as shown in Table 1 together with the corresponding ranges of Financial Risk Ratio and Absolute Physical Risk Score values. The "very low risk" category is associated with the highest absolute scores, between 81 and 100, and corresponds to a Financial Risk Ratio lower than 0.01% of issuer revenue. On the other hand, the highest risk category ("very high risk") is associated with the lowest absolute scores (0 to 20) and corresponds to a Financial Risk Ratio above 10% of issuer revenue.

The overall (total) Absolute Physical Risk Score and overall (total) Absolute Risk Category can be used to identify the company-specific physical risk exposure in an immediate, easy-to-interpret way, and to answer the question of whether a company is at risk of physical climate hazards. For instance, a company with a Total Absolute Score of 90 would correspond to the "very low" total risk category corresponding to a very low Total Financial Risk Ratio that is below 0.01 % of its revenue (Table 1). Similarly, a company with a Total Absolute Score of 30 would be in the "high risk" category that corresponds to a significant Total Financial Risk Ratio between 1% and 10% of its revenue (Table 1). Similarly, the individual-hazard absolute scores and risk categories can be used to assess the absolute level of risk associated with each individual physical hazard.

The scale of risk provided by these factors is absolute in the sense that it is sector-independent and depends only on the financials and risk exposure of each individual company. Therefore, the factors can be used to compare companies in different sectors and contributions from different hazards on the same absolute scale. The factors are unaffected by sector changes or changes in sector peer company values.

Table 1: Absolute Physical Risk Categories
Absolute Physical Risk Categories (first column), range of Absolute Physical Risk Scores corresponding to each risk category (second column) and corresponding range of Financial Risk Ratio values shown as a percentage of issuer revenue (third column).

RISK CATEGORY	ABSOLUTE SCORE	FINANCIAL RISK RATIO AS % OF REVENUE
very low risk	100 to 81	< 0.01 %
low risk	80 to 61	0.01 % - 0.1 %
moderate risk	60 to 41	0.1 % - 1 %
high risk	40 to 21	1 % - 10 %
very high risk	20 to 0	≥ 10 %

Examples of Physical Risk Scores and Risk Category usage

Practical examples of how to use and present these factors can be found below. Figure 3 shows an example of how the physical risks of a particular company could be disclosed using the Absolute Physical Risk Scores, the Absolute Physical Risk Categories (color coding) and the Sector-Percentile Relative Scores (explained in the next section). Color-coding can be used to provide a useful visualization of the risk categories, with dark and light green corresponding to very low and low risk, respectively, yellow to moderate risk, and orange and red to high and very high risk, respectively. This allows a quick identification of the hazards that most affect a company. For the company shown in the example in Figure 3, the highest risk exposure comes from tropical cyclones, coastal floods and river floods. We can also see that, for several hazards such as tropical cyclones, heat stress or floods, this company does better in absolute terms (higher absolute scores) than when compared to its sector peers (lower corresponding Sector-Percentile Relative scores in the bottom half of the table).

Figure 4 shows a display of Total Absolute Physical Risk Scores and Total Risk Categories for an example portfolio of eight different issuers. The Total Absolute Scores are shown on the columns on the left part of the table for the different time frames and scenarios. The corresponding Total Risk Categories are shown on the right part of the table, with color coding for easy identification. It is easy to see how risk levels increase from the present time to the future (absolute scores decrease). In this example portfolio, issuer 5 presents the lowest overall physical risk level, while issuer 7 presents the highest overall physical risk level (considering all hazards and times).

Figure 3: Example of how a company could disclose its physical risks.

Example of how a company could disclose its physical risks using Absolute Physical Risk Scores (top half of table) and Physical Risk Sector-Percentile Relative Scores (bottom half of table). Absolute Physical Risk Categories are indicated by the colors as displayed at the top of the figure.

Color-coding for Absolute Physical Risk Categories

very low | low | moderate | high | very high

		Current	Future-likely	Future-worst
Absolute Scores	Total abs score	55	36	33
	Heat Stress abs score	86	85	84
	Tropical Cycl. abs score	61	60	59
	Wildfire abs score	85	85	85
	Drought abs score	71	71	70
	River Flood abs score	64	62	60
	Coastal Flood abs score	64	60	55
Sector-Percentile Relative Scores	Total relative score	10	5	5
	Heat Stress rel score	20	20	20
	Tropical Cycl. rel score	10	10	10
	Wildfire rel score	15	15	15
	Drought rel score	20	20	20
	River Flood rel score	10	10	10
	Coastal Flood rel score	5	5	5

Figure 4: Example of presentation of the Total Absolute Physical Risk Scores and Total Risk Categories

Example of presentation of the Total Absolute Physical Risk Scores and Total Risk Categories for 8 different issuers in a portfolio, with background color-coding of the risk categories.

	Absolute Physical Risk Score			Absolute Physical Risk Categories		
issuer	Current	Future Likely	Future Worst	Current	Future Likely	Future Worst
1	67	62	59	low	low	moderate
2	77	63	58	low	low	moderate
3	51	45	43	moderate	moderate	moderate
4	66	56	54	low	moderate	moderate
5	83	82	81	very low	very low	very low
6	77	66	64	low	low	low
7	51	36	33	moderate	high	high
8	81	78	76	very low	low	low

Physical Risk Sector-Percentile Relative Scores

The Physical Risk Sector-Percentile Relative Scores measure issuer risk at a particular time (current or future) relative to other companies in the same GICS sector. These scores take integer values in the range 5 to 100 (in steps of 5), where 5 corresponds to the highest risk in the sector and 100 corresponds to the lowest risk in the sector. The score calculation is based on the Financial Risk Ratio factors as a starting point, and uses a methodology closely related to that of the Absolute Scores. The scores can be interpreted intuitively as each score represents the relevant percentile in the corresponding sector distribution of risk values. In summary, a company is compared to all other companies in its GICS sector and assigned a percentile score as an integer value.

There are 70 Physical Risk Sector-Percentile Relative Score factors. These include overall (total) factors representing the overall risk from all hazards, and hazard-specific factors representing risk from each individual hazard. Factors are provided for the current time and for the future time (2050) under the total of nine climate change scenarios (likely, worst-case and 7 NGFS scenarios). Tables with all the available Sector-Percentile Relative Score factors can be found in the "Factor Dictionary" which is available to clients.

The following process is followed to calculate the Sector-Percentile Relative Scores:

- We start by re-scaling the corresponding Financial Risk Ratio factor for all companies in a given sector in a similar way to that used for the Absolute Scores. For this, we calculate the re-scaled Financial Risk Ratio as $\mathrm{RFRR} = -20\ Log_{10}(\mathrm{Financial\ Risk\ Ratio})$. The values generated are roughly in the range 0-100 (with 0 corresponding to the highest risk and ~100 to the lowest risk) and form the relevant probability distribution of **re-scaled risk** (RFRR) for each sector. The re-scaled risk (RFRR) is the same as the Absolute Score for each company, except for the fact that RFRR values above 100 are not truncated to 100 (RFRR values >100 can occur for very low, below-threshold risk levels when $\mathrm{Financial\ Risk\ Ratio} < 10^{-5}$ and they are kept here in order to ensure granular percentiles; note that Absolute Scores are constrained to the range 0-100).

- We then calculate discrete percentile values for the corresponding sector probability distribution of re-scaled risk (RFRR) in steps of 5%, i.e., the 5%, 10%, 15%, …, 90%, 95% and 100% percentiles. This means that the possible values of the Sector-Percentile Relative Scores are discrete and in steps of 5, as follows: 5, 10, 15, … 90, 95 and 100.

- For a given issuer risk value, we assign as Sector-Percentile Relative Score the closest percentile value above the re-scaled risk value. This process is illustrated in Figure 5.

- In this way, the Sector-Percentile Relative Scores are equivalent to ranking the companies within a sector in order of re-scaled risk (non-truncated Absolute Score) and placing them into buckets, e.g.: top 5% highest risk companies, second 5%, third 5%, …, and bottom 5% (lowest risk, highest score).

Figure 5: Example of distribution of re-scaled risk from all physical hazards by 2050 in the likely scenario used to calculate Sector-Percentile Relative Scores for Utilities-sector companies.

The distribution of re-scaled Total Financial Risk values ($\boldsymbol{RFRR} = -\mathbf{20}\ \boldsymbol{Log_{10}}(\boldsymbol{Financial\ Risk\ Ratio})$) for all companies in the sector is shown together with percentiles as vertical lines (only ten percentiles are shown for clarity). In this particular example, $\boldsymbol{RFRR}$ for all companies is exactly equivalent to the Absolute Scores as all $\boldsymbol{RFRR}$ values are in the range 0-100. A company with $\boldsymbol{RFRR} = \mathbf{33}$ (marked by the black arrow in the figure) is assigned as its Total Likely Sector-Percentile Relative Score the closest percentile above it, which in this case is 10 (orange line, 10th percentile), meaning that this company has a total likely-scenario risk by 2050 that is within the 10% highest risk in its sector. Similarly, a company with $\boldsymbol{RFRR} = \mathbf{70}$ (gray arrow in the figure) is assigned a Sector-Percentile Relative Score of 90 (light blue line, 90th percentile), meaning that it is within the 10% lowest risk in its sector.

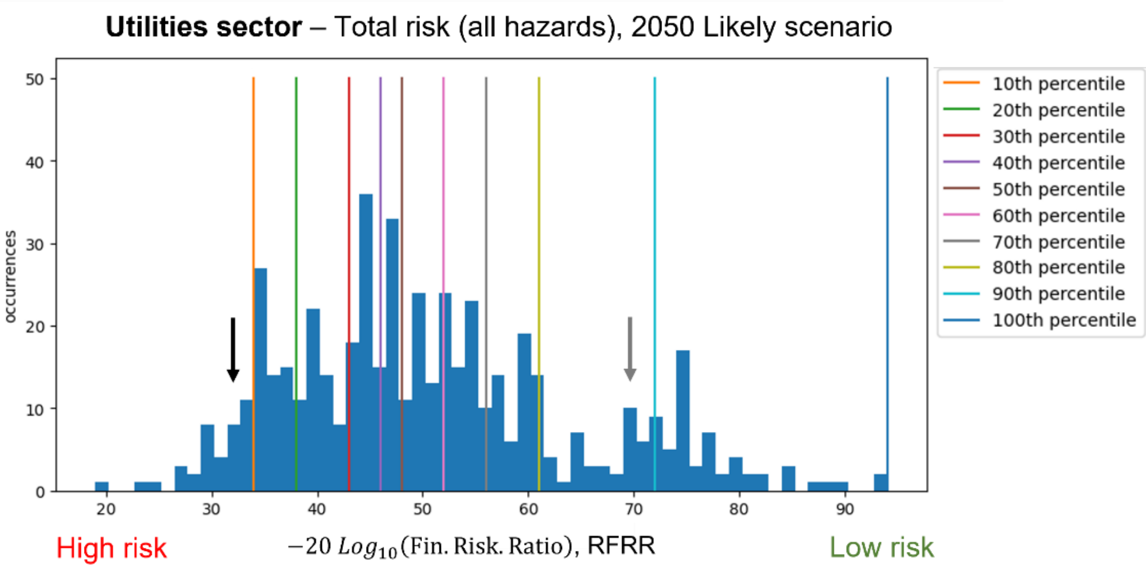
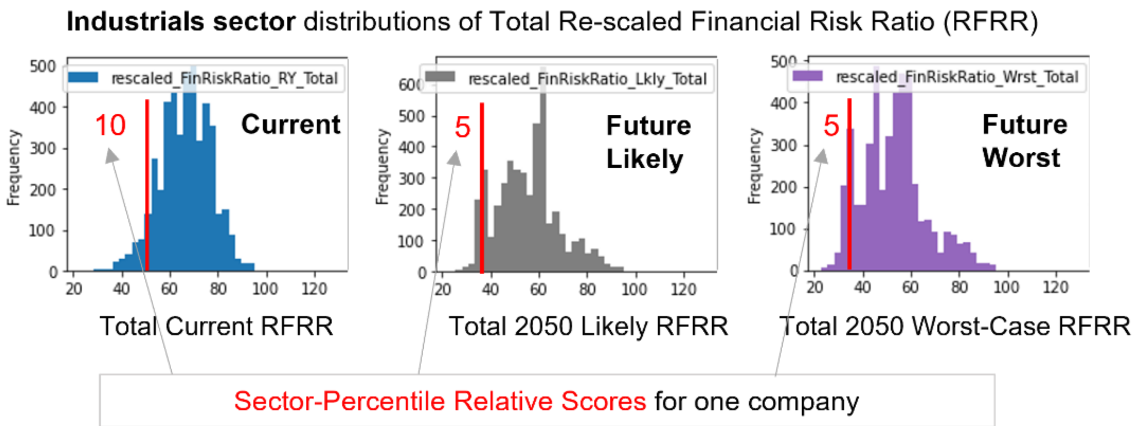


Figure 6: Example of Sector-Percentile Relative Scores (red numbers) for a company in the Industrials GICS sector.

The vertical red lines show the position of the re-scaled Financial Risk Ratio ($\boldsymbol{RFRR}$) values for the company relative to the distribution of values for all companies in the sector for the current time (left) and future times in the likely (middle) and worst-case (right) scenarios. The company ranks poorly compared to its sector: it is currently within the 10% highest risk companies in the sector (Relative Score = 10), and its total risk is modeled to increase to within the 5% highest risk in the sector by 2050 in both scenarios (Relative Score = 5).



Examples of interpretation of the Sector-Percentile Relative Scores are shown within Figure 6 as well as below. Each score represents a percentile in the distribution of sector-relative risk. Low scores represent high physical risk compared to other issuers in the sector, with scores ≤ 50 corresponding to a risk above the sector median. Similarly, high scores (>50) represent a risk level lower than other issuers in the sector and below the sector median. Values between 5 and 100 have the following percentile-associated meanings:

- A Sector-Percentile Relative Score of **5** means that an issuer is within the 5% of issuers with highest physical risk in the sector (within the top 5th percentile of risk), equivalent to the lowest 5% of RFRR values.

- A Sector-Percentile Relative Score of **10** means that an issuer is between the 5% and 10% highest risk in the sector (risk in the highest 10% but not in the highest 5%, between the top 5th and 10th percentiles), equivalent to a RFRR value between the 5% and 10% lowest values.

- A Sector-Percentile Relative Score of **50** corresponds to a risk level close to that of the sector median, specifically to the 5% of issuers with risk just above the sector median. It means that an issuer's risk is in the top 50% but not in the top 45% risk.

- A Sector-Percentile Relative Score of **55** corresponds to a risk level close to that of the sector median, specifically to the 5% of issuers with risk just below the sector median. It means that an issuer's risk is in the top 55% but not in the top 50% risk.

- A Sector-Percentile Relative Score of **95** means that an issuer is between the 90% and 95% ranking in order of decreasing risk in the sector, i.e. between the 5% and 10% lowest risk in the sector, or between the bottom 5th and 10th percentiles of risk. This is equivalent to a RFRR value between the 5% and the 10% highest values.

- A Sector-Percentile Relative Score of **100** means that an issuer is within the 5% of issuers with lowest physical risk in the sector, or within the bottom 5th percentile of risk. This is equivalent to the highest 5% of RFRR values in the sector.

The Sector-Percentile Relative Scores for an issuer depend on the Financial Risks from all companies in the sector and can therefore change if an issuer changes sector, or when risk levels change for other issuers in the sector.

Physical Risk Change Sector-Relative Scores

The Physical Risk Change sector-relative Scores measure the **change** over time in an issuer's Financial Risk relative to all companies in its GICS sector (2 digits). The scores are bounded to the range 1-100 and are calculated by scaling and transforming the change in Financial Risk Ratio over time (future risk minus current risk) for a specific scenario. Change over time is used here under the assumption that companies can have adapted to current risk levels and, therefore, that the difference in risk between the future and the present time can be the meaningful metric to measure physical risks.

The Physical Risk Change sector-relative Scores reflect risk levels relative to a company's sector, with a score of around 50 reflecting a level of risk close to that of the median of the sector. A low score below 50 reflects a higher level of risk than the sector median, with a score of 1 corresponding to the worst-in-class companies that have the highest risk in the sector (within the 99.75th percentile with highest risk). Conversely, a high score above 50 reflects a level of risk lower than the sector median, with a score of 100 corresponding to the best-in-class companies or to negligible risk (corresponding to a Financial Risk Ratio ≤0.0001% of revenue).

The Physical Risk Change sector-relative Scores consider the change in Financial Risk Ratio from current risk levels to future ones by calculating the difference in future minus current risk relative to revenue. The differences corresponding to all companies in a sector are normalised to be between 0 and 1 (by subtracting the minimum value and dividing by the full range of values for that sector). The normalised differences are then re-scaled and transformed into relative score values (in the range 1 to 100) via a log-odds function and a linear transformation. For a detailed description of the relative Score calculation, refer to Appendix III: Physical Risk Change Sector-Relative Score Calculation.

Two sets of Physical Risk Change sector-relative Score factors are available. The first set evaluates the change in Financial Risk Ratio in the likely scenario and includes a total relative score that considers all hazards together, as well as relative scores for all individual hazards. The second set of factors considers the worst-case scenario and similarly includes a total score and individual hazard scores. A list of relative score factors available on DataDesk can be found in the “Factor Dictionary – Physical Risk Change sector-relative Score metrics” which is available to clients.

The Physical Risk Change sector-relative Scores for a company depend on the Financial Risks from all companies in the sector and can therefore change if companies change sector or when risk levels within the sector change. Note that a fixed decrease in score does not correspond to a fixed increase in Financial Risk. Instead, a fixed reduction of approximately 10 points corresponds to a doubling of the Financial Risk.

Management Score

Each company that reports to the CDP[1] is given a Physical Risk Management Score. The Management Score indicates how well a company has considered physical climate risks in its risk management strategies. If a company does not report to the CDP, the Management Score will appear as “Not Collected”.

The issuer must specifically mention how they are affected by physical risks, what strategies are in place, and how they expect costs to affect their balance sheet. The more detail an issuer provides about their physical risk management strategy, the higher their score. The metric value defines four possible categories of risk-management:

- None or not covered (value = 0): no risk management strategy,
- Weak management strategy (value = 20),
- Moderate management strategy (value = 60),
- Robust management strategy (value = 100).

The Management Score and physical risk management strategy classification is based on the information provided by companies to specific questions in the CDP questionnaire and on reported physical risk costs, as shown in Table 2.

[1] Carbon Disclosure Project (CDP)

Table 2: Information reported by issuers annually to the Carbon Disclosure Project (CDP) that is used to generate a Physical Risk Management Score.

A company will have a Management Score “Not collected” if it does not report to CDP. If the company reports to CDP, the Management Score can be one of four different categories: “None or not covered”, “Weak strategy”, “Moderate strategy” or “Robust strategy”.

CDP INFORMATION	NOT COLLECTED	NONE OR NOT COVERED (VALUE = 0)	WEAK STRATEGY (VALUE = 20)	MODERATE STRATEGY (VALUE = 60)	ROBUST STRATEGY (VALUE = 100)
The company reports to CDP	×	✓	✓	✓	✓
The company has board-level oversight of climate-related issues	×	×	✓	✓	✓
The company has a process for identifying, assessing, and managing environmental risks and/or opportunities?	×	×	✓	✓	✓
The company has identified inherent climate-related risks with potential to have substantive financial/strategic impact on its business	×	×	×	✓	✓
The company considers chronic/acute physical risk types in the organization's climate-related risk assessments	×	×	×	✓	✓
The reported physical risk cost is of a magnitude comparable to values reported by other companies in the same sector (as opposed to a low outlier)	N/A	N/A	N/A	×	✓

Relative Resilience Score

The Physical Risk Relative Resilience Score summarizes an issuer’s resilience to climate physical risks relative to its sector and encompasses an evaluation of an issuer’s asset intensity, supply-chain dependency and fraction of asset value owned (out of all owned plus rented assets). The Physical Risk Relative Resilience Score allows investors to compare companies within the same sector and optimize resilience while keeping a stable sector allocation.

Asset intensive companies are typically less resilient as they have a significant value of PP&E assets, i.e., long-term physical tangible assets such as factory and office buildings, machinery, equipment, vehicles and land, which constitutes a higher exposure to financial losses resulting from climate physical hazards (e.g. building damages and business interruptions). A higher asset intensity correlates with a higher Financial Risk and higher Value at Risk. Asset depreciation and increasing insurance premiums (or lack of insurance) at high-risk locations can also result in larger losses for asset intensive companies.

The degree of asset ownership compared to the capitalized lease expenses can also give an indication of the level of flexibility (e.g. to relocate or repurpose assets) that a company might have to react and quickly adapt to minimize the impacts of climate physical hazards on its assets, with a lower ownership ratio linked to higher resilience.

Supply-chain dependency is typically quantified via the relative size of the Cost of Goods Sold (COGS), which includes most supply-chain costs and all costs related to the production or acquisition of all the products (or services) that a company sells, including raw materials, factory costs, labor costs, etc. A disrupted supply-chain can lead to increased costs, for instance to replace suppliers or to shift and adapt production, such that higher COGS expenses can indicate a lower resilience.

The Relative Resilience Score is calculated as the average of three intermediate sector-relative scores (each with values in the range 0-100):

- A sector-relative **asset-intensity score**: this score compares an issuer's asset intensity to that of other issuers in its GICS sector. The asset intensity is calculated here as the ratio of PP&E value to issuer revenue (SALES), i.e., PP&E/SALES, and is the total value of assets used to generate each unit of revenue. Revenue is used as a proxy for company size, to allow comparison of differently sized companies. A low score (<50) indicates lower resilience within the sector due to an issuer's asset intensity that is above the sector median, whereas a higher score (>50) indicates higher relative resilience from an asset intensity below the sector median.

- A sector-relative **asset-ownership score**: this score compares an issuer's asset-ownership ratio to that of other issuers in its sector. The asset-ownership ratio is calculated as the owned asset value (owned PP&E) divided by the sum of the owned PP&E and capitalized lease expenses. A low score (<50) indicates low relative resilience due to an issuer's asset-ownership ratio that is above the median of its sector, whereas a high score (>50) indicates a higher resilience within the sector due to a below-median asset-ownership ratio.

- A sector-relative **supply-chain-dependency score**: this score compares an issuer's supply-chain dependency to that of other issuers in its sector. Supply-chain dependency is estimated as COGS divided by issuer revenue (SALES), i.e., COGS/SALES. A low score (<50) reflects a low relative resilience due to a large supply-chain dependency above the sector median, whereas a high score reflects a higher resilience within the sector due to a lower, below-median supply-chain dependency.

The specific methodology for the calculation of each of the intermediate sector-relative scores can be found in Appendix D: Calculation of Relative Resilience Score and Intermediate Scores.

The Physical Risk Relative Resilience Score is an average of the above three intermediate scores and takes values in the range 0 to 100, where 0 corresponds to the lowest resilience in the sector, 100 to the highest and 50 to the sector-median resilience.

Aggregate Metrics

Acute and chronic aggregates

Separating physical risks into acute and chronic (see section "Acute and Chronic Physical Risks" for details) can be useful to identify different types of financial risks that take place over different time scales. Acute physical risks are typically sudden and short-lived, while chronic physical risks are gradual and take place over longer time periods.

Reporting of aggregate acute and chronic risks is typically required in regulatory/reporting frameworks such as the Taskforce for Climate-related Financial Disclosures (TCFD) and the European Banking Authority (EBA) Pillar 3 disclosure framework, and can also be useful for monitoring use cases.

Acute and chronic aggregate metrics are provided for Financial Risk, Financial Risk Ratio, Absolute Scores and Absolute Risk Categories.

For the Financial Risk metrics, for each time frame/scenario, the Acute aggregate is calculated as the sum of the Financial Risks for tropical cyclones, wildfires, river floods and coastal floods (all of which are operational, damage-related financial risks). The Chronic aggregate is calculated as the Total Financial Risk minus the Acute aggregate Financial Risk. The same methodology is followed for the Financial Risk Ratio metrics (financial risk relative to issuer revenue).

For the Absolute Score metrics, for each time frame/scenario, the Acute and Chronic aggregates are calculated based on the corresponding aggregate Acute or Chronic Financial Risk Ratio as follows:

$$\text{Acute Absolute Score} = -20\ Log_{10}(\text{Acute Financial Risk Ratio}),$$

$$\text{Chronic Absolute Score} = -20\ Log_{10}(\text{Chronic Financial Risk Ratio}).$$

The Acute and Chronic aggregate Absolute Risk Categories help users identify the aggregate level of risk (5 categories from "very low risk" to "very high risk") based on the values of the Acute and Chronic Absolute Scores, respectively, following the correspondence in Table 1.

Factor names and descriptions for all acute and chronic aggregate metrics can be found in the "Factor Dictionary – Acute and Chronic Aggregates" which is available to clients.

Operational and Market Financial Risk Aggregates

Separating operational and market financial risks can be useful for a more in-depth analysis of physical risks (see sections "Operational Risks" and "Market Risks"). Operational and market financial risk aggregate metrics are provided for Financial Risk and Financial Risk Ratio.

For both types of metrics (Financial Risk and Financial Risk Ratio), for each time frame/scenario, the Operational risk aggregate is calculated as the sum of all operational financial risks, i.e. those from tropical cyclones, wildfires, river floods, coastal floods and heat stress. On the other hand, the Market risk aggregate is calculated as the Total Financial Risk minus the Operational risk aggregate.

Factor names and descriptions for all operational and market risk aggregate metrics can be found in the "Factor Dictionary – Operational and Market Risk Aggregates" which is available to clients.

Issuer-Level Analysis and Portfolio Aggregation

The analysis is performed at the issuer level, i.e., company by company, and a data export of over 160 factors per company is available from the DataDesk platform for any selected portfolio of covered listed companies.

Results aggregated at the portfolio level are available via the ISS STOXX Portfolio Analytics function on the DataDesk platform. The function makes it possible for investors to upload their portfolios and see the financial impact of physical climate risks on their investments. The analysis showcases several aggregated metrics in a Climate Impact Report (CIR) that evaluates the portfolio's physical risk exposure. For example, the Value at Risk metrics of the portfolio's issuers are aggregated into a **Portfolio Value at Risk, i.e.,** the portfolio value that is at risk due to exposure to climate physical hazards. The analysis also showcases the risk in the form of a map that shows physical risk exposure geography. For more details, refer to the "Climate Impact Report" section of this document as well as to the separate Climate Impact Report Methodology document.

Sources/Inputs

Physical Risk draws on a combination of company-reported information, third-party datasets, proprietary resources, and scientific models. The solution integrates both public and non-public data sources, applies estimation and proxy methods where data gaps exist. Data is not sourced from sustainability statements required under Directive 2013/34/EU or from information disclosed under Regulation (EU) 2019/2088.

- Company inputs include financial data such as revenue (SALES), Property, Plant & Equipment (PP&E), Cost of Goods Sold (COGS), and Selling, General & Administrative expenses (SG&A), together with geographical revenue exposure from FactSet GeoRev and PP&E country-level data from FactSet.

- Asset exposure is informed by ISS STOXX's in-house database of approximately 210,000 geolocated assets linked to around 5,000 issuers, supplemented by disclosures to Environmental Protection Agencies and the Carbon Disclosure Project (CDP).

- Where granular asset data are unavailable, PP&E values are spatially distributed using the LitPop model, which combines satellite night-time light intensity (Black Marble) and population data (Gridded Population of the World).

- Climate hazard inputs are derived from established scientific sources and models, including IPCC AR5-consistent CMIP5 climate models, the CLIMADA platform for tropical cyclones, World Resources Institute Aqueduct riverine and coastal flood projections, hydrological and wildfire models, and peer-reviewed impact and damage functions.

- Market risk estimates rely on macroeconomic modelling using the GTAP-INT framework, with GDP projections informed by OECD and IIASA datasets.

- Scenario inputs include temperature pathways under IPCC Representative Concentration Pathways and NGFS Phase 5 scenarios.

Scientific Foundations of the Methodology

Physical Risk is grounded in established scientific literature and models used by the climate science and economics communities.

- Climate hazard projections are based on outputs from climate models participating in the IPCC Fifth Assessment Report (AR5) and the Coupled Model Intercomparison Project Phase 5 (CMIP5).

- Scenario analysis applies IPCC Representative Concentration Pathways and Network for Greening the Financial System (NGFS) Phase 5 scenarios, with temperature pathways derived from Integrated Assessment Models and translated into physical risk estimates using standard climate modelling approaches.

- Hazard and impact modelling incorporates peer-reviewed tools and datasets, including CLIMADA for tropical cyclones, World Resources Institute Aqueduct data for coastal flooding, and published damage and impact functions linking changes in climate to physical and economic impacts.

Scientific foundations also extend to the translation of hazards into financial outcomes using established impact and economic modelling techniques.

- Acute hazards are modelled through hazard intensity and vulnerability relationships that convert event severity into damage and interruption effects, while chronic hazards are reflected through macroeconomic transmission channels that link climate conditions to productivity and growth impacts.

- For NGFS scenarios specifically, the methodology applies a temperature-based mapping approach (time slicing) to align NGFS temperature pathways with equivalent warming levels in the high emission reference pathway, supporting coherent scenario coverage across the NGFS suite.

- Economic impacts from chronic risks are represented using an established, peer reviewed macroeconomic modelling basis (GTAP-INT) to estimate country level GDP effects that are then translated into company level revenue impacts, complementing the hazard and damage modelling used for operational risks.

- Finally, the solution’s valuation and risk metrics build on recognised finance and economics concepts by linking climate driven changes in revenues, costs, and asset values to measures such as financial risk ratios and value at risk, ensuring outputs remain interpretable within conventional risk management and investment analysis frameworks.

Relevant scientific evidence is identified through a structured review of publicly available climate scenarios, climate datasets and associated technical documentation produced by these recognized institutions, complemented by ongoing assessment of developments in climate science, industry standards and methodological best practice as part of the annual methodology review and update process.

Note, this solution does not assess the alignment of an issuer's commitments, targets, or transition plans against the objectives of the Paris Agreement (or any other international agreement). It quantifies physical climate risk and financial impacts under alternative climate scenarios that can be used by users as an input to their own alignment analyses.

Industry Classifications

Physical Risk applies the **Global Industry Classification Standard (GICS)** to group issuers by industry for the calculation and interpretation of sector-relative metrics, including sector-percentile relative scores, sector-relative change metrics, and resilience assessments.

The **Global Industry Classification Standard (GICS)** is developed and maintained by **MSCI and S&P Dow Jones Indices**. The classification is applied at the **GICS sector level**, as relevant for the calculation of sector-based distributions and comparisons within the methodology.

Assessment Process

Data Collection

The following data is collected by ISS STOXX from third-party data providers, publicly available scientific datasets, and internally maintained databases. Company financial and geographic information is sourced from data vendor based on issuer disclosures, while asset-level data is compiled and maintained in-house using company-reported and publicly available information, including CDP. Relevant references and links to underlying data sources are provided throughout the document in the respective sections.

Corporate, Financial, and Issuer Footprint Inputs

- FactSet Geographical Revenue Exposure (GeoRev) to determine the country-level distribution of issuer revenues.
- FactSet geographic distribution of Property, Plant and Equipment (PP&E) to allocate issuer PP&E values by country where available.
- FactSet issuer financial statement inputs including SALES (revenue), PP&E, COGS, and SG&A.
- ISS in-house asset geolocation database linking physical asset locations to parent issuers and subsidiaries.
- Carbon Disclosure Project (CDP) disclosures used as an input for the Physical Risk Management Score and as a supplementary source of issuer information.

Climate Scenarios and Climate Model Inputs

- CMIP5 climate model outputs used as the core climate model inputs for hazard and impact modelling across the assessment.

- NGFS Climate Scenarios (Phase 5) used as scenario inputs to provide physical risk metrics across multiple climate pathways.
- WRI Aqueduct Coastal Floods Hazard Maps (flood inundation maps) used as the coastal flood hazard input.
- The International Best Track Archive for Climate Stewardship (IBTrACS) used through CLIMADA modelling platform for tropical cyclone hazard and impact modelling.
- FLOPROS flood protection database used to reflect flood protection levels when estimating inundation exceedance.
- Published global flood depth-damage functions used to translate inundation depth into damage fractions.
- MODIS Burned Area Product (NASA) satellite observations used to adjust wildfire burned-area outputs to be consistent with observed data.
- HAZUS-MH (FEMA) recovery-time module inputs used to estimate business interruption duration by building occupancy class mapped to sectors.
- LitPop Produced Capital used to spatially disaggregate PP&E exposure within countries and regions when granular asset locations are not available.

Macroeconomic and Business Interruption Inputs

- GTAP-INT macroeconomic model inputs used to estimate country-level GDP impacts from chronic physical risks and translate them into revenue impacts.
- OECD and IIASA GDP projections (SSP2) used to support longer-horizon sales projections within the valuation calibration approach.
- EM-DAT (Emergency Events Database) used as an input source for historical global damage context presented in the document.

Update Cycle

The Physical Risk Corporate factors are updated on an annual cycle, with the primary release taking place in Q1. Company financial data that underpins the solution is also refreshed once per year as part of this process. A limited refresh is typically conducted in Q3 to incorporate late reported financials and other minor data adjustments.

In addition, there may be instances where material enhancements to the methodology or updates to the underlying scenarios are introduced outside the standard update cycle. These changes are implemented as required to ensure the solution continues to reflect best available assumptions and practices.

The outputs of the Physical Risk Corporate, together with the underlying raw data, remain valid and applicable until the next scheduled update.

Estimation of Data

- Asset location gaps are filled by modelling exposure locations: when issuer asset geolocations are not available or incomplete, PP&E is spatially distributed using the LitPop approach (population and nightlight-based weights) rather than observed facility locations.

- PP&E country allocation can be estimated from revenue geography: if the geographic detail of PP&E is incomplete, the methodology distributes global PP&E across countries where revenues are generated (using GeoRev) and then disaggregates within countries using LitPop.

- NGFS scenario risk levels are estimated via temperature-based mapping: for NGFS scenarios, physical risk is not simulated directly for each NGFS pathway; instead, it is estimated using a time-slicing method that matches NGFS global mean temperature to an equivalent year in high-emission scenario and transfers the corresponding risk estimates.

- Market (GDP-driven) revenue impacts are estimated with a proportionality assumption: the approach assumes a one-to-one relationship between modelled country-level GDP change and issuer revenue change in that country, rather than using observed demand elasticity or company-specific pass-through dynamics.

- Business interruption duration is estimated from a sector-mapped recovery model: interruption time is derived from the HAZUS recovery-time module by mapping building occupancy classes to GICS sectors.

- Sales projections in the valuation step are partly modelled: where consensus sales estimates are unavailable, a regression model is used to project sales, and longer-horizon growth uses scenario-based GDP projections redistributed by revenue geography.

Limitations

Physical Risk assesses current and forward-looking physical climate risks by translating modelled climate hazards into financial impacts using a multi-step modelling framework. This approach relies on climate scenarios, hazard models, impact functions, and financial valuation models, each of which represents simplified representations of complex physical, economic, and corporate processes. Results are scenario-dependent and reflect modelled average outcomes over time rather than the timing or severity of individual extreme events. The assessment is not a prediction of realized losses but an estimate of potential financial exposure under defined scenarios and assumptions.

Accordingly, Physical Risk's methodology and data may be subject to certain limitations. The below outlines such limitations as well as the action taken to address these:

Limitations in availability or consistency of data sources

- The analysis relies on a combination of company-reported information, third-party datasets, proprietary asset databases, and scientific models. The availability and level of granularity of issuer data varies across companies, regions, and sectors.

- While detailed asset-level geolocation data are available for a large subset of issuers, for others geographic exposure must be inferred using revenue distributions or spatial allocation methods. Differences in disclosure practices and data coverage may affect the comparability of results across issuers.

Limitations in the completeness, timeliness and accuracy of information

- Company financial and geographic inputs are primarily derived from publicly available disclosures and third-party data providers and are updated in line with their respective reporting cycles. As a result, Physical Risk may not fully reflect the most recent changes to issuer operations, asset locations, or risk management practices at the time of analysis.

- Model outputs are sensitive to the accuracy of underlying inputs, and any limitations or delays in reported or sourced data may be reflected in the resulting risk estimates.

Limitations in the use of assumptions, proxy reference points and data estimation

- Where granular or complete issuer data are unavailable, the methodology applies standardized assumptions, proxy variables, and estimation techniques to ensure coverage and consistency. Examples include the use of the LitPop model to spatially distribute Property, Plant & Equipment values, assumptions linking country-level GDP impacts to issuer revenues, and the application of generalized impact and damage functions to translate hazard intensities into financial impacts.

- Future risk estimates are contingent on scenario-specific climate model outputs and macroeconomic projections. While these approaches are applied consistently across issuers, they may not fully capture issuer-specific adaptive measures or localized risk-mitigation actions.

Quality Assurance

The Quality Assurance process for the Climate Physical Risk combines scientific validation, robust data controls, and disciplined model governance to ensure consistent, meaningful outputs.

The methodology relies on established climate science inputs and scenario frameworks, including CMIP5 model outputs used in IPCC AR5, RCP4.5 and RCP8.5 pathways, and NGFS Phase 5 scenarios, which supports methodological consistency across time horizons and scenario runs. Quality checks include steps to improve alignment with observed conditions where feasible, for example climate variables are adjusted for consistency with observations and wildfire model outputs are adjusted to satellite observations to reduce discrepancies at coarse model resolution.

The approach also uses historical damage information for context and reasonableness, drawing on global catastrophe damage data to evaluate historical damages and frame the trend in physical risk impacts over time. In addition, issuer financial inputs are monitored through distribution analyses and maintained change logs to flag outliers and material step-changes.

Finally, model and pipeline development follow a controlled lifecycle with version control and structured review to ensure reproducibility, stability, and interpretability of results; and changes to models, data, and assumptions are managed through documented releases to preserve traceability and auditability across versions.

Climate Hazards Deep Dive

The following section explains the hazard modeling methodology further. An overview schematic of how the different hazards relate to the overall impacts and financial risks was shown in Figure 2.

Scenario Analysis

Climate scenarios simulate how the climate responds to different greenhouse gas (GHG) concentration pathways in the atmosphere over time, e.g., how the concentrations of CO_2 change over a specific period. For example, if the CO_2 concentrations increase rapidly, the climate may respond with a swift increase in global temperatures, resulting in changes in extreme weather occurrences and intensities. If the concentrations increase slowly, the same changes may occur but at a different pace and intensity.

ISS STOXX's analysis extends to the year 2050 and includes the two most relevant scenarios used as part of the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5)[2] as well as seven scenarios from the Network for Greening the Financial System (NGFS[3]). These climate scenario pathways are commonly used to analyze progress toward global temperature goals that are consistent with the Paris Agreement (limiting warming to well below 2°C and pursuing efforts toward 1.5°C). The scenarios applied are IPCC AR5 Representative Concentration Pathways (RCP4.5 and RCP8.5) and NGFS Phase 5 scenarios (including Net Zero 2050 and Below 2°C), which provide temperature trajectories and policy pathways used to generate forward-looking physical risk metrics in this methodology. No other international agreements are explicitly modelled within this product beyond the Paris-relevant temperature goal context embedded in these scenario pathways. For clarity, the Paris Agreement is the relevant international agreement referenced for temperature-goal context, while NGFS and IPCC pathways are scenario frameworks used to operationalize those temperature outcomes for risk quantification.

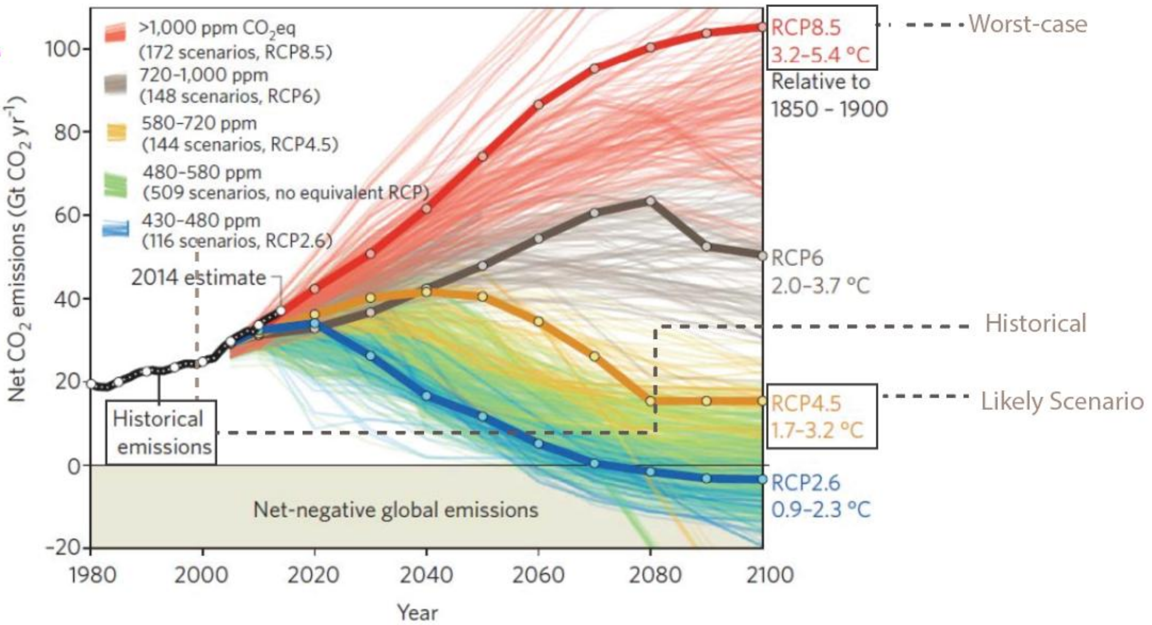
[2] Synthesis Report (SYR) of the IPCC Fifth Assessment Report (AR5)
[3] https://www.ngfs.net/

Likely and Worst-case Scenarios

ISS STOXX provides company-level forward-looking climate physical risk assessment under a likely scenario built around Representative Concentration Pathway (RCP) 4.5, which predicts a 1.7-3.2 °C temperature rise by 2100, and a worst-case scenario based on RCP 8.5, which predicts a 3.2-5.4 °C temperature rise by 2100. These scenarios are shown in Figure 7.

As a comparison point, past risk levels are assessed in terms of a historical (or baseline) scenario and are calculated using a window of years around 1975, specifically by taking the average over the time period 1950-2000. This historical period is used to define baselines for climate-change impacts since global observational climate datasets exist for this period, and because the impacts of climate change were negligible then. The future time frames around the year 2050 correspond to the time period 2030-2070 for both the likely and worst-case warming scenarios.

Figure 7: Representative Concentration Pathways (RCP) emission scenarios adapted from Fuss et al. 2014.
The range of estimated global temperature increases is indicated next to each scenario. ISS STOXX's physical risk analysis uses the RCP4.5 scenario as a likely scenario, and the RCP8.5 scenario as a worst-case scenario. Physical risks for historical climatic conditions are also assessed as a baseline period.



When simulating hazards, ISS STOXX uses the same climate-model outputs as the IPCC used in the 5th Assessment Report (AR5). Several scientific institutions manage these models, and all participated in the Coupled Model Intercomparison Project 5 (CMIP5). The purpose of CMIP5 was to provide a standardized approach for simulating the effects of increased emissions on the world's climate. For example, all institutions following the CMIP5 protocol use the same CO_2-representative concentration pathways, thus generating comparable results across models.

NGFS Framework

The Network for Greening the Financial System (NGFS) has developed a comprehensive scenario framework to support the analysis of climate-related risks to the global economy and financial system. The NGFS scenarios are constructed in collaboration with leading academic climate institutions and are designed to provide a consistent basis for assessing both transition and physical risks across a range of plausible climate futures. To support this consistency across transition and physical risk estimation the ISS STOXX Physical Risk also provides a comprehensive set of physical risk metrics under the NGFS scenarios. The following seven scenarios are covered by the solution and are derived from the NGFS Phase 5[4] published in November 2024.

- **Low Demand (LD):** Orderly transition, limiting warming to below 1.5°C by 2050, driven by lower energy demand.
- **Net Zero 2050 (NZ):** Stringent policies and innovation to reach net zero CO_2 emissions by 2050, limiting warming to 1.5°C.
- **Below 2°C (B2D):** Gradual policy tightening, giving a 67% chance of limiting warming to below 2°C.
- **Delayed Transition (DT):** Emissions do not decrease until 2030, requiring stronger policies later to limit warming below 2°C.
- **Nationally Determined Contributions (NDC):** Reflects all pledged targets, even if not yet implemented.
- **Current Policies (CP):** Only currently implemented policies are preserved, resulting in high physical risks.
- **Fragmented World (FW):** Delayed and divergent policy responses, leading to high physical and transition risks.

These scenarios are defined by their global mean temperature (GMT) trajectories that are, in turn, generated using Integrated Assessment Models (IAMs). IAMs are models that simulate the interactions between the economy, energy systems, land use, and the climate. They are used to assess the impacts of different policy ambitions on emissions and energy transitions. To translate these simulated emissions into global temperature outcomes, they are input into a reduced complexity climate simulator, MAGICC (Model for the Assessment of Greenhouse Gas Induced Climate Change). MAGICC is a widely used tool that converts projected greenhouse gas emissions into estimates of atmospheric concentrations and resulting changes in global mean temperature over time. This process allows each scenario to be associated with a specific temperature trajectory, providing a consistent basis for assessing physical climate risks under different policy and socio-economic futures[5,6].

[4] https://www.ngfs.net/en/publications-and-statistics/publications/ngfs-climate-scenarios-central-banks-and-supervisors-phase-v
[5] https://www.iamconsortium.org/what-are-iams/
[6] http://wiki.magicc.org/index.php?title=Model_Description

Table 3: End of century warmings under NGFS Phase 5 scenario. Source: NGFS Phase 5 Scenario Explorer7

NGFS SCENARIO NAME	ABBREVIATION	WARMING BY 2100
Low Demand	LD	1.1 °C
Net Zero 2050	NZ	1.4 °C
Delayed Transition	DT	1.7 °C
Below 2°C	B2C	1.8 °C
Nationally Determined Contributions	NDC	2.3 °C
Fragmented World	FW	2.4 °C
Current Policies	CP	3 °C

Physical Risk Estimates for NGFS Scenarios

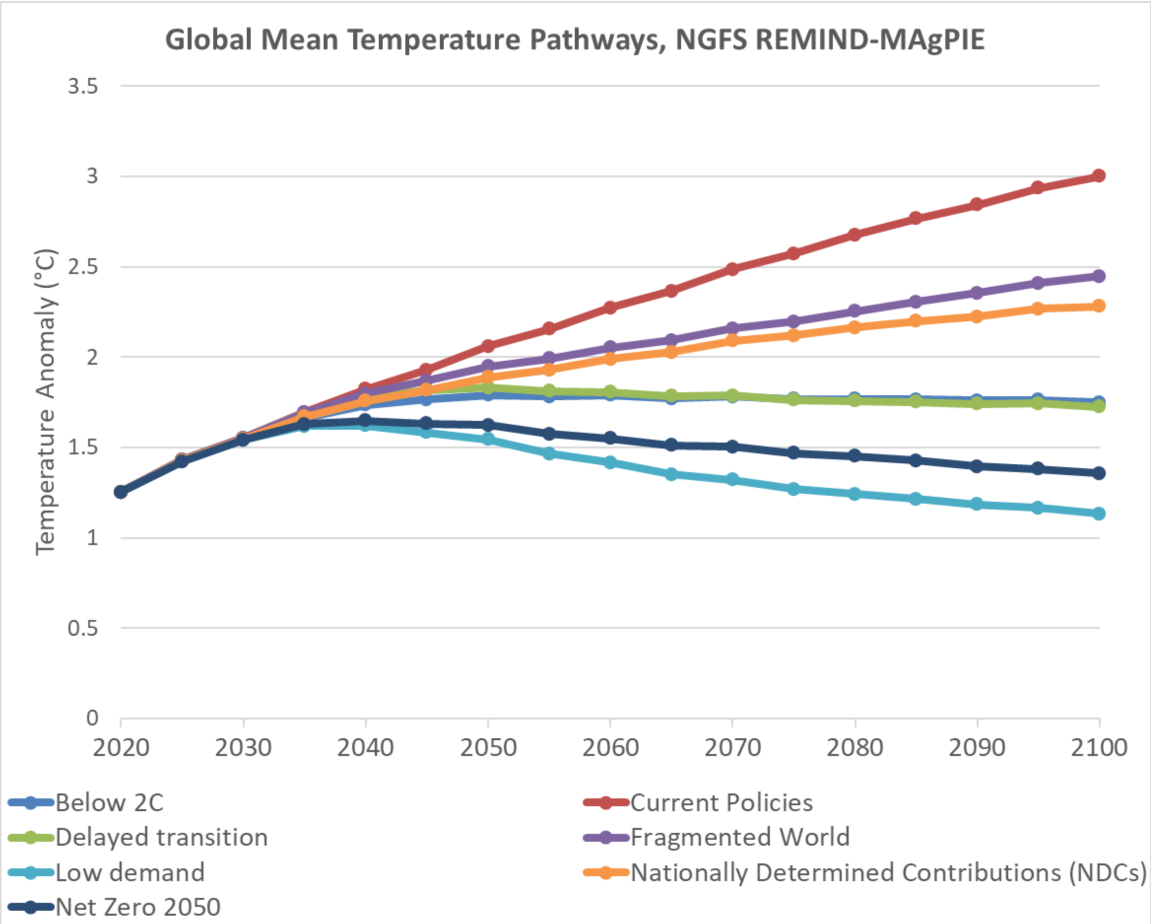
To provide risk estimates under the full range of NGFS scenarios, we extend our physical risk model suite beyond the two RCP scenarios using a time slicing method, as outlined in the NGFS technical documentation[8]. This approach enables us to leverage the risk estimates available from high-emission scenarios (notably the RCP8.5 or "worst" scenario) and map them onto the global temperature pathways defined by each NGFS scenario (Figure 8). This method for estimate NGFS risk levels consists of the following steps:

- For each NGFS scenario, we use the global mean temperature (GMT) trajectory as defined by the scenario's underlying Integrated Assessment Model (REMIND-MAgPIE) simulation.
- For a given NGFS scenario and target year, we identify the year in the RCP8.5 pathway where the GMT matches that of the NGFS scenario.
- We take the risk estimates from RCP8.5, averaged over a 21-year window centred on the matching year (10 years before and after), to represent the risk under the NGFS scenario at the target year.
- This process is repeated for all relevant years and scenarios, allowing us to provide a consistent set of physical risk factors (including acute and chronic risks as well as value at risk) across the full NGFS scenario suite.

[7] https://data.ene.iiasa.ac.at/ngfs/
[8] https://www.ngfs.net/en/publications-and-statistics/publications/ngfs-climate-scenarios-central-banks-and-supervisors-phase-v, see technical documentation.

Figure 8: Global mean temperature pathways under NGFS scenarios based on the REMIND-MAgPIE integrated assessment model.

The chart illustrates projected temperature anomalies relative to pre-industrial levels under 7 NGFS scenarios. These pathways reflect varying levels of climate policy ambition and timing, with Low Demand scenario resulting in the lowest global temperature by 2100. Source: NGFS Phase 5 Scenario Explorer[9]



Climate Hazards

Physical climate hazards are climate processes, extreme events or disasters that can harm human health, livelihoods, assets, business activities and/or natural resources[10,11]. The ISS STOXX physical risk analysis includes six hazards that are the costliest in terms of past damage incurred and which are expected to continue to cause substantial financial impacts on both business and civil society. The six hazards covered in the assessment are:

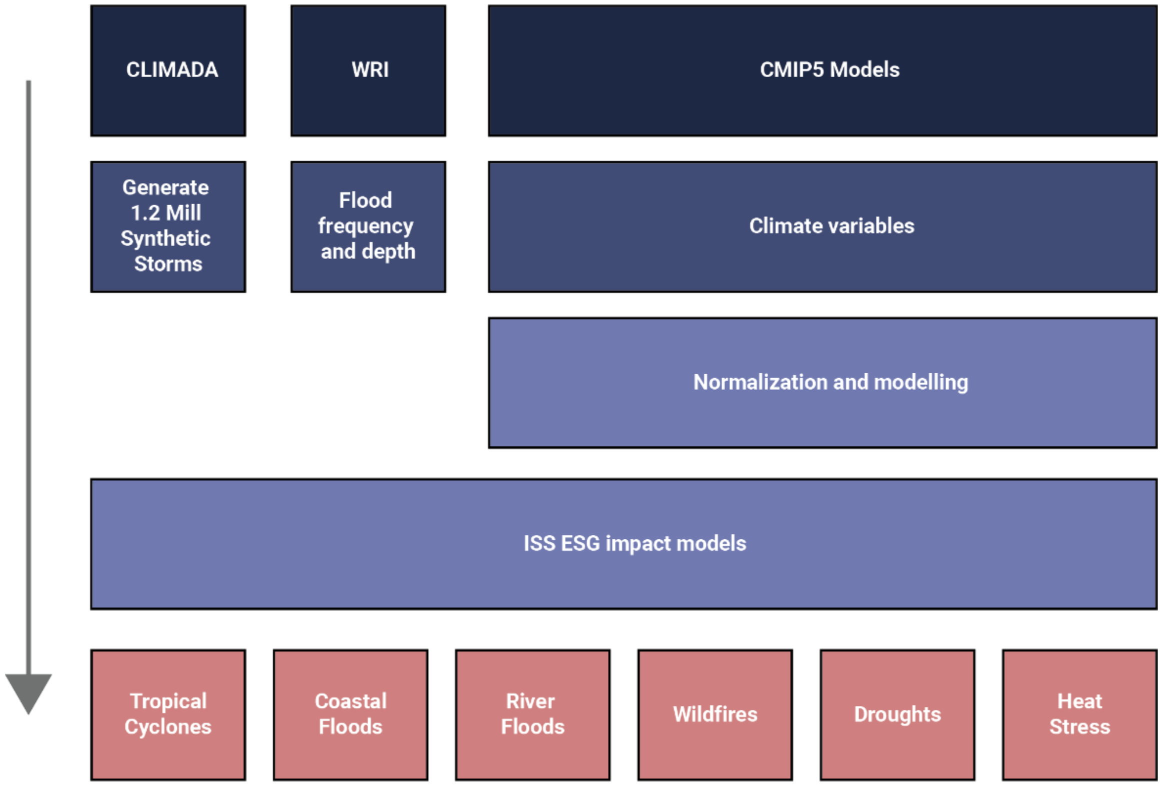
[9] https://data.ene.iiasa.ac.at/ngfs/
[10] Managing the risks of extreme events and disasters to advance climate change adaptation, Field et al. (2012), IPCC.
[11] In-depth Q&A: The IPPC's sixth assessment on how climate change impacts the world, Chandrasekhar et al. (2022), Carbon Brief.

- Tropical cyclones
- Coastal Floods
- River Floods
- Wildfires
- Heat waves
- Droughts

We use climate models that simulate climate variables such as surface temperature, precipitation, and humidity, etc., and impact models to represent the physical hazards above. For each hazard, hazard intensities (maximum cyclone wind speed, flood inundation level, burned area fraction, etc.) are derived from climate variables and used to compute impacts such as damages, productivity loss, or effects on GDP, which are in turn used to calculate operational and market financial risks.

We use several of the IPCC's CMIP5 models (for wildfires, river floods, droughts, and heat stress), the climate risk modelling tool CLIMADA for tropical cyclones, and the World Resources Institute's Aqueduct Coastal Floods Hazard Maps to derive hazard intensities (see Figure 9). Climate variables that come directly from climate models such as temperature, precipitation, and humidity are adjusted to ensure that they are consistent with observations. Hazard intensities and impact metrics are all represented on a spatial grid of the world with a spatial resolution of 100 km by 100 km, a common resolution used in the CMIP5 models.

Figure 9: Hazard modelling in ISS STOXX's Physical Risk.



Tropical Cyclones

"A tropical cyclone is a rapidly rotating storm originating over tropical oceans from where it draws the energy to develop".[12] It is associated with violent winds, storm surges and floods. It is the costliest weather-related hazard in terms of the damages and impacts it generates.

ISS STOXX's tropical cyclone model applies the CLIMate ADAptation modeling platform, CLIMADA[13], a natural catastrophe damage model. Tropical cyclone trajectories and intensities are simulated based on historical cyclone tracks and observations, and scenario-dependent relationships derived from scientific literature are used to model future hazard intensities (maximum wind speed). Extreme winds are modeled on a grid (100 km by 100 km) based on 1.2 million simulated tropical cyclone trajectories. Risk maps are then generated for a variety of return periods, which indicate the maximum wind speed over intervals of 10, 20, 50, and 100 years. From the extreme wind speeds, regional impact functions provided in CLIMADA are used to calculate expected average annual damages at each location in the map grid.

Coastal Floods

Extreme sea-level events such as tides, surges and waves can result in coastal flooding. The global mean sea level is rising at an accelerated pace due to thermal expansion of ocean water and ocean mass gain, the latter primarily due to a decrease in land-ice mass. The combination of this gradual sea level rise with extreme sea level surge events will increasingly expose coastlines all over the world to floods.[14]
ISS STOXX uses the World Resource Institute (WRI) Coastal Hazard projections[15] to represent coastal floods. The WRI future extreme sea level projections are estimated using two data sets as inputs:

- The Global Tide and Surge Reanalysis (GTSR) data set[16]: a validated data product that consists of global information on coastal flooding and includes time series of high tides and storm surges and estimates of extreme sea levels,

- A data set of extreme water levels and gridded sea level changes[17] from the project "Responses to Coastal Climate Change: Innovative Strategies for High-End Scenarios— Adaptation and Mitigation".

Coastal flooding is represented by the WRI in terms of high-resolution flood risk maps, which we aggregate to a resolution of 100 km by 100 km. The WRI flood risk maps, which indicate the maximum inundation level at each grid point, are provided for return periods of 1.5, 2, 5, 10, 50, 100, 250, 500, and 1000 years. We additionally apply the FLOPROS flood protection database to calculate inundation at all grid points where the flood risk is greater than the protection level and then calculate the average inundation from these risk maps. Damage is then calculated from these average inundation levels based on a published set of global flood depth-damage functions[18].

[12] Tropical cyclones description, World Meteorological Organization.
[13] CLIMate ADAptation modeling platform, CLIMADA.
[14] Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities, Oppenheimer et al. (2019), IPCC Special Report.
[15] Aqueduct Floods Methodology, Ward et al. (2020), World Resources Institute.
[16] A global reanalysis of storm surges and extreme sea levels, Muis et al. (2016), Nature Communications.
[17] Upper limit for sea level projections by 2100, Jevrejeva et al. (2014), Environmental Research Letters.
[18] Global flood depth-damage functions: Methodology and the database with guidelines, Huizinga et al. (2017), Publications Office of the European Union.

River Floods

Flooding is an overflowing of water onto land that is usually dry.[19] Areas near rivers are at risk from floods due to the possibility of increased water levels in the riverbeds due to excessive run-off. Run-off refers to the amount of water that flows through a river. If the amount of water surpasses manageable levels, for example, via intense precipitation, a flood can occur. ISS STOXX uses a hydrological model to simulate river flood inundation from the output of four CMIP5 models and applies the same flood depth-damage functions.

Wildfires

"A wildfire is an unplanned fire that burns in a natural area such as a forest, grassland, or prairie"[20]. This analysis uses global burned areas simulated by CMIP5-generation climate models and land surface impact models at a resolution of 100 km by 100 km[21]. Certain physical processes, such as fire ignition, surface winds and topography, however, affect wildfire risk at spatial scales that are smaller than 100 km. This limitation can cause there to be differences between the simulated wildfire output and that which was observed. To remedy this difference, simulated global burned areas are adjusted to be consistent with satellite observations from 2001-2019[22]. We assume that burning generates a complete loss and so the damage ratio for all assets in a grid point is the same as the burned area fraction.

Heat Stress

Heat stress is a series of human conditions resulting from challenges for the human body to maintain a temperature of 37°C. A variety of conditions determines how the human body perceives heat. Heat stress is assessed by looking at a combination of factors: rising temperatures, humidity, wind speed, cloud cover, and amount of direct sunlight. The combination of these factors is expressed in terms of the wet bulb globe temperature (WBGT). We calculate the WGBT directly from temperature, pressure, and relative humidity, all at the level of the surface, using output from climate models that participated in CMIP5. Urban-island effects are not considered in the analysis.

ISS STOXX uses an impact model that simulates labor productivity changes based on the WBGT for different work intensities. A work intensity refers to the physical efforts required for the activity, e.g., manual labor will have a high work intensity. In contrast, office work will have a low work intensity.

Drought

A drought is defined as a long period of below-average net water supply to a specific area. Droughts can result in reduced agricultural crop yields on a large scale, e.g., countrywide, resulting in significant financial impacts.

[19] Severe Weather 101 - Floods, NOAA National Severe Storms Laboratory.
[20] Wildfires, World Health Organization.
[21] The Inter-Sectoral Impact Model Intercomparison Project, ISI-MIP.
[22] MODIS Burned Area Product, NASA.

To assess droughts, ISS STOXX uses a standard precipitation index (SPI) based on temperature and precipitation output from CMIP5-generation climate models. The index indicates whether conditions are dryer or wetter than usual over the past six-month period compared to the historical record.[23]

Acute and Chronic Physical Risks

The analysis includes both acute and chronic physical risks. Acute physical risks are typically short-lived event-based risks that lead to instantaneous damages. On the other hand, chronic physical risks are gradual and build up over longer time periods. The acute physical risks considered here are those that derive from tropical cyclones, wildfires, river floods and coastal floods due to rain and storm surges without sea-level rise. The chronic physical risks included are those resulting from heat stress, droughts and coastal floods due to gradual sea-level rise (from sea-water expansion due to temperature increase, or from inflow of fresh water from melting ice caps). The different acute and chronic physical hazard contributions are summarized in Table 4.

The metrics (Financial Risk, Absolute Scores, Risk Categories, Percentile Relative Scores and Risk-Change Relative Scores) provided for tropical cyclones, wildfires and river floods are acute-risk metrics, whereas the metrics for heat stress and droughts are chronic-risk metrics. The metrics for coastal floods correspond to the acute component (rain/storm surges) of the coastal flood hazard (see details in Appendix I: Calculation of Financial Risk Metrics). Market financial risks considered in the analysis are all chronic risks and include the combined effects of heat stress, drought and chronic coastal floods (gradual sea-level rise).

Table 4: Acute and chronic physical risks considered in ISS STOXX's analysis.

ACUTE RISKS	CHRONIC RISKS
Tropical Cyclones	Heat Stress
Wildfires	Droughts
River Floods	Coastal Floods (gradual sea level rise)
Coastal Floods (rain/storm surges)	

Issuer Exposure Profile

A company's exposure profile can be created by understanding its corporate structure, including its financial data, where it operates and where it generates revenue. The profiles are created by combining geographical and financial company-specific information.

The ISS STOXX analysis uses the following financial factors found on a company's balance sheet:

- **Property, Plant & Equipment (PP&E) value** – total value of a company's fixed assets such as buildings, machinery, or land.

[23] Standardized Precipitation Index User Guide, 2012, World Meteorological Organization.

- **SALES** – yearly revenue.
- **Costs of Goods Sold (COGS) –** yearly cost of goods that are either manufactured or purchased.
- **Selling, General & Administrative expenses (SG&A)** – general expenses pertaining to operational overhead expenses that impact the entire business.

Company Inputs – Geographical and Financial Footprint

Sales

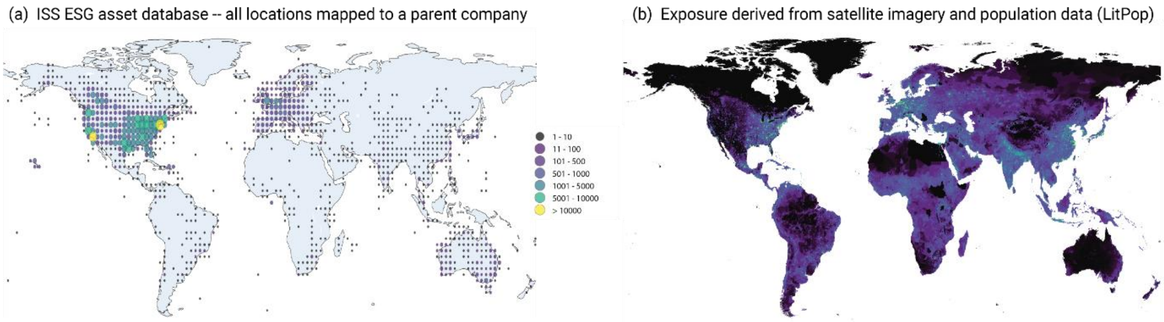
A company's global revenue stream serves as a strong indication of where a company has financial interests. FactSet's Geographical Revenue Exposure data set, GeoRev[24], is used to establish how much and in which countries an issuer generates revenue. Revenues can be affected by operational risks, via business interruptions, or by market risks, via a reduction in a market's gross domestic product (GDP).

For companies where the geographical distribution of asset (PP&E) value is missing (see details below), the country distribution of revenue is used to distribute global PP&E value and generate the issuer's operational footprint.

Asset geolocations

For most companies, the main operational risks stem from the exposure of the physical assets they own and operate, e.g., factories, including the buildings and machinery, or other types of real estate. When a climate hazard hits an asset, physical damages may result in repair costs and reduced revenues because of the resulting business interruptions.

Figure 10: Asset geolocations and LitPop model.
(a) Locations of ~210,000 physical assets in the ISS STOXX asset database. All assets have been mapped to their parent issuer. Dot colors indicate number of assets at each location. (b) LitPop exposure weights derived from satellite nightlight intensity (Black Marble 2016[25]) and gridded population data (Gridded Population of the World v4[26]) using the LitPop model (Eberenz et al. 2019[27]).



[24] FactSet's Geographic Revenue Exposure, GeoRev, FactSet.
[25] NASA's Black Marble, NASA.
[26] Gridded Population of the World (GPW) v4, Socioeconomic Data and Applications Center.
[27] Asset exposure data for global physical risk assessment (LitPop), Eberenz et al., 2020, Earth System Science Data.

ISS STOXX maintains an in-house database of PP&E asset geolocations tied to issuers (directly or via owned subsidiaries) covered in the present physical risk assessment (Figure 10(a)). Most companies do not publicize their assets unless regulatorily bound to do so. ISS STOXX continuously gathers data from different sources to improve its asset database. Sources include company-reported data to the national and international Environmental Protection Agencies (EPAs) and voluntary disclosures such as the Carbon Disclosure Project (CDP). More asset data is available for high-income regions such as the EU, US, UK, Canada and Australia, due to regulations that require reporting of high-emitting assets.

ISS STOXX asset database covers around 210,000 assets mapped to approximately 5,000 issuers. Assets for a parent issuer and its owned subsidiaries are included. Assets go beyond just the headquarters and are geolocated precisely at the latitude and longitude level. The number of assets per company varies between a few and a few thousand.

Property, Plant & Equipment (PP&E) Value

PP&E refers to the value of tangible assets that are necessary for a company to operate. Examples of this may be operating facilities and equipment. If a company's PP&E is hit by a hazard, costs can occur relating to repairs and business interruptions resulting in reduced sales.

Companies report PP&E value at different levels of geographic detail. ISS STOXX uses data from FactSet for the geographical distribution of PP&E value by country for over 18,000 issuers (approximately 80% of all issuers covered by the Physical Risk analysis). Most companies report at country level but some report for larger regions or only report the global value. The majority of companies (approx. 15,000) operate in 5 countries or less, whereas a few thousand companies operate in 20 or more countries.

If geographical detail is provided, PP&E values are distributed across available asset locations and countries of operation. If asset locations are missing, a combination of population and night-light intensity (LitPop model, see below) is used to distribute the PP&E values over the most densely populated areas within each country or region. If geographic detail is missing, PP&E values are distributed based on the LitPop model in countries where revenues are generated (using FactSet's GeoRev data).

LitPop Model

When used, the LitPop model (Eberenz et al. 2019[28]) disaggregates PP&E value to go from a country-level spatial distribution to a more granular spatial distribution. In this way, high-resolution maps of asset exposure values are generated (Figure 10.b). LitPop is an open-source and publicly available dataset. The LitPop model uses weights that are proportional to a combination of night-light intensity and geographical population data. Light-intensity data is based on night-time luminosity measurements from NASA Earth Observatory's satellite images, as a proxy for infrastructure density. Population data is obtained from the Gridded Population of the World – GPW – dataset and includes non-spatial population data and cartography data.

Country-level PP&E value is disaggregated (or distributed) within each country as follows. For every cell (pixel) in a map grid, night-light intensity and population data are combined to compute a LitPop weight (via a

[28] Asset exposure data for global physical risk assessment (LitPop), Eberenz et al., 2020, Earth System Science Data.

multiplicative and power-law function). The PP&E value for a country is then distributed onto each grid cell within that country proportionally to the gridded LitPop weights, resulting in a gridded asset value map. Specifically, for each cell within a country region, a weight is computed by dividing the cell's LitPop value by the sum of LitPop values over all cells within that country. The PP&E value at each cell in the grid is then determined by multiplying the total country asset value by the weight at that cell, resulting in spatially disaggregated data.

Selling, General & Administrative expenses (SG&A)

SG&A refers to the direct and indirect costs associated with selling the company's goods (products) and all general and administrative expenses, such as labor costs. An example of how SG&A is affected by physical risks is through heat stress. Increasing temperatures can lead to reduced labor productivity. A company can then adjust this by hiring, thus increasing SG&A expenses associated with labor costs.

Cost of Goods Sold (COGS)

COGS refers to the direct costs associated with producing the goods sold by a company. In some cases, labor costs are reported under COGS rather than SG&A. The ISS STOXX analysis is adapted depending on company reporting.

Financial Impact Deep Dive

Impact Functions

Impact functions are used to estimate the impact of a hazard on a company's operations by relating a simulated climate quantity (typically a hazard intensity, e.g., wind speed) to an impact (e.g., degree of destruction, change in labor productivity).

Impact functions and impact types differ between hazards. For example, an impact function for tropical cyclones relates the simulated maximum wind speed to the degree of destruction of physical property. If the value of the damaged asset is known, then the associated repair costs can be computed. Table 5 details the impact functions and associated climate variables used in the analysis for each hazard. Refer to Figure 2 for a schematic of all the hazards and impacts considered.

For the acute hazards, impact functions are used to calculate physical asset damages in terms of direct impacts. Indirect impacts are then calculated with other impact functions that relate the degree of damage of the direct impact to the number of days of business interruption (see details below).

The impacts of heat stress consider how changes in temperature affect workplace performance and so, reduce work capacity. Higher temperatures can lead to a reduced labor productivity, affecting the relationship between labor costs, production and sales. If production volumes and sales are to remain the same as before the temperature increase, the company will have to hire more people, yielding an increase in labor costs. The heat stress impact functions relate the mean wet-bulb-globe temperature to a percentage loss of productivity for three different work-intensity levels, with physically intense labor having a higher intensity than office work[29]. This analysis assumes that a decrease in productivity will generate an equivalent increase in production costs.

Table 5: Impact functions: climate inputs used by the various impact functions and types of impacts generated. For example, an impact function converts tropical cyclone wind-speeds into a degree of damage; another impact function then converts the degree of damage into days of business interruption.

HAZARD	CLIMATE VARIABLE	DIRECT IMPACT	INDIRECT IMPACT
Tropical Cyclones	Maximum daily sustained wind speed (m/s)	Degree of damage (% of value)	Business interruption (no. of days)
River Floods	Maximum flood depth (m)	Degree of damage (% of value)	Business interruption (no. of days)
Coastal Floods	Maximum flood depth (m)	Degree of damage (% of value)	Business interruption (no. of days)
Wildfires	Burned area fraction	Degree of damage (% of value)	Business interruption (no. of days)
Heat stress	Daily wet-bulb-globe temperature	Change in labor productivity (%)	No indirect impact
Droughts	Standard precipitation index (SPI)	Change in crop yield (%)	No indirect impact

Heat stress is also known to affect human health and agricultural output. These effects at the country-GDP level are included in the market-risk model used to compute market financial risks (see details on market risks below). Similarly, droughts are a key driver of reduced agricultural production and are considered via the market-risk model.

Damages

For the acute hazards (tropical cyclones, coastal floods, river floods and wildfires), damages are calculated using hazard-specific damage functions that link hazard intensities to fractional damage for a physical asset. The fractional damage or degree of damage is the percent of the value of an asset that is damaged from a direct impact from the acute hazards.

For tropical cyclones, the analysis uses the built-in tropical cyclone impact functions from the open-source CLIMADA modeling platform[30]. These are 9 different functions, corresponding to 9 world regions, that link maximum cyclone wind speed to damage degree. For wildfires, the burned area fraction is directly assumed to be the damaged fraction and hence the fully lost fraction of value at each relevant location. The damage degree for coastal and river floods is calculated based on published flood damage functions[31] (depth-damage curves) for each continent that relate specific flood-water depths to damage fractions.

Asset damages result in repair costs as well as business interruptions that reduce revenues.

[29] Working on a warmer planet: The impact of heat stress on labour productivity and decent work, 2019, International Labour Organization.
[30] Regional tropical cyclone impact functions for globally consistent risk assessments, Eberenz et al., 2021, Natural Hazards and Earth System Sciences.
[31] Global flood depth-damage functions: Methodology and the database with guidelines, Huizinga et al., 2017, Publications Office of the European Union.

Repair Costs

Repair costs are calculated by multiplying the degree of damage for each asset by the known exposed asset value. This is done for each map grid point that conforms to a company's value exposure profile. Repair costs associated with physical asset damages are assumed to generate an increase in capital expenditure.

Business Interruptions

In addition to the physical damage explained above, extreme events from acute hazards also interrupt business operations. These interruptions are modelled using an impact function that relates the degree of damage to the fraction of time in the year in which the business is interrupted (business interruption fraction). Assuming that revenues are not generated when business is interrupted, we multiply the business interruption fraction by the revenue that would have been generated to determine the value lost due to business interruptions for a year. This procedure is applied to every grid point where the issuer has revenues.

The business interruption impact functions are sector dependent and are based on the building-recovery-time module of the HAZUS-MH risk-modelling platform, a natural hazard model developed by the US Federal Emergency Management Agency[32]. The fraction of the year that is interrupted includes the time required for repairs, cleaning-up, construction works, decision-making, financing, and inspection. HAZUS-MH represents 28 building-occupancy classes that we map to GICS sectors. Business-interruption time is capped to a maximum of one year.

Calculation of Market Financial Risks

Market financial risks quantify the country-level impact of chronic physical risks on GDP and translate those impacts into revenue losses for companies in each country.

ISS STOXX's market risk assessment makes use of a peer-reviewed integrative market-risk model[33] that estimates the impact of climate change on the GDP of countries at different times, for various warming scenarios. The analysis jointly considers:

- The chronic effects of sea-level rise (chronic component of Coastal Floods),
- The combined impact of Droughts and Heat Stress on agricultural productivity,
- The temperature-induced decrease in labor productivity (Heat Stress),
- The effect of extreme temperatures on human health (Heat Stress).

The analysis focuses on the macroeconomic impacts of the chronic climate physical hazards (see Table 5) and is based on the results of a computational general equilibrium model of the economy, named Global Trade

[32] Multi-hazard Loss Estimation Methodology Earthquake Model Hazus®–MH 2.1 Technical Manual, 2013, Federal Emergency Management Agency.
[33] The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord, T. Kompas et al. (2018), Earth's Future.

Analysis Project, GTAP-INT[34]. This model represents macroeconomic interactions between 139 economic regions/countries and 57 sectors in terms of supply and demand equations for producers, households, investment demand and governments. The impacts of climate change due to sea level rise, heat stress and droughts are used to shock the economy, with region- and sector-specific damages resulting in country-level changes in future GDP.

ISS STOXX's physical risk assessment assumes that there is a one-to-one relationship between the model country's GDP change and the change in country-level sales for a company. For example, suppose that company X generates revenue in both India and Australia and that the model estimates that, by 2050, due to climate change in a likely emission scenario, India's GDP will be reduced by 3.2% and Australia's GDP will be reduced by 0.17%. The market model then assumes that the 2050 revenues raised by company X will be reduced by 3.2% in India and by 0.17% in Australia, compared to revenues in the absence of physical risks. In absolute terms, for instance, if company X's projected 2050 revenues in Australia amount to 1M USD, the Australian revenue at risk for that year would be 1,700 USD. The market model assumes that the sales of all companies in a country are affected in the same way.

Summary of Financial Impacts

A company's exposure profile provides a spatially explicit financial footprint. The exposure profile in conjunction with the modeled hazard impacts allows the quantification of various financial impacts that will affect a company's balance sheet:

Repair costs due to the exposure of owned assets to:

- Tropical Cyclones
- Coastal Floods
- River Floods
- Wildfires

Loss of income from business interruptions due to:

- Tropical Cyclones
- Coastal Floods
- River Floods
- Wildfires

[34] Building a better trade model to determine local effects: a regional and intertemporal GTAP model, P. Van Ha, T. Kompas et al. (2017), Economic Modelling.

Production costs incurred from changes in labor productivity due to:

- Heat Stress

Loss of income from market risks, i.e., linked to changes in GDP due to:

- Sea level rise (Coastal Floods)
- Combined impact of Drought and Heat Stress on agriculture
- Impact of Heat Stress on health

Financial Risk Calculation

As explained in the "Main Metrics" section, the Total Financial Risk is defined as the sum of the financial impacts (costs and losses) listed above, as follows:

$$\text{Total Financial Risk} = \text{Cost}_{\text{repairs}} + \text{Cost}_{\text{production}} + \text{Loss}_{\text{business interruption}} + \text{Loss}_{\text{market risk}}$$

The Total Financial Risk includes all operational and market risks from all hazards.

For example, let's assume that in a likely scenario, the projected financial impacts for company X by 2050 are:

- 10 Mill USD/year of repair costs,
- 1 Mill USD/year of reduced sales due to business interruptions,
- 0.5 Mill USD/year of increased production costs due to decreased labor productivity,
- 3 Mill USD/year loss of income due to market risks.

Then, the Total Likely Financial Risk would be calculated as:

$$\text{Total Financial Risk, Likely} = 10 + 1 + 0.5 + 3 = 14.5 \text{ Mill USD/year.}$$

The Financial Risk Ratio metrics are calculated as the Financial Risk divided by the company's annual revenue. Financial Risk Ratios are numbers between 0 and 1. For instance, the Total Financial Risk Ratio is calculated using the Total Financial Risk as follows:

$$\text{Total Financial Risk Ratio} = \frac{\text{Total Financial Risk}}{\text{revenue}}.$$

Financial Risk Ratios are also calculated for each individual hazard. For example, for wildfires, we have:

$$\text{Financial Risk Ratio Wildfires} = \frac{\text{Financial Risk Wildfires}}{\text{revenue}}.$$

Further details can be found in Appendix A: Calculation of Financial Risk Metrics.

EVA Valuation Model

In order to evaluate the impact of physical risks on the value of a company, ISS STOXX employs a proprietary valuation model based on the Economic Value Added (EVA) methodology. The ISS STOXX EVA model differentiates itself by estimating a company's economic profit rather than its accounting profit, yielding a more robust measure of the company's intrinsic value.
In particular, the methodology considers the market costs associated with equity and capital investments to evaluate the investor's required rate of return on those investments. Items that would traditionally be treated as expenses, such as research and development (R&D) or intangible assets that would be assigned no value, are used to assess future shareholder value and potential dividends. By doing so, the investor's opportunity cost is priced in. It also makes it possible for the investor to compare potential profits across companies, sectors and regions through a consistent framework. For physical risk specifically, the ISS STOXX EVA model and data allow to, for example, account not only for owned assets or PP&E (as in the traditional accounting method) but also for rented and leased PP&E. This is critical, as business interruptions can occur independently of whether a production facility is rented or owned.

Value at Risk Calculation

The Value at Risk (VaR) of an individual issuer estimates the change in equity or market value (market capitalization) resulting from the financial impacts of physical risks. Issuers are first valued without the consideration of physical risks to calibrate the model and are then re-evaluated accounting for financial changes due to physical risks. The calculation of the VaR for physical risk is therefore a two-step process.

Step 1. EVA valuation model calibration (without physical risks)

In a first step, the company's SALES is projected 30 years into the future from the reporting year. Three sources of data are used to build this SALES projection:

a) Historical financial data (5 years prior to reporting year).

b) Consensus estimates (5 years into the future beyond the reporting year). When consensus sales estimates are not available, a regression model is instead used to project sales.

c) GDP projection (years 6 to 30 beyond the reporting year). The GDP projection uses an average of two integrated assessment model GDP simulations (OECD and IIASA) based on the SSP2 scenario (Shared Socioeconomic Pathway, Middle of the Road). The global GDP projections are redistributed to each country in which the company raises revenue based on the GeoRev dataset.

Based on the projection of SALES, the future values of PP&E, SG&A, and COGS are calibrated such that the model's "default" equity value prediction is equal to the actual equity value of the issuer. The calibrated financial values represent "default" trajectories without the consideration of physical risks.

Step 2. EVA valuation with physical risks

The valuation model is then run a second time, with the EVA model taking as input projected company financials that integrate the following physical risk impacts:

a) SALES: fall due to business interruptions and market risks,

b) SG&A and COGS: increase due to labor productivity reductions driven by heat stress,

c) PP&E and CAPEX: damage to assets from river floods, coastal floods, wildfires, and tropical cyclones reduce PP&E and the associated damage repair costs are treated as investments that increase CAPEX.

The valuation model considers the above changes and calculates an adjusted equity value. The difference in the equity value with and without physical risks is the Value at Risk (VaR), or climate-adjusted value.

Example: Company X

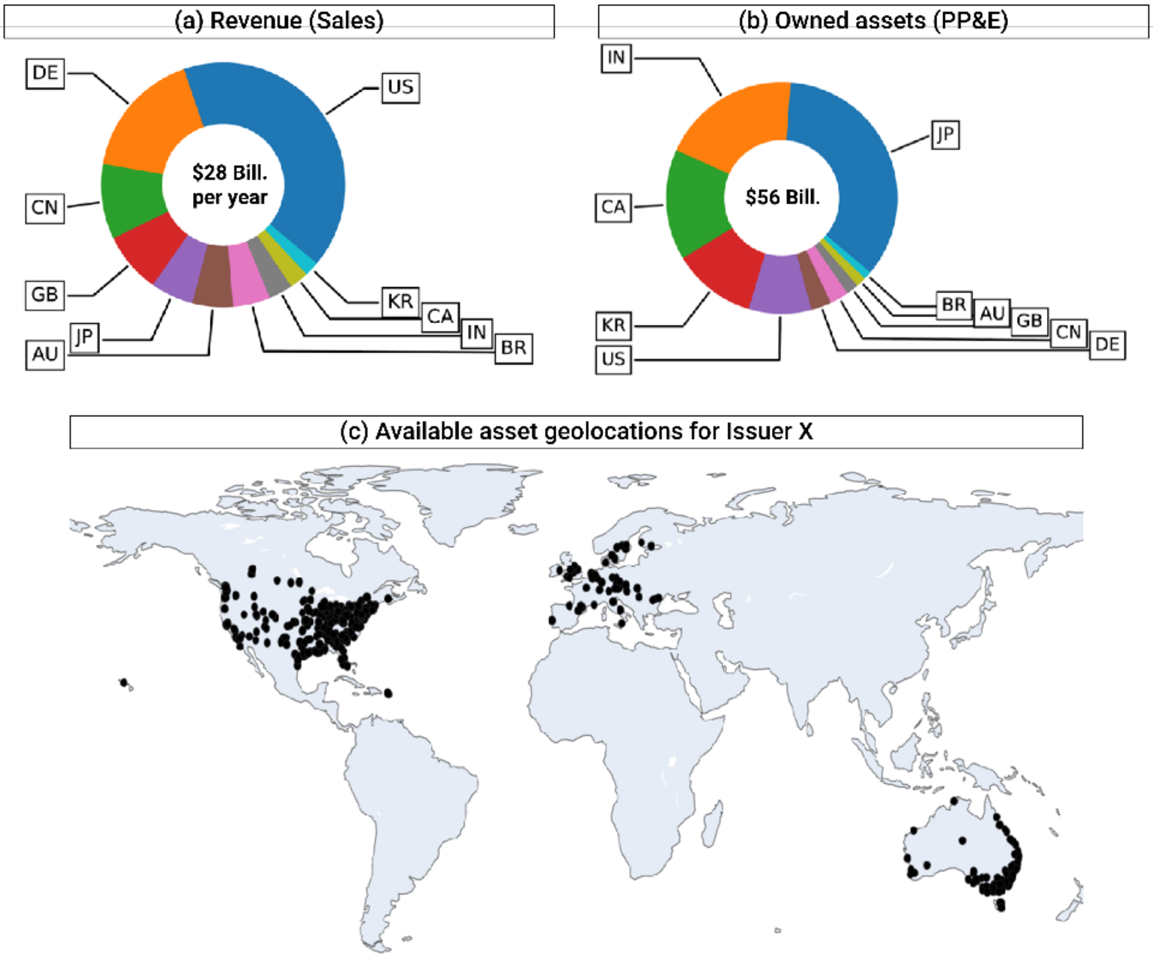
This example showcases the underlying data used in the physical risk analysis of an issuer X in the Materials sector.

Geographical Footprint

Issuer X generated $28 Bill. in revenue (SALES) in 2019 and owned $56 Bill. worth of assets (PP&E). Figure 11(a) and Figure 11(b) respectively show how the global revenue and PP&E value is distributed by country. Note the very different geographies of revenues and operations. The issuer generates most of its revenue in the USA, Germany and China while operating primarily in Japan, India and Canada. This example illustrates the importance of considering the geographical distribution of PP&E in addition to the revenue distribution to build the company's exposure profile. Assessments that use only the revenue distribution as a proxy for operational exposure will often be incorrect.

The total asset value (PP&E) per country in Figure 11(b) are distributed to asset locations (Figure 11(c)), if available. If no asset locations are available for a country, the LitPop exposure weights, displayed in Figure 10(b) (based on satellite nightlight intensity and population data), are used to distribute PP&E value within that country. For issuer X, asset locations are used to distribute USA PP&E value. Since no asset locations are available for Japan, LitPop exposure weights are used to spatially disaggregate Japanese PP&E value.

Figure 11: (a) Distribution of revenue per country for issuer X in 2019. (b) Distribution of total owned PP&E asset value per country for issuer X in 2019. (c) Asset geolocations associated with issuer X (ISS STOXX asset database).



Financial Risk

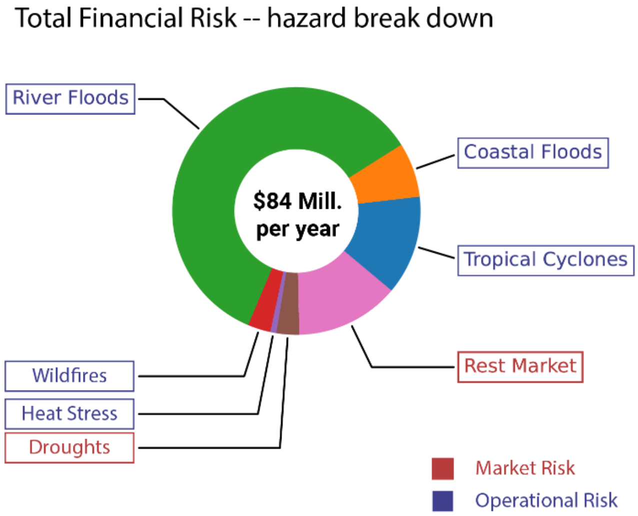
The geographical footprint of issuer X together with the hazard maps are used to calculate the financial impacts. The analysis yields a Total Financial Risk of 84 Million USD per year by 2050 in the likely scenario, with approximately 80% stemming from operational risks and 20% from market risks. Asset-repair costs and business interruptions due to river floods and tropical cyclones are responsible for most of the operational risks, as shown in Figure 12.

For issuer X in the likely scenario, we have the following values for the Total Financial Risk Ratio (Total Financial Risk divided by revenue) in the current time and by 2050, respectively:

$$\text{Total Financial Risk Ratio current (ClimatePhysRiskFinRYTotalRatio)} = \frac{21\ \text{Mill.\$/year}}{28\ Bill.\$/year} = 0.0008,$$

$$\text{Total Financial Risk Ratio Likely 2050 (ClimatePhysRiskFinLklyTotalRatio)} = \frac{84\ \text{Mill.\$/year}}{28\ Bill.\$/year} = 0.0030.$$

Figure 12: Total likely Financial Risk breakdown by hazard for company X by 2050.
Operational risks are indicated in blue and market risks are indicated in red. "Rest Market" corresponds to the market risk contribution from heat stress and chronic coastal floods (sea level rise).



Value at Risk

The EVA valuation model is calibrated to issuer X based on the method described in the EVA valuation model section. The various costs and the loss of income that add up to make the Total Financial Risk figure of $84 Million are used to adjust the *default* financial projection of the EVA model (i.e., the projection that does not account for climate physical risks). For example, the SALES projection is adjusted to reflect the loss of income due to business interruptions and market risks, while CAPEX is increased to reflect the increase in repair costs over time. The added expenses and the loss of income result in a downward adjustment of issuer X's equity value by 3%, i.e., the Value at Risk of issuer X for the likely scenario is **3%**.

Physical Risk Absolute Score and Risk Category

The current-time Physical Risk Absolute Score is 62, calculated using the above current Financial Risk Ratio (0.08 % of revenue) as $-20\ Log_{10}(\text{Total Financial Risk Ratio})$. It corresponds to the "low risk" category. On the other hand, by 2050 in the likely climate-change scenario, the risk level increases and the Absolute Score becomes 50 (the 2050 Financial Risk Ratio is 0.30% of revenue), which is associated with the "moderate risk" category.

Physical Risk Sector-Percentile Relative Score

Within the Materials sector, the above Absolute Scores (re-scaled risk, RFRR) are associated with the 50th and 55th sector-distribution percentiles for the current and future times, respectively. The respective Sector-Percentile Relative Scores are 50 and 55 and indicate a risk near the sector-median compared to all other issuers in the same sector.

Physical Risk Change Sector-Relative Score

The Physical Risk Change sector-relative Score for the likely scenario is computed based on the change in the Total Financial Risk Ratio (future minus current Total Financial Risk divided by revenue) of the issuer relative to its sector. For issuer X in the likely scenario, we have:

$$\begin{aligned} &\text{Total Financial Risk Ratio Change} = \\ &\qquad = \text{Total Financial Risk Ratio Likely 2050} - \text{Total Financial Risk Ratio current} \\ &\qquad = 0.0030 - 0.0008 = 0.0022 = 0.22\% \end{aligned}$$

A 0.22% increase in Total Financial Risk Ratio in the Materials sector yields a Change Relative Score of **64**. This score indicates that issuer X will have a lower increase in physical risk exposure than its sector median (0.54% is the median change in this example). For a detailed description of the calculation of this score, refer to Appendix III: Physical Risk Change Sector-Relative Score Calculation.

Climate Impact Report

The output of the physical risk analysis can be used to analyze risk exposure of a portfolio of issuers and identify positive and negative outliers. The Climate Impact Report (Figure 13), downloadable from DataDesk (as a pdf), presents results at the portfolio level allowing comparison with a benchmark.

The report includes:

- A summary with portfolio-level metrics including average VaR, average Total Physical Risk Change sector-relative Score and number of issuers at risk (issuers with Total Change sector-relative Score ≤ 49), compared to the benchmark,
- A breakdown of portfolio VaR by sector,
- A breakdown of portfolio companies into the different Management Score categories,
- A breakdown of the portfolio VaR into current- and future-time contributions for the likely and worst-case scenarios, for the portfolio compared to the benchmark,
- Physical Risk Change relative Scores by sector, including portfolio averages and ranges, and compared to the benchmark,
- Portfolio average Change relative scores for each individual hazard compared to the benchmark,
- Top 5 individual companies with the largest portfolio weights with their main metrics,
- Top 10 individual companies with the highest physical risk exposure with their main metrics.

A dedicated Climate Impact Report (CIR) Methodology document is available that explains the details of the graphs and metrics shown in the CIR (Figure 13).

Full company-level data is also available on the DataDesk platform as a spreadsheet download with over 160 factors per company.

Figure 13: Example showing the Physical Risk section of ISS STOXX Climate Impact Report, available from the DataDesk platform.

Disclaimer

Physical Risks analysis data in the Climate Impact Report is available as of 2020 onwards. Climate Impact Reports generated for historical portfolios before 2020 via the DataDesk Portfolio Analytics function will use 2020 data on physical risks.

Appendix

Appendix A: Calculation of Financial Risk Metrics

The **Total Financial Risk** factor considers the combined impact of all hazards considered in the analysis, including operational risks and market risks from all hazards:

$$\begin{aligned}\text{Total Financial Risk} &= \text{Operational Risks} + \text{Market Risks}\\ &= \text{Cost}_{\text{repairs}} + \text{Cost}_{\text{productivity}} + \text{Loss}_{\text{business interruption}} + \text{Loss}_{\text{market risk}}.\end{aligned}$$

Here, the repair-costs term, $\text{Cost}_{\text{repairs}}$, includes repair costs from damages of all acute hazards, including tropical cyclones, acute coastal floods, river floods and wildfires. Similarly, the business-interruption losses, $\text{Loss}_{\text{business interruption}}$, derive from damages caused by the same acute hazards. The increased production costs, $\text{Cost}_{\text{productivity}}$, are derived from loss of labor productivity caused by the heat stress hazard. The first three terms in the equation, repair costs, increased production costs and business-interruption losses are operational financial risks. The last term in the equation, $\text{Loss}_{\text{market risk}}$, is the total market financial risk that results from all the chronic hazards, i.e., from heat stress, droughts and the chronic component of coastal floods (chronic sea-level rise). $\text{Loss}_{\text{market risk}}$ is calculated with the integrative market-risk model (GTAP-INT) described in the section "Calculation of Market Financial Risks".

The **individual hazard Financial Risk** factors are calculated as follows. For **tropical cyclones**, **wildfires** and **river floods**, all financial risks are operational risks, specifically repair costs and revenue losses due to business interruptions derived from asset damages:

$$\begin{aligned}\text{Financial Risk T. Cyclones} &= \text{Operational Risks T. Cyclones}\\ &= \text{Cost}_{\text{repairs}}\ \text{T. Cyclones} + \text{Loss}_{\text{business interruption}}\ \text{T. Cyclones},\end{aligned}$$

$$\begin{aligned}\text{Financial Risk Wildfires} &= \text{Operational Risks Wildfires}\\ &= \text{Cost}_{\text{repairs}}\ \text{Wildfires} + \text{Loss}_{\text{business interruption}}\ \text{Wildfires},\end{aligned}$$

$$\begin{aligned}\text{Financial Risk R. Floods} &= \text{Operational Risks R. Floods}\\ &= \text{Cost}_{\text{repairs}}\ \text{R. Floods} + \text{Loss}_{\text{business interruption}}\ \text{R. Floods}.\end{aligned}$$

The **coastal flood Financial Risk** factor accounts for the operational financial risks derived from the acute component of the coastal flood hazard, which include damage-driven repair costs and business-interruption revenue losses:

$$\begin{aligned}\text{Financial Risk C. Floods} &= \text{Operational Risks C. Floods}\\ &= \text{Cost}_{\text{repairs}}\ \text{C. Floods} + \text{Loss}_{\text{business interruption}}\ \text{C. Floods}.\end{aligned}$$

The market financial risk derived from the chronic component of coastal floods is accounted for in the integrative market-risk model (GTAP-INT) that jointly considers the effect of all chronic hazards (chronic sea-level rise coastal floods, heat stress and droughts) on GDP at country level.

The **heat stress Financial Risk** factor accounts for the operational financial risk of the heat stress hazard, i.e., increased production costs derived from heat-induced reductions in labor productivity:

$$\text{Financial Risk Heat Stress} = \text{Operational Risks Heat Stress} \;\; = \text{Cost}_{\text{productivity}} \text{ Heat Stress.}$$

Similarly to the case of coastal floods, the market financial risk component of the heat stress hazard is jointly considered together with the other chronic hazards in the integrative market-risk model.

The **drought Financial Risk** factor is based on a separate estimation of the effect of chronic drought on agriculture generated outside the integrative market-risk model, using an alternative model to isolate the effect of droughts and estimate the drought contribution to the overall market risk. Therefore, we have:

$$\text{Financial Risk Droughts} = \text{Market Risks Droughts estimate} \;\; = \text{Loss}_{\text{market risk}} \text{ Droughts estimate.}$$

Note that this estimate of the effect of droughts is not included in the calculation of the Total Financial Risk from all hazards. Instead, the overall market risk, $\text{Loss}_{\text{market risk}}$, calculated with the integrated market-risk model for all chronic hazards, which includes the contribution from droughts, is used to calculate the Total Financial Risk factor.

To summarize, the Financial Risk factors corresponding to tropical cyclones, wildfires, river floods, coastal floods and heat stress all represent purely operational risks, whereas the Financial Risk factor corresponding to droughts represents purely a market risk.

The **total operational financial risk** can be calculated as:

$$\begin{aligned}&\text{Operational Risks} =\\ &\qquad = \text{Financial Risk T. Cyclones} + \text{Financial Risk Wildfires} + \text{Financial Risk R. Floods}\\ &\qquad + \text{Financial Risk C. Floods} + \text{Financial Risk Heat Stress.}\end{aligned}$$

The **total market financial risk** can be calculated as:

$$\text{Market Risks} = \text{Loss}_{\text{market risk}} = \text{Total Financial Risk} - \text{Operational Risks.}$$

The Total Financial Risk can be written as the sum of the Financial Risk factors for all the individual hazards plus the market risk contributions from heat stress and coastal floods:

$$\begin{aligned}&\text{Total Financial Risk} =\\ &\qquad = \text{Financial Risk T. Cyclones} + \text{Financial Risk Wildfires} + \text{Financial Risk R. Floods}\\ &\qquad + \text{Financial Risk C. Floods} + \text{Financial Risk Heat Stress} + \text{Financial Risk Droughts}\\ &\qquad + \text{ Market Risks (Heat Stress, C. Floods).}\end{aligned}$$

In the previous expression, the last term in the sum, $\text{Market Risks (Heat Stress, C. Floods)}$, excludes the contribution of droughts to avoid double counting and is equal to:

$$\text{Market Risks (Heat Stress, C. Floods)} = \text{Market Risks} - \text{Financial Risk Droughts.}$$

The market risk contributions from heat stress and coastal floods can be obtained from the provided Financial Risk factors as:

$$\begin{aligned}\text{Market Risks (Heat Stress, C. Floods)} &= \\ &= \text{Total Financial Risk} - (\text{Financial Risk T. Cyclones} + \text{Financial Risk Wildfires} \\ &+ \text{Financial Risk R. Floods} + \text{Financial Risk C. Floods} + \text{Financial Risk Heat Stress} \\ &+ \text{Financial Risk Droughts}).\end{aligned}$$

The percentage contributions of the different hazards and types of risks to the Total Financial Risk can be calculated as follows:

$$\text{contrib (\%) T. Cyclones, op. risk} = 100 \times \text{Financial Risk T. Cyclones / Total Financial Risk},$$

$$\text{contrib (\%) Wildfires, op. risk} = 100 \times \text{Financial Risk Wildfires / Total Financial Risk},$$

$$\text{contrib (\%) R. Floods, op. risk} = 100 \times \text{Financial Risk R. Floods / Total Financial Risk},$$

$$\text{contrib (\%) C. Floods, op. risk} = 100 \times \text{Financial Risk C. Floods / Total Financial Risk},$$

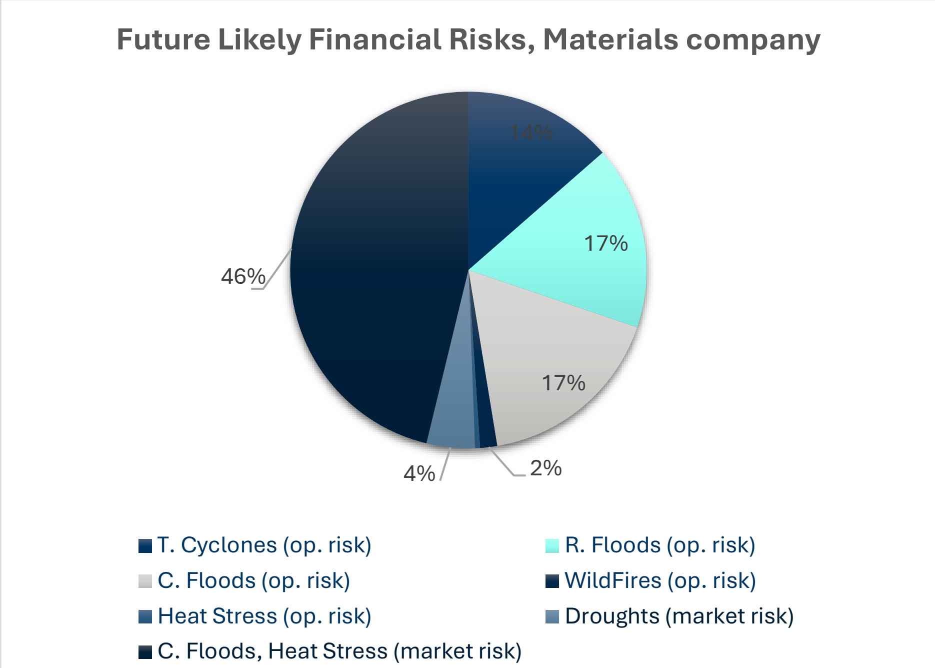
$$\text{contrib (\%) Heat Stress, op. risk} = 100 \times \text{Financial Risk Heat Stress / Total Financial Risk},$$

$$\text{contrib (\%) Droughts, market risk} = 100 \times \text{Financial Risk Droughts / Total Financial Risk},$$

$$\begin{aligned}\text{contrib (\%) (Heat Stress, C. Floods), market risk} &= \\ &= 100 \times \text{Market Risks (Heat Stress, C. Floods) / Total Financial Risk} \\ &= 100 - [\text{contrib (\%) T. Cyclones, op. risk} + \text{contrib (\%) Wildfires, op. risk} \\ &+ \text{contrib (\%) R. Floods, op. risk} + \text{contrib (\%) C. Floods, op. risk} \\ &+ \text{contrib (\%) Heat Stress, op. risk} + \text{contrib (\%) Droughts, market risk}].\end{aligned}$$

An example showing a plot of all the above contributions for an issuer in the Materials sector can be found in Figure 14.

Figure 14. Example showing all the Financial Risk contributions to the Total Financial Risk for a company
Example showing all the Financial Risk contributions to the Total Financial Risk for a company in the Materials sector, including the operational risks (blue text) and market risks (red text) for all climate physical hazards.



Appendix B: Calculation of Absolute Physical Risk Score Metrics

The formulas used to calculate the Absolute Physical Risk Scores are as follows.

For the **Total** Absolute Physical Risk Scores corresponding to the overall risk from all hazards combined, we have, for each time frame (current, future likely scenario and future worst-case scenario):

$$\text{current Total Absolute Physical Risk Score} = -20\ Log_{10}(\text{current Total Financial Risk Ratio}),$$

$$\text{future likely Total Absolute Physical Risk Score} = -20\ Log_{10}(\text{future likely Total Financial Risk Ratio}),$$

$$\text{future worst case Total Absolute Physical Risk Score} \\ = -20\ Log_{10}(\text{future worst case Total Financial Risk Ratio}).$$

Additionally, the Absolute Physical Risk Scores for each individual hazard are calculated from the Financial Risk Ratio corresponding to each hazard. For instance, for wildfires, we would have:

$$\text{current Wildfire Absolute Physical Risk Score} = -20\ Log_{10}(\text{current Wildfire Financial Risk Ratio}),$$

$$\text{future likely Wildfire Absolute Physical Risk Score} \\ = -20\ Log_{10}(\text{future likely Wildfire Financial Risk Ratio}),$$

$$\text{future worst case Wildfire Absolute Physical Risk Score} \\ = -20\ Log_{10}(\text{future worst case Wildfire Financial Risk Ratio}).$$

Appendix C: Physical Risk Change Sector-Relative Score Calculation

The aim is to obtain a risk-change sector-relative score in the range 1 to 100 for each issuer, where a score of 100 indicates the lowest risk in the issuer's GICS sector, a score of 1 indicates the highest risk in the issuer's sector and a score of 50 indicates a risk comparable to the median of the issuer's sector. The steps followed to calculate the Physical Risk Change sector-relative Score are explained below.

1. We calculate the change in Financial Risk Ratio over time, i.e., the change in Financial Risk relative to revenue between 2050 and the present time:

   $$\mathrm{dFR} = \text{future Financial Risk Ratio} - \text{current Financial Risk Ratio.}$$

   Here, the future Financial Risk Ratio can correspond to the likely or worst-case scenario. dFR takes values between 0 and 1 (it is also a ratio relative to issuer revenue).

   For example, using the factor names that can be found in the "Factor Dictionary" of the APPENDIX, for the Total Physical Risk Change sector-relative Score in a likely scenario, we would calculate:

   $$\mathrm{dFR} = \mathrm{ClimatePhysRiskFinLklyTotalRatio} - \mathrm{ClimatePhysRiskFinRYTotalRatio}.$$

   Similarly, for an individual hazard, for example, for wildfires, for the worst-case scenario, we would calculate:

   $$\mathrm{dFR} = \mathrm{ClimatePhysRiskFinWrstWldfrRatio} - \mathrm{ClimatePhysRiskFinRYWldfrRatio}.$$

2. The maximum Physical Risk Change sector-relative Score value of 100 is assigned to issuers that do not surpass a low-risk threshold of 0.0001% of revenue, i.e., a threshold ratio $\mathrm{dFR}_{\mathrm{threshold}} = 0.000001$, as their risk is considered negligible.

3. Min-max normalization is then performed within each issuer's sector. dFR values are normalized to a range between 0 and 1 by subtracting the minimum value in the sector ($\mathrm{dFR}_{\mathrm{min}}$) and dividing by the range of values in the sector (maximum minus minimum), as follows:

   $$\mathrm{dFR}_{\mathrm{neg}} = \frac{\mathrm{dFR} - \mathrm{dFR}_{\mathrm{min}}}{\mathrm{dFR}_{\mathrm{max}} - \mathrm{dFR}_{\mathrm{min}}}.$$

   Normalization is done for each issuer using the minimum ($\mathrm{dFR}_{\mathrm{min}}$) and maximum ($\mathrm{dFR}_{\mathrm{max}}$) values in the distribution corresponding to its sector. The minimum and maximum values are calculated considering only issuers above the low-risk threshold, i.e., issuers with $\mathrm{dFR} > \mathrm{dFR}_{\mathrm{threshold}}$.

   The resulting normalized values, $\mathrm{dFR}_{\mathrm{neg}}$, are referred to as the "negative" model response. This is because, at this point, low normalized values (close to 0) correspond to low risk, while high normalized values (close to 1) correspond to high risk. The goal is to generate final scores that exhibit a "positive" response in such a way that high scores correspond to the lowest risk and are considered good or positive, and low scores correspond to high risk.

4. The sector statistics for the negative response are then calculated. For each of the 11 GICS sectors considered, we calculate the median value ($\mathrm{dFR}_{\mathrm{neg}}^{\mathrm{median}}$) and the 99.75th percentile ($\mathrm{dFR}_{\mathrm{neg}}^{99\mathrm{th}}$) of the $\mathrm{dFR}_{\mathrm{neg}}$ values for all issuers in the sector above the low-risk threshold (with $\mathrm{dFR} > \mathrm{dFR}_{\mathrm{threshold}}$). These values are used later to impose constraints on the final scores.

5. We then calculate the equivalent "positive" response:

$$\mathrm{dFR}_{\mathrm{pos}} = 1 - \mathrm{dFR}_{\mathrm{neg}}.$$

The "positive"-response values are in the range 0 to 1 and are such that the largest values (close to 1) correspond to the lowest risk, and the lowest values (close to 0) correspond to the highest risk.

6. A transformation is then applied using the logit function in order to generate a probability distribution of scores that is closer to a normal (bell-shaped) distribution. In this step, $\mathrm{dFR}_{\mathrm{pos}}$ is considered as a "positive" probability with values between 0 and 1. The logit function or log-odds (logarithm of the odds) of the positive response is:

$$\mathrm{dFR}_{\mathrm{log-odds-pos}} = \log\left(\frac{\mathrm{dFR}_{\mathrm{pos}}}{1 - \mathrm{dFR}_{\mathrm{pos}}}\right) = -\log\left(\frac{1}{\mathrm{dFR}_{\mathrm{pos}}} - 1\right).$$

The logit function maps probability values in the range 0 to 1 to resulting numbers between minus infinity and plus infinity. Note that the log-odds can also be calculated as:

$$\mathrm{dFR}_{\mathrm{log-odds-pos}} = \log\left(\frac{\mathrm{dFR}_{\mathrm{pos}}}{\mathrm{dFR}_{\mathrm{neg}}}\right) = \log\left(\frac{1 - \mathrm{dFR}_{\mathrm{neg}}}{\mathrm{dFR}_{\mathrm{neg}}}\right).$$

7. A linear transformation is then applied to re-scale the log-odds (positive) values to the range 1-100. The re-scaling is done imposing two constraints that ease interpretability:
   a. A score of 50 is constrained to correspond to the median risk of the issuer's sector. In other words, if an issuer has a score of 50, then its financial risk is precisely equal to that of its sector median.
   b. A score of 1 is constrained to correspond to the 99.75th percentile highest financial risk in the issuer's sector. In other words, if an issuer has a score of 1, it has one of the highest financial risks in its sector.

   To apply these constraints, the previously calculated values (see previous step 4) of the median and 99.75th percentile of the negative response, $\mathrm{dFR}_{\mathrm{neg}}^{\mathrm{median}}$ and $\mathrm{dFR}_{\mathrm{neg}}^{99\mathrm{th}}$, respectively, are used.

   The positive log-odds, $\mathrm{dFR}_{\mathrm{log-odds-pos}}$, is re-scaled and transformed into the physical risk score, $\mathrm{PR}_{\mathrm{score}}$, with values in the range 1-100, using a linear relationship with slope m (scaling factor) and intercept b, as follows:

$$\mathrm{PR}_{\mathrm{score}} = b + m \times \mathrm{dFR}_{\mathrm{log-odds-pos}}.$$

   In general, to linearly transform a variable x into a variable y, with constraints that certain values of the new variable, y_1 and y_2, must match specific values of the original variable, x_1 and x_2, respectively, the following geometrical relationship applies:

$$\frac{y - y_1}{x - x_1} = \frac{y_2 - y_1}{x_2 - x_1}.$$

Identifying the right-hand side of the previous equation as the slope of the line, m, and the intercept of the line as $b = y_1 - m\,x_1 = y_2 - m\,x_2$, we can write the constrained linear transformation from variable x to variable y as:

$$y = b + m\,x,$$

$$m = \frac{y_2 - y_1}{x_2 - x_1},$$

$$b = y_2 - m\,x_2.$$

Here, variable x is the positive log-odds, $\mathrm{dFR}_{\mathrm{log-odds-pos}}$, and variable y is the final physical risk score, $\mathrm{PR}_{\mathrm{score}}$. The constraints related to the 99.75$^{\mathrm{th}}$ percentile (assigned to a score of 1), and the median (assigned to a score of 50) mean that:

$$x_1 = \mathrm{dFR}^{\mathrm{99th}}_{\mathrm{log-odds-pos}}, \qquad y_1 = 1,$$

$$x_2 = \mathrm{dFR}^{\mathrm{median}}_{\mathrm{log-odds-pos}}, \qquad y_2 = 50.$$

Therefore, substituting x and y variables, the physical risk scores can be finally calculated using the log-odds values as:

$$\mathrm{PR}_{\mathrm{score}} = b + m \times \mathrm{dFR}_{\mathrm{log-odds-pos}},$$

where the slope (scaling factor) is:

$$m = \frac{49}{\mathrm{dFR}^{\mathrm{median}}_{\mathrm{log-odds-pos}} - \mathrm{dFR}^{\mathrm{99th}}_{\mathrm{log-odds-pos}}} = \frac{49}{\log\left(\frac{1-\mathrm{dFR}^{\mathrm{median}}_{\mathrm{neg}}}{\mathrm{dFR}^{\mathrm{median}}_{\mathrm{neg}}}\right) - \log\left(\frac{1-\mathrm{dFR}^{\mathrm{99th}}_{\mathrm{neg}}}{\mathrm{dFR}^{\mathrm{99th}}_{\mathrm{neg}}}\right)},$$

and the intercept is:

$$b = 50 - m \times \mathrm{dFR}^{\mathrm{median}}_{\mathrm{log-odds-pos}} = 50 - m \times \log\left(\frac{1 - \mathrm{dFR}^{\mathrm{median}}_{\mathrm{neg}}}{\mathrm{dFR}^{\mathrm{median}}_{\mathrm{neg}}}\right).$$

Appendix D: Calculation of Relative Resilience Score and Intermediate Scores

The Physical Risk Relative Resilience Score is calculated as the average of the three intermediate sector-relative scores:

$$\text{Resilience Score} == \frac{\text{asset intensity}_{\text{score}} + \text{asset ownership}_{\text{score}} + \text{supply chain dependency}_{\text{score}}}{3}.$$

The following steps are used to calculate a sector-relative score for each quantity x, where x can be: x = asset intensity, x = asset ownership and x = supply-chain dependency. For each intermediate sector-relative score, a low score (<50) corresponds to a low relative resilience below the sector median. On the other hand, a high score (>50) reflects a higher relative resilience due to a lower, below-median asset intensity, supply-chain dependency or asset-ownership ratio, respectively. A score of 50 corresponds to the sector median.

For each quantity x (for example, for x = asset intensity), the corresponding sector-relative score is calculated via the following steps:

1. Calculate how many standard deviations (x_{dev}) the value x is away from the sector median (x_{median}). This is done by calculating: $x_{\text{dev}} = (x - x_{\text{median}})/x_{mad}$, where $x_{mad} = \text{median}(|x_i - x_{\text{median}}|)$ is the median absolute deviation (MAD) from the median of all values of x within the sector, which is used instead of the typical standard deviation (the MAD is more appropriate for the non-Gaussian distributions that apply here).

2. Normalize x_{dev} to a score with values in the range 0 to 1 by subtracting the minimum value in the sector distribution and dividing the result by the overall range (maximum minus minimum). The normalized value is therefore: $x_{\text{dev},1} = (x_{\text{dev}} - x_{\text{dev-min}})/(x_{\text{dev-max}} - x_{\text{dev-min}})$. Here, the minimum and maximum values of x_{dev} considered are $x_{\text{dev-min}} = -2$ and $x_{\text{dev-min}} = +2$, respectively (similar to a range of x values within ±2 standard deviations from the distribution mean, i.e. ~95% of all data points, if Gaussian distributions were considered).

3. Re-scale $x_{\text{dev},1}$ to a score between 0 and 100 by multiplying the previous score by 100: $x_{\text{dev},2} = 100\, x_{\text{dev},1}$.

4. To ensure that any possible values of x at the edges of the sector distribution (values that are further away from the sector median than ±2 times the x_{mad}) do not result in scores outside the range 0 to 100, a score of 0 is assigned to deviation values $x_{\text{dev}} \leq -2$, and a score of 100 is assigned to deviation values $x_{\text{dev}} \geq +2$. The resulting score is x_{score}.

For the asset-intensity score, asset-ownership score and supply-chain-dependency score, the final score is calculated as $x_{\text{score-inverted}} = 100 - x_{\text{score}}$. This is so that a high score (closer to 100) that indicates high relative resilience corresponds to below-median asset intensity, below-median asset ownership or below-median supply-chain dependency.

Appendix E: Relevant Supporting Models and Key Rating Assumptions

Models

- **Physical risk assessment and scoring model**: Assessment of company exposure to physical risk through the simulation of hazard impacts on company operations and sales, producing current and future financial risks and Value at Risk of companies.

- **Scenario analysis model suite**: Evaluates future risk levels using RCP4.5 and RCP8.5 plus seven NGFS phase 5 scenarios.

- **Value at Risk (VaR) model**: Computes VaR using an EVA-based valuation model.

- **Climate Hazard Models**: Covers six hazards (tropical cyclones, coastal floods, river floods, wildfires, heat waves, and drought) and produces metrics for acute and chronic risks. Leverages the IPCC's CMIP5 models (for wildfires, river floods, droughts, and heat stress), the climate risk modelling tool CLIMADA for tropical cyclones, and the World Resources Institute's Aqueduct Coastal Floods Hazard Maps to derive hazard intensities.

- **Market financial risks model**: Estimates country-level GDP impacts from chronic climate physical hazards via GTAP-INT (Global Trade Analysis Project, GTAP-INT: a computational general equilibrium model of the economy) and translates them into issuer revenue losses using a proportionality assumption.

- **LitPop model**: Spatially distributes PP&E exposure within countries where asset location data are missing using LitPop weights derived from satellite observation of nightlight intensity and population data.

Assumptions

- **Operational risk cost equivalence for heat stress**: Assumes reduced labor productivity generates an equivalent increase in production costs.

- **Likely vs worst-case scenario framing**: Uses RCP4.5 as likely and RCP8.5 as worst-case scenarios; historical baseline uses average risk levels across 1950–2000; future time frame of 2050 represented by 2030–2070 averaging window.

- **Market risk proportionality assumption**: Assumes one-to-one relationship between modeled country GDP change and the change in company revenues in that country.

- **PP&E geography fallback**: If PP&E geographic detail is incomplete, PP&E is distributed across countries where revenues are generated (GeoRev) and then within countries the disaggregation is done using LitPop.

- **Physical Risk Change sector-relative Scores**: Change scores use future minus current relative Financial Risk under the assumption that issuers may have adapted to current risk; delta therefore meaningful.

Appendix F: Version Control

Name of Methodology: Physical Risk

VERSION	DATE	DETAILS
1.0	July 2026	Publication of the Physical Risk Methodology and Research Process document Inclusion of the Public Disclosure on the Methodology, Models, and Key Rating Assumptions Used in ESG Rating Activities (as defined by the Regulation (EU) 2024/3005)

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