Climate Risk Index

Climate Risk Index Methodology

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IKI INTERNATIONAL CLIMATE INITIATIVE

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Contents

List of abbreviations

AF	Adaptation Fund
AR6	IPCC Sixth Assessment Report
BRICS	Brazil, Russia, India, China, South Africa
C3S	Copernicus Climate Change Service
COP	Conference of the Parties
CRI	Climate Risk Index
DPO	UN Department of Peace Operations
DPPA	UN Department of Political and Peacebuilding Affairs
EM-DAT	Emergency Events Database
FRLD	Fund for responding to Loss and Damage
GBV	Gender based violence
GDP	Gross domestic product
GGA	Global Goal on Adaptation
GHG	Greenhouse Gas emissions
HDI	Human Development Index
ICJ	International Court of Justice
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
L&D	Loss and Damage
LDCs	Least Developed Countries
LLDCs	Least Developed Land-Locked Countries
MHEWS	Multi Hazard Early Warning Systems
NAPs	National Adaptation Plan
NCQG	New Collective Quantified Goal
ND GAIN	Notre Dame Global Adaptation Initiative
NDCs	Nationally Determined Contributions
PPP	Purchasing Power Parity
SB	Subsidiary Bodies
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
UNDP	UN Development Programme
UNDRR	United Nations Office of Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	UN General Assembly
UNOCHA	United Nations Office for Humanitarian Assistance
UNSG	United Nations Secretary-General
WMO	World Meteorological Organization

List of figures and tables

1 CRI background and methodological revision

Since 2006, the Climate Risk Index (CRI) has been indicating how extreme weather events affect countries, making the CRI one of the longest standing annual climate impact-related indices.[1] The index is aimed at raising awareness of expanding climate-related loss events worldwide, provoking necessary policy discussions on climate change adaptation, disaster preparedness, risk reduction, and addressing loss and damage (L&D).

The index's first version and methodology (2006–2021) were developed by Britta Horstmann, Sven Harmeling, and Christoph Bals.[2] The analysis included weather-related events (storms, floods, temperature extremes and mass movements), though drought was not included because of data gaps. The following indicators were analysed: (1) Number of deaths, (2) Number of deaths per 100,000 inhabitants, (3) Sum of loss in USD in purchasing power parity (PPP); and (4) Loss per unit of gross domestic product (GDP). From 2006 to 2021, the CRI analysis was based on Munich Re's NatCatSERVICE.

From 2023, the index was methodologically and graphically revised to correspond with evolving empirical understanding of risk and vulnerability and to increase the CRI's potential and scope. The EM-DAT international disaster database became the new database for the index to create a consistent basis for the CRI, with the prospect of annual compilation and publication. These revisions established a foundation so the CRI can serve as a reliable instrument for identifying countries' realised climate risks, which (1) raises awareness of steadily increasing worldwide L&D caused by climate change and (2) stimulates climate policy measures for adapting to climate change, disaster prevention, risk reduction, and coping with L&D.

The methodological revision focused on revising the: (1) existing index dimensions to better reflect the degree of effect and (2) CRI calculation formula while introducing data normalisation and revising the weighting of indicators.

The CRI's methodological revision followed the structure for the development of composite indicators by the EU Competence Centre on Composite Indicators and Scoreboards.[3] The CRI revision process followed seven steps in the structure:

1. Developing a theoretical framework to obtain clear understanding of the multidimensional phenomenon to be measured
2. Selecting indicators based on relevance, data availability/reliability, credibility, and quality check of indicators and scale indicators by appropriate size measure to achieve an objective comparison across countries
3. Data analysis and treatment
4. Data normalisation
5. Weighting and aggregation with appropriate procedures that respect the theoretical framework and data properties
6. Robustness and sensitivity assessment
7. Visualising results

1 The CRI has not been available in recent years because extreme weather event data from the previous data provider was discontinued.
2 The CRI team is grateful to those who have contributed to the index in the past, particularly Britta Horstmann, Sven Harmeling, Christoph Bals, and Sönke Kreft.
3 Home | Composite Indicators & Scoreboards Explorer

2 Objectives and scope

Key message of the CRI

The CRI analyses climate-related extreme weather events' economic and human effects on countries and, thereby, measures the realised risks' consequences for countries. The index ranks countries according to their economic and human effect, with the most affected country ranked first. Climate science and significantly improved attribution science clearly show that climate change is affecting the intensity, frequency, and duration of many extreme weather events. Also, extreme weather events' impacts on, for example, economic costs and human health are more clearly attributable to climate change.[4]

The results and a high rank in the CRI should be understood as a warning signal for the respective countries. The strong connection between the increasing climate crisis and extreme weather events indicates hazards' potential to continue occurring and intensifying. Some changes are happening faster than scientists previously assessed and every fraction of a degree of warming will intensify these impacts.

Aim of the CRI

The CRI aims to visualise how extreme weather events affected countries two years before publication and over the preceding 30 years. It simplifies the aggregation and understanding of climate impacts[5] across different regions and time periods, spotlighting nations that extreme weather events most severely affect. The index aims to contextualise climate policy debates and related policy processes with a view to the climate risks and impacts countries are facing. Apart from the ranking, the index brings forward concrete policy demands and formulates options for taking action, with a particular focus on the UN climate negotiations, debates, and processes on the climate–security nexus at different policy levels, and multilateral fora, such as G7 and G20.

Scope of the CRI

The CRI is a backward-looking index based on past data and giving an indication of 171 countries' realised risks. It is not intended to be used for linear projection of future climate impacts or as a standalone source of information for planning risk management and adaptation measures. The index covers the degree of effect from extreme weather events, including hydrological, meteorological, and climatological events, included in EM-DAT. In these categories,[6] the CRI includes the following seven hazards.[7]

2.1 Hydrological

- Flood (including general, flash flood, riverine flood)
- Mass movement wet (including avalanches wet, landslides wet, mudslides wet, rockslides wet)

2.2 Meteorological

- Storm (including extra-tropical storm, tropical cyclone,[8] severe weather, tornado, blizzard/winter storm, hail, derecho, lightning/thunderstorm, sand/dust storm, storm surge, wind action, connective storm)
- Extreme temperature (including severe winter conditions, heat wave, cold wave)

2.3 Climatological

- Wildfire (including wildfire general, forest fire)
- Drought
- Glacial lake outburst flood

4 Otto 2023a

5 The authors acknowledge that risks and impacts are subject to value judgements and based on cultural and social conceptualisation (see e.g. Farbotko and Campbell 2022).

6 Following the EM-DAT categorization and definitions.

7 For definitions for all hazards included in CRI, see the method document here: Ahmed et al. 2025: Methodology of the Climate Risk Index. Germanwatch.

8 Depending on its location and strength, a tropical cyclone can be called a 'hurricane,' 'typhoon,' 'tropical storm,' 'cyclonic storm,' 'tropical depression,' or simply 'cyclone.' Hurricanes are strong tropical cyclones that occur in the Atlantic Ocean or northeastern Pacific Ocean and typhoons occur in the northwestern Pacific Ocean. In the Indian Ocean and South Pacific, comparable storms are referred to as 'tropical cyclones.'

3 Components and indicators

The CRI investigates hazards and their related impacts[9] and, thus, countries' realised risks driven by extreme weather events. The index includes three hazard categories and seven hazards. Each hazard's impact factor is measured with three indicators, each measured in absolute and relative terms.

Table 1: CRI Indicators Overview

CRI Indicators Overview		
1	**Losses due to hazard**	Absolute losses (in purchasing power parity)
		Relative losses due to hazard (per unit gross domestic product)
2	**Fatalities[10] due to hazard**	Absolute fatalities (absolute number)
		Relative fatalities (per 100,000 inhabitants)
3	**Affectedness[11] due to hazard**	Absolute affected (absolute number)
		Relative affected (per 100,000 inhabitants)

Relative and absolute indicators: While absolute numbers tend to more prominently represent populous or economically capable countries, relative values capture the proportional impacts on smaller and poorer countries. The CRI analysis is based on absolute and relative indicators in order to consider both effects. With double-weighting in the average ranking of all indicators generating the CRI score, more emphasis and, therefore, greater importance is placed on the relative indicators. Identifying relative values in the index represents an important complement to the otherwise often-dominating absolute values, as it allows for analysing country-specific data on damage in relation to real conditions and capacities in those countries. Clearly, for example, damage of USD 1 billion causes much lighter relative economic consequences for richer countries such as the United States and Japan, than for poor countries, where damage often amounts to a substantial share of the annual GDP.

Use of purchasing power parity values for a more comprehensive estimation of how different societies are affected

Absolute losses are counted in purchasing power parity (PPP) values. These values allow for a more appropriate expression of how the loss of USD 1 actually affects people compared with using nominal exchange rates. PPP is a measure of the price of specific goods in different countries and is used to compare the absolute purchasing power of the countries' currencies. For example, this means a farmer in India can buy more crops with USD 1 than a farmer in the United States. Thus, the same nominal damage's relative economic impact is much higher in India.

Influence of economic and population growth on results: It should be noted that values and, thus, country rankings in the CRI regarding the respective indicators may not only change because of extreme weather events' absolute impacts, but also because of economic and population growth or decline. If, for example,

9 IPCC definition of impact: The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability.

10 Fatalities include confirmed fatalities directly attributed to the disaster plus missing people whose whereabouts since the disaster are unknown and, therefore, they are presumed dead based on official figures.

11 Affected is the total of injured, otherwise affected, and homeless people.

population increases (as in most countries), the same absolute number of deaths leads to a relatively lower assessment in the following year. The same applies for economic growth. However, this does not diminish this approach's significance. Society's ability to cope with damage through disaster risk management generally grows as economic strength increases, as greater resources often allow for better preparedness and response measures. Nevertheless, improved ability does not necessarily imply stronger implementation of effective preparation and response measures, or that such measures are applied equitably across different regions or communities in the country.

The following table provides a full overview of all hazards and indicators included in the index.

Table 2: Overview of Hazards and Indicators in the CRI

Hazard category	Hazard	Indicators
1. Hydrological	1.1 Flood	Losses due to flood (absolute, in PPP) Losses due to flood (relative per unit GDP)
		Fatalities due to flood (absolute) Fatalities due to flood (relative per 100,000 inhabitants)
		Affected by flood (absolute) Affected by flood (relative)
	1.2 Mass movement wet	Losses due to mass movement wet (absolute, in PPP) Losses due to mass movement wet (relative per unit GDP)
		Fatalities due to mass movement wet (absolute) Fatalities due to mass movement wet (relative per 100,000 inhabitants)
		Affected by mass movement wet (absolute) Affected by mass movement wet (relative)
2.Metrological	2.1 Storm	Losses due to mass storm (absolute, in PPP) Losses due to storm (relative per unit GDP)
		Fatalities due to storm (absolute) Fatalities due to storm (relative per 100,000 inhabitants)
		Affected by storm (absolute) Affected by storm (relative)
	2.2 Extreme temperature	Losses due to extreme temperature (absolute, in PPP) Losses due to extreme temperature (relative per unit GDP)
		Fatalities due to extreme temperature (absolute) Fatalities due to extreme temperature (relative per 100,000 inhabitants)
		Affected by extreme temperature (absolute) Affected by extreme temperature (relative)
3.Climatological	3.1 Wildfire	Losses due to wildfire (absolute, in PPP) Losses due to wildfire (relative per unit GDP)
		Fatalities due to wildfire (absolute) Fatalities due to wildfire (relative per 100,000 inhabitants)
		Affected by wildfire (absolute) Affected by wildfire (relative)
	3.2 Drought	Losses due to drought (absolute, in PPP) Losses due to wet mass movement (relative per unit GDP)
		Fatalities due to drought (absolute) Fatalities due to drought (relative per 100,000 inhabitants)
		Affected by drought (absolute) Affected by drought (relative)
	3.3 Glacial lake outburst flood (GLOF)	Losses due to GLOF (absolute, in PPP) Losses due to GLOF (relative per unit GDP)
		Fatalities due to GLOF (absolute) Fatalities due to GLOF (relative per 100,000 inhabitants)
		Affected by GLOF (absolute) Affected by GLOF (relative)

4 Calculating the CRI score

The CRI uses the following procedure for converting raw data into an index and calculating the CRI score, based on the process developed by the EU Competence Centre on Composite Indicators and Scoreboards.[12]

Figure 1: Calculation the CRI score

1 Raw data from sources is selected (for sources see References and Annex).
Data errors (i.e. tabulation errors coming from the source) are identified and corrected at this stage (see chapter 7 on data sources).

2 An indicator is labeled as ‚missing' for a country, if data that is missing for one or more countries. This particular indicator will not be considered in the averaging process. The raw data was selected to cover a high number of UN countries (see chapter 6 on CRI countries and country groups).

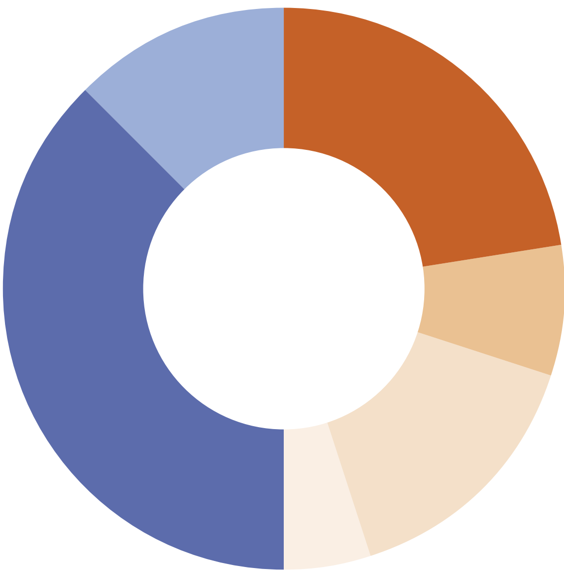
3 The CRI indicators are normalised by determining the distance from the group leader, which assigns 100 to the leading country and other countries are ranked as percentage points way from the the leader.

4 The absolute economic and human loss indicators are weighted 1/8 (12.5%), the relative economic and human loss indicators are weighted 3/8 (37.5%). The human loss indicator consists of fatalities (weighted 3/5 (60%)) and people affected (weighted with 2/5 (40%)).

5 The CRI score is calculated as follows:
CRI score = [3/5 (Absolute fatalities) + 2/5 (Absolute affectedness)] x 1/8 + [3/5 (Relative fatalities) + 2/5 (Relative affectedness)] x 3/8 + (Absolute losses) x 1/8 + (Relative losses) x 3/8

* Fatalities in recent years are weighted higher in order to better reflect the status quo and to factor in the increasing influence of climate change as a risk multiplier for shifting extreme weather patterns.

Figure 2: CRI indicators and weighting



Indicators

Fatalities, relative	22,50 %
Fatalities, absolute	7,50 %
Affected, relative	15,00 %
Affected, absolute	5,00 %
Economic losses, relative	37,50 %
Economic losses, absolute	12,50 %

12 European Commission 2024

5 Time frames

The CRI ranking addresses two time frames. The short-term ranking considers impacts of extreme weather events that occurred two years before publication. The two-year interval between events and publication is because of the index's data basis. The data were published in certain cycles. For a publication with a one-year interval, the World Bank dataset as the basis for determining/categorising countries' economic losses would not yet be fully available. The EM-DAT database's data quality also increases with the time lag to the year of the events, as the data is validated and supplemented several times. The two-year interval, therefore, ensures higher data quality and better coverage.

The long-term ranking is based on average values over a 30-year period, which was chosen to cover a climate-relevant timeframe. This ranking allows showing of extreme-weather events' long-term degree of effect on countries. It shows the degree of effect by unusually extreme events and recurring extreme weather events.

Table 3: Climate Risk Index time frames

Short-term CRI	Most impacted countries, usually two years before publication (2022 for CRI 2025)
Long-term CRI	Most impacted countries over the preceding 30 years (1993–2022 for CRI 2025)

6 CRI countries and country groups

The CRI was designed to cover as many United Nations countries as possible, with the current CRI covering 171 countries.

The index uses the following country groupings:

- Asia
- Europe
- Americas
- Africa
- Oceania

7 Data sources

The CRI uses data from the following sources:

Table 4: CRI Data Sources

Data source	Link	CRI component
The Emergency Events Database – EM-DAT	https://www.emdat.be/	Hazards and impacts data
World Bank	https://data.worldbank.org/	GDP, PPP, and population data
International Monetary Fund	https://www.imf.org/en/Data	GDP, PPP, and population data

The selected data sources ensure the index's reliability and consistency. These sources were selected based on the following criteria: (1) availability for many United Nations countries, (2) availability of time-series for the preceding 30 years, and (3) collected and maintained by reliable and authoritative organisations that perform data quality checks.

8 Limitations of the index

The CRI does not provide an all-encompassing analysis of countries' realised or future risks of anthropogenic climate change. It should be seen as one analysis, which helps explain countries' degree of effect from climate-related impacts and risks based, on the best publicly available historical data set on extreme weather events' impacts, alongside other analysis.[13]

The index is based on data reflecting current and past natural climate variability and on climate change, to the extent that it has already left a footprint on climate variability over the preceding 30 years.

Hazards and impacts:[14] For collecting data, EM-DAT uses a threshold for defining which events to include in the database. One of the following criteria must be satisfied for inclusion:

- 10+ reported deaths
- 100+ people reported affected
- Declaration of a state of emergency
- Call for international assistance

An international appeal for assistance, however, takes first precedence for entry, even if the first two criteria are not fulfilled.[15]

Due to the EM-DAT collection criteria, events that do not satisfy the outlined criteria are not included in the database and, therefore, also not in the CRI.

Phenomena included in the CRI

Climate change's effects can be divided into two categories in accordance with the temporal scale over which they occur and the differing speed of their impacts' manifestation: slow-onset processes and rap-

13 Notre Dame Global Adaptation Initiative 2024
14 EM-DAT Project 2022
15 Sapir and Misson 1992

id-onset events. The CRI analysis only incorporates extreme weather (rapid-onset) events, including hydrological events, such as floods and mass movements, meteorological events, such as storms and temperature extremes, and climatological events, such as wildfires, glacial lake outburst floods, and drought. The CRI does not include slow-onset processes, which are taken as 'phenomena caused or intensified by anthropogenic climate change that take place over prolonged periods of time – typically years, decades, or even centuries – without a clear start or end point.' [16] Slow-onset processes include: increasing mean temperatures, sea level rise, ocean acidification, glacial retreat, permafrost degradation, salinisation, land and forest degradation, and desertification, decreasing precipitation, and loss of biodiversity (see IPCC 2022, UNFCCC 2012, UNU 2017). Such processes cannot be included in this index because of the limited data availability on economic and human effects.

Geological events, including earthquakes, volcanic eruptions, and tsunamis, which are independent of weather, are also not included in this index and, thus, not attributable to climate change.

Level

The CRI compares how countries are affected at the national level. It does not allow for conclusions about damage distribution below that level.

Climate change parameters

The CRI's event-related examination does not allow for assessment of continuous changes of important climate parameters. For instance, the CRI cannot show a long-term decline in precipitation that was shown in some African countries and resulting from climate change. Nevertheless, such parameters often greatly influence important development factors, such as agricultural output and drinking water availability.

Impacts covered

Lagged impacts that manifest significantly later than an event occurred (e.g. a person's death due to injuries as a consequence of an event's impacts, or downstream economic damage due to the loss of economic buffers or loss of income in the recovery phase of affected people[17]), may not be included in the calculations of the CRI.

Climate change-related extreme weather events can cause both economic (including [a] physical assets and [b] income) and non-economic losses and damages (including [a] material and [b] non-material forms).[18] The index covers a broad range of economic and non-economic losses and damages. Measuring non-economic loss and damage is particularly challenging. Therefore, the index does not cover some forms of non-economic loss and damage (e.g. loss of heritage, identity and culture).

Data gaps as challenges to determining climate risks and impacts

A vast amount of data must be analysed in preparing an index; thus, data availability and quality are central in the index's quality. The data analysed for the CRI rely on scientific best practices and methodologies that are constantly evolving, with a view to ensuring the highest accuracy, completeness, and granularity. Several challenges arise regarding available data.

1. Data quality and coverage vary from country to country and within countries. This situation may incur geographical bias in EM-DAT resulting from unequal reporting quality and coverage across space.[19] There are particular data gaps for Global South countries, which might lead to these countries' misrepresentation in the CRI.[20] This issue is particularly pronounced for heat waves, also with a view to EM-DAT. Heat waves are not well recorded for Sub-Saharan Africa.[21] Extreme weather damage databases, such as EM-DAT, report no significant heat wave impacts in Sub-Saharan Africa since 1900, though the region has experienced several

16 Schaefer et al. 2023
17 see e.g. Sauer et al. 2023
18 Serdeczny 2018
19 EM-DAT Project 2022
20 Dinku 2019
21 Otto and Harrington 2020c

heat waves.[22] About 52% of heat wave events in EM-DAT occurred in nine countries: Japan, India, Pakistan, and the United States, followed by western European countries (France, Belgium, United Kingdom, Spain, and Germany).

The existence of data gaps is well known. The Sendai Framework, for example, aims to 'promote the collection, analysis, management and use of relevant data' and, particularly, includes mortality data improvement as a high priority.[23]

There are numerous reasons for data gaps, including the following.

a. Distribution of meteorological stations: Meteorological stations are distributed very unevenly worldwide, leading to significant data gaps for developing countries in particular (see, for example, UNDRR 2023b).[24] Meteorological stations provide a wealth of high-quality data for observing global meteorological changes. The stations are needed for registering extreme weather events. Zhan et al. (2023)[25] found that GDP and government spending were the main factors influencing the number of active stations in each country. The researchers also summarised that most meteorological stations are in developed countries. The WMO (2024) highlighted that, despite progress, there are still significant gaps in the coverage of observing networks, most notably in LDCs and SIDS, which are only collecting and internationally exchanging 9% of mandated Global Basic Observing Network data.[26] The large difference between Global South and Global North becomes clearer when looking at the number of weather stations in the United States, European Union, and Africa. While the United States and European Union (population: 1.1 billion) have 636 weather radar stations, the entire African continent (population: 1.2 billion) has 37 (Otto 2023). Otto (2023)[27] also concluded that, 'Floods are one of the deadliest natural disasters worldwide, but deaths linked with flooding aren't distributed evenly. They most often occur in places that lack weather data and warning systems — and most of those places are in the Global South.'

b. Insufficient systematic data collection and cataloguing: The data quantity and quality and the coverage of disaster events are insufficient in some areas.[28] For Global North countries, national governments provide numbers on fatalities, affected people, and economic losses. For Global South countries, however, this is often done by different non-governmental organisations that lack (sufficient) connection with meteorological services.[29] This shortcoming results in a severe lack of collated data that could accurately show losses. Systematic collection and cataloguing are needed for making information robust enough for planning and policymaking, especially for low-income, highly vulnerable countries and regions.[30],[31]

c. Use of different data collection techniques: Countries use different techniques to collect data on extreme weather events, and this might lead to distorted index results. For instance, some countries use 'excess mortality rate' to determine heat wave-related fatalities (in contrast to an [officially] recorded number of such deaths). This rate is expressed as a percentage of additional deaths in a month compared with a baseline period. The higher the value, the more additional deaths compared with the baseline.[32]

d. Under-representation of regions in research: Science clearly shows that research on climate change impacts is not evenly distributed worldwide. Campbell et al. (2018), focussing on heat wave and health impact research, found that 'regions most at risk from heat waves and health impact are under-represented in the research' (ibid). One reason for this outcome is that climate research is largely carried out by research institutes in Global North countries, resulting in a bias

22 Otto and Harrington 2020b
23 United Nations Office for Disaster Risk Reduction 2015
24 United Nations Office for Disaster Risk Reduction 2023b
25 Zhan et al. 2023
26 World Meteorological Organization 2024b
27 Otto 2023b
28 Osuteye et al. 2017
29 Otto and Harrington 2020c
30 Otto and Harrington 2020b
31 Ritchie and Rosado 2024
32 eurostat 2020

towards events in these countries.[33] Also, huge geographical differences exist in attribution science (see chapter 4).[34] Large attribution knowledge gaps are particularly found in Global South countries because of a lack of good weather data and well-evaluated climate models.[35] Therefore, current attribution studies 'provide very little information about those events and regions where the largest damages and socio-economic losses are incurred.'[36] Attribution studies, thus far, have focused on Europe (22%), eastern and southeast Asia (22%), and Northern America (19%), with only 1% covering northern Africa and western Asia.[37]

2. Methodological boundaries of data collection: Accurately attributing human loss to a particular extreme event faces certain methodological boundaries for data collectors (e.g. in determining whether the death of an older person during a heat wave resulted from the extreme temperature or from their advanced age).

9 Sensitivity analysis: Including HDI data to balance out data gaps

To balance out the potential misrepresentation of Global South countries due to data gaps (see chapter 8), a CRI sensitivity analysis including HDI is used as a correcting factor for missing data. As studies concluded that data gaps correlate with GDP and government spending,[38] the Human Development Index (HDI) is used as a proxy for data availability. However, this correlation still is not fully consistent across all assessed countries. There are instances, for example, of SIDS with high HDI rankings but that still exhibit significant data gaps.

The HDI is a summary measure of average achievement in key human development dimensions: a long and healthy life, being knowledgeable, and having a decent standard of living. The HDI is the geometric mean of normalised indices for each of the three dimensions and represented by a value of 0–1. Countries are ranked in four groups: low (<0.55), medium (0.55–0.699), high (0.7–0.799), and very high (≥0.8).

For the CRI, the HDI is incorporated as a proxy for data availability. First, the 'HDI gap' is determined for each country, illustrating the gap between a country's HDI score and the 'perfect' HDI score of 1. The result is weighted and added to a country's CRI score as an 'HDI correction.' So as not to overcorrect the factual data calculations in the CRI, a conservative weighting of 10% is used for the correction. Additionally, countries with a very high HDI score (≥0.8) are excluded under the assumption that data gaps are less likely within them. This adjustment should not be interpreted as a definitive correction for the disparities in data availability but rather as an attempt to account for potential underreporting in a methodologically consistent way.

Accordingly, the 'HDI-corrected' CRI score can be written as:

$$\textbf{CRI score}_{\textbf{HDI-corrected}} = \textbf{CRI score x 0.9 + 'HDI gap' x 0.1}$$

33 Otto and Harrington 2020c
34 Clarke et al. 2022
35 Friederike et al. 2020a
36 ibid.
37 McSweeney and Tandon 2024
38 Reference: Zhan, C./ Jian, W./ Zheng, Y./ Lu, J./ Zhang, Q. 2023: A data-driven study of active meteorological stations and the factors motivating their establishment. In: Sustainable Energy Technologies and Assessments

10 Terminology

Key concepts for the CRI components and indicators are defined below, with detailed definitions for all hazards.

Extreme weather event

An event that is rare in a particular place and at a particular time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as, or rarer than, the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of 'extreme weather' may vary from place to place in an absolute sense (IPCC AR6).

The dedicated chapter in the IPCC Sixth Assessment Report on extreme weather events covers 'temperature extremes, heavy precipitation and pluvial floods, river floods, droughts, storms (including tropical cyclones), as well as compound events.'

Climate change impacts

The consequences of realised risks on **natural and human systems**, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on **lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure.** Impacts may be referred to as 'consequences' or 'outcomes' and can be adverse or beneficial (IPCC AR6).

Risk

The CRI understands risk according to the IPCC Sixth Assessment Report as, 'The potential for adverse consequences for **human or ecological systems,** recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential **impacts of climate change** as well as human responses to climate change. Relevant adverse consequences include those on **lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.** In the context of climate change impacts, risks result from dynamic interactions between climate-related **hazards with the exposure and vulnerability** of the affected human or ecological system to the hazards. Hazards, exposure and vulnerability may each be subject to uncertainty in terms of magnitude and likelihood of occurrence, and each may change over time and space due to socio-economic changes and human decision-making (see also risk management, adaptation and mitigation). In the context of climate change responses, risks result from the potential for such responses not achieving the intended objective(s), or from potential trade-offs with, or negative side-effects on, other societal objectives, such as the Sustainable Development Goals (SDGs) (see also risk trade-off). Risks can arise, for example, from uncertainty in implementation, effectiveness or outcomes of climate policy, climate-related investments, technology development or adoption, and system transitions.' (IPCC AR6)

Hazard: This indicates the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. The CRI includes the following hazards, following the 2014 IRDR Peril Classification and Hazard Glossary[39]

1. Hydrological: Caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater.
2. Meteorological: Caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions lasting from minutes to days.
3. Climatological: Caused by long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability.

39 https://council.science/wp-content/uploads/2019/12/Peril-Classification-and-Hazard-Glossary-1.pdf

Table 5: Definitions of Hazards

Hazard definitions in EM-DAT (https://www.emdat.be/sites/default/files/adsr_2016.pdf)[40]	
Term	**Definition**
Flood	**A general term for the overflow of water from a stream channel onto normally dry land in the floodplain (riverine flooding), higher than normal levels along the coast and in lakes or reservoirs (coastal flooding), and ponding of water at or near the point where the rain fell (flash floods).**
Flash flood	Heavy or excessive rainfall in a short time period and that produces immediate runoff, creating flood conditions within minutes or a few hours during or after the rainfall.
Mass movement	**Any type of downslope movement of earth materials.**
Wet avalanche	A large mass of loosened earth material, snow, or ice that slides, flows, or falls rapidly down a mountainside under gravitational force. Snow avalanche: Rapid downslope movement of a mix of snow and ice. Debris avalanche: Sudden and very rapid downslope movement of an unsorted mass of rock and soil. There are two general types of debris avalanches. A cold debris avalanche usually results from an unstable slope suddenly collapsing, whereas a hot debris avalanche results from volcanic activity leading to slope instability and collapse.
Wet landslide, mudslide, wet rockslide	Landslide types that occur when heavy rain or rapid snow/ice melt and send large amounts of vegetation, mud, or rock downslope by gravitational force.
Riverine flood	A flood type resulting from the overflow of water from a stream or river channel onto normally dry land in the floodplain adjacent to the channel.
Storm	**Including extra-tropical storm, tropical cyclone, tornado, blizzard/ winter storm, hail, derecho, lightning/thunderstorm, sand/dust storm, storm surge, wind action, connective storms.**
Extra-tropical storm	A type of low-pressure cyclonic system in the middle and high latitudes (also called a ‘mid-latitude cyclone’) that primarily gets its energy from the horizontal temperature contrasts (fronts) existing in the atmosphere. When associated with cold fronts, extratropical cyclones may be particularly damaging (e.g. European winter/windstorm).
Tropical cyclone	Originates over tropical or subtropical waters. It is characterised by a warm-core, non-frontal synoptic-scale cyclone with a low pressure centre, spiral rain bands, and strong winds. Depending on their location, a tropical cyclone can be referred to as a ‘hurricane’ (Atlantic, Northeast Pacific), ‘typhoon’ (Northwest Pacific), or ‘cyclone’ (South Pacific and Indian Ocean).
Tornado	A violently rotating column of air that reaches the ground or open water (waterspout).
Blizzard/winter storm	A low-pressure system in winter months and with significant accumulations of snow, freezing rain, sleet, or ice. A blizzard is a severe snowstorm with winds >35 mph (56 km/h) for three or more hours and producing reduced visibility (<0.25 miles [400 m]).
Hail	Solid precipitation in the form of irregular pellets or balls of ice >5 mm in diameter.
Derecho	Widespread and usually fast-moving windstorms associated with convection/convective storms. Derechos include downburst and straight-line winds. Damage from derechos is often confused with tornado damage.
Lightning/thunderstorms	A high-voltage, visible electrical discharge produced by a thunderstorm and followed by thunder.
Sand/dust storm	Strong winds carry particles of sand aloft, though generally confined to <50 feet (15 m), especially common in arid and semi-arid environments. A dust storm is also characterised by strong winds but it carries smaller particles of dust, rather than sand, over an extensive area.
Storm surge	An abnormal rise in sea level generated by a tropical cyclone or other intense storm.

40 These definitions have been established by IRDR Disaster Los Data (DATA group): “IRDR (2014) Peril classification and hzard glossary (IRDR DATA Publication n°1). Beijing: IRDR

Hazard definitions in EM-DAT (https://www.emdat.be/sites/default/files/adsr_2016.pdf)[40]	
Term	**Definition**
Wind action	Wind-generated surface waves that can occur on the surface of any open body of water such as an ocean, river, or lake. The wave size depends on the strength of the wind and the travelled distance (fetch).
Convective storm	A type of meteorological hazard generated by the heating of air and the availability of moist and unstable air masses. Convective storms range from localised thunderstorms (with heavy rain and/or hail, lightning, high winds, and tornadoes) to meso-scale, multi-day events.
Extreme temperature	**A general term for temperature variations above (extreme heat) or below (extreme cold) normal conditions.**
Severe/extreme winter condition	Damage caused by snow and ice. Winter damage refers to damage to buildings, infrastructure, traffic (especially navigation) inflicted by snow and ice in the form of, for example, snow pressure, freezing rain, and frozen waterways.
Heat wave	A period of abnormally hot and/or unusually humid weather. It typically lasts two or more days. The exact temperature criteria for what constitutes a heat wave vary by location.
Cold wave	A period of abnormally cold weather. It typically lasts two or more days and may be aggravated by high winds. The exact temperature criteria for what constitutes a cold wave vary by location.
Wildfire	**Any uncontrolled and unpredictable combustion or burning of plants in a natural setting, such as forest, grassland, brush land, or tundra, and that consumes the natural fuels and spreads depending on environmental conditions (e.g. wind, topography). Wildfires can be triggered by lightning or human actions.**
Forest fire	A type of wildfire in a wooded area.
Glacial lake outburst flood	**A flood that occurs when water dammed by a glacier or moraine is suddenly released. Glacial lakes can be at the front of the glacial (marginal) or below the ice sheet (sub-glacial lake).**
Drought	**An extended period of unusually low precipitation, which produces a water shortage for people, animals, and plants. Drought differs from most other hazards in that it develops slowly, sometimes even over years, and its onset is generally difficult to detect. Drought is not solely a physical phenomenon because human activities and water supply demands can exacerbate its impacts. Drought is, therefore, often defined both conceptually and operationally. Operational definitions of drought, meaning the degree of precipitation reduction constituting a drought, vary by locality, climate, and environmental sector.**

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