Climate Risk Index

Climate Risk Index Methodology

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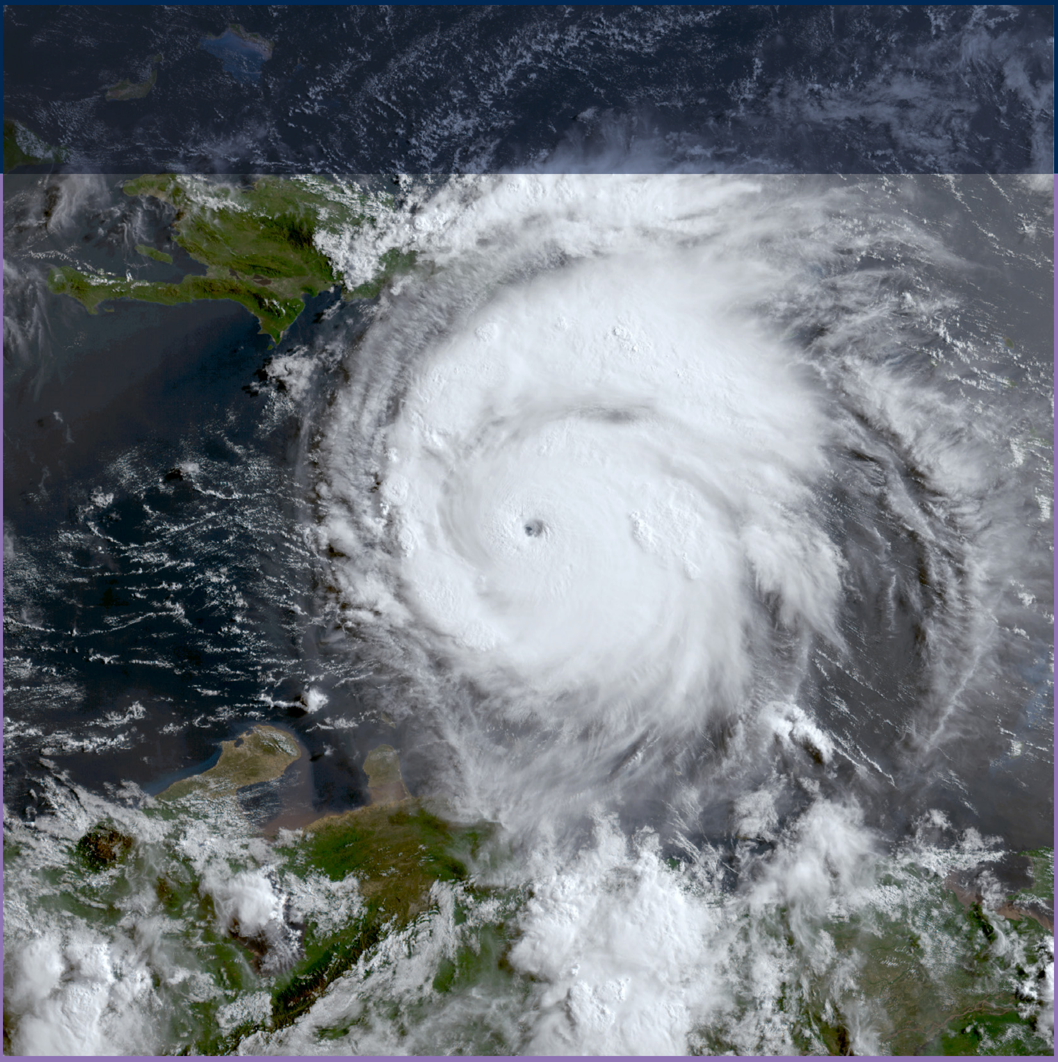

GERMANWATCH

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giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Contents

List of abbreviations

CDAP	Climate Diplomacy Action Programme
CRI	Climate Risk Index
EM-DAT	Emergency Events Database (used for disaster risk and loss data)
EU	European Union
FFO	German Federal Foreign Office
G7	Group of Seven
G20	Group of Twenty (major advanced and emerging economies)
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLOF	Glacial lake outburst flood
HDI	Human Development Index
IKI	International Climate Initiative
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRDR	Integrated Research on Disaster Risk
L&D	Loss and damage
LDCs	Least Developed Countries
PIK	Potsdam Institute for Climate Impact Research
PPP	Purchasing power parity
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNU	United Nations University
USD	United States dollar
WMO	World Meteorological Organization

List of figures and tables

1 CRI background and methodological revision

Since 2006, the Climate Risk Index (CRI) has indicated how extreme weather events affect countries, making the it one of the longest running annual climate impact-related indices.[1] This 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. Four indicators were analysed: number of deaths, number of deaths per 100,000 inhabitants, sum of loss in USD in purchasing power parity (PPP), and loss per unit of gross domestic product (GDP). From 2006 to 2021, the CRI analysis was based on Munich Re's NatCatSERVICE database.

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 that 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 revisiting the weighting of indicators.

The CRI underwent a 2-year methodological revision process (CRI 2025–CRI 2026). CRI 2026 applies a further refined methodology including logarithmic transformation of original values, which makes the analysis more robust (see section 4). While this refinement of the normalisation method yields some differences compared with previous editions in the understanding of global distribution of the degree to which countries are affected, the overall findings and their interpretation as a warning signal remain consistent. 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:

1 The CRI was not available from 2022 to 2024 because extreme weather event data from the previous data provider was discontinued.

2 The CRI team is grateful to those who have previously contributed to the index, particularly Britta Horstmann, Sven Harmeling, Christoph Bals, and Sönke Kreft.

3 European Commission 2024.

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

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 consequences of realised risks for countries. The index ranks countries based on 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 many extreme weather events' intensity, frequency, and duration. These events' impacts on, for example, economic costs and human health also are more clearly attributable to climate change.[4]

The results and a high CRI rank should be taken 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 1 year before publication and over the preceding 30 years. It simplifies the aggregation and understanding of climate impacts[5] across different regions and time periods, bringing attention to nations that extreme weather events most severely affect. This 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.

4 Otto 2023a.

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

Scope of the CRI

The CRI is a retrospective index based on past data and indicating 174 countries' realised risks. It is not intended for use as 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 seven hazard types.[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)
- Extreme temperature (including severe winter conditions, heat wave, cold wave)

2.3 Climatological

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

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, with each measured in absolute and relative terms.

6 Following EM-DAT categorisation and definitions.

7 For definitions for all hazards included in the CRI, see: 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, a cyclone. Hurricanes are strong tropical cyclones that occur in the Atlantic Ocean or northeastern Pacific Ocean, and typhoons occur in the northwestern Pacific Ocean. When occurring in the Indian Ocean and South Pacific, comparable storms are referred to as tropical cyclones.

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.

Table 1: CRI Indicators Overview

CRI Indicators Overview		
1	**Economic losses due to hazard**	Absolute economic losses (in purchasing power parity)
		Relative economic 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 enables analysis of country-specific data on economic damage in relation to real conditions and capacities in the countries. Clearly, for example, economic damage of USD 1 billion causes much less severe relative economic consequences for richer countries, such as the United States and Japan, than for poorer countries, where economic damage often is 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 enable a more appropriate expression of how a loss of USD 1 actually affects people compared with using nominal exchange rates. PPP measures 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 a greater amount of 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: Note 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, population increases (as in most countries), the same absolute number of deaths leads to a relatively lower CRI relative fatalities rank in the following year. The same relation applies for economic growth. However, this effect does not diminish this approach's significance. Society's ability to cope with damage through disaster risk management generally grows as economic strength increases, because 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 a country.

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

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

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

Table 2: Overview of Hazards and Indicators in the CRI

Hazard category	Hazard	Indicators
1. Hydrological	1.1 Flood	Economic losses due to flood (absolute, in PPP) Economic 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	Economic losses due to mass movement wet (absolute, in PPP) Economic 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	Economic losses due to mass storm (absolute, in PPP) Economic 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	Economic losses due to extreme temperature (absolute, in PPP) Economic 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	Economic losses due to wildfire (absolute, in PPP) Economic 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	Economic losses due to drought (absolute, in PPP) Economic 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)	Economic losses due to GLOF (absolute, in PPP) Economic 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 combines several indicators that measure disaster impacts in markedly different ways: absolute fatalities, number of people affected, and absolute economic losses, as well as relative values (in relation to population size and GDP). These indicators cannot simply be added together in their raw form because they are expressed in different units and on very different scales. To enable comparability, each indicator is first rescaled to a common 0–1 range.

In the last edition of the CRI, this rescaling was applied directly to the original values. While this approach ensured comparability, it also meant that extremely large values in a single year or for one indicator could dominate the results. For example, the exceptionally high heat-related fatalities recorded in Italy, Spain, and Greece in 2022 pushed these countries into the top 10 of the 30-year ranking, despite much lower impacts in most other years.

We refined the methods, applying a logarithmic transformation before rescaling. This refinement reduces extreme values' weights while keeping their signal visible. As a result, one exceptional year (e.g. the 2022 heat wave) no longer overshadows three decades of data, and a single indicator (e.g. fatalities or losses) cannot disproportionately outweigh the others. This adjustment ensures that the index reflects long-term patterns and preserves the balance intended in the weighting scheme (e.g. between fatalities and the degree affected, or between absolute and relative values). The methodological refinement produces a ranking less sensitive to outliers and more representative of sustained climate impacts across countries.

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: Calculating 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.

2 An indicator is labelled as 'missing' for a country if data is missing for one or more years. This particular indicator will not be considered in the averaging process. The raw data was selected to cover a high number of UN countries.

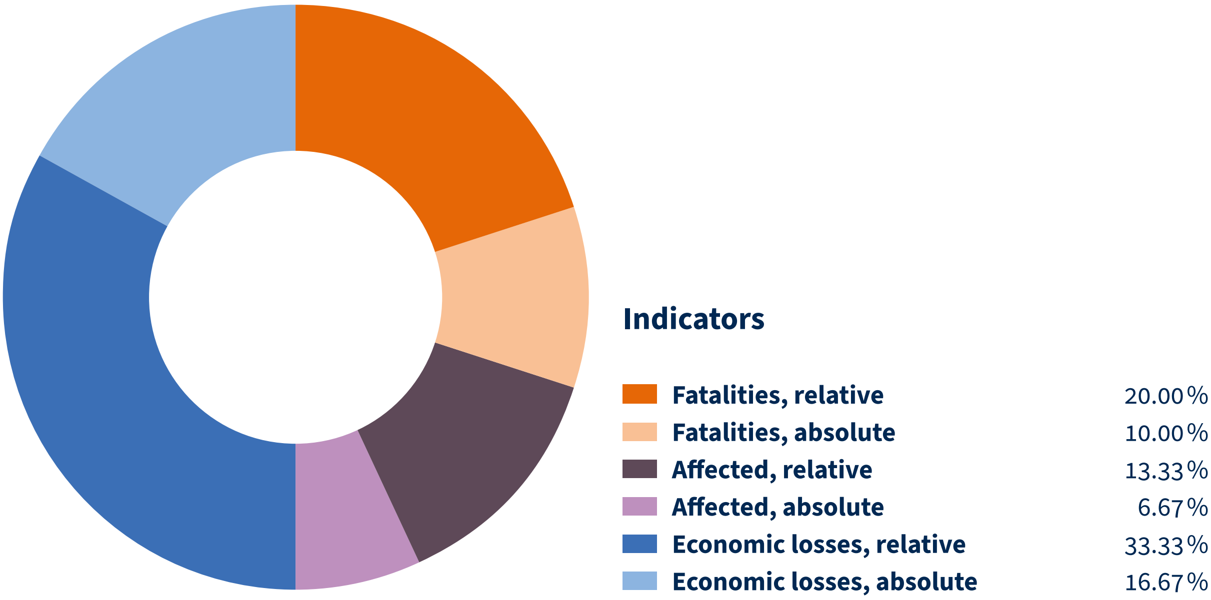
3 The original values in CRI indicators undergo a logarithmic transformation and are then normalised by determining the distance from the group leader. In this process, 100 is assigned to the leading country, while other countries are ranked as percentage points behind the leader.

4 The absolute economic and human loss indicators are weighted 1/6 (16.67%). The relative economic and human loss indicators are weighted 2/6 (33.33%). The human loss indicator consists of fatalities (weighted with 3/5 (60%)) and people affected (weighted with 2/5 (40%)).

5 The CRI score is calculated as follows: **CRI score** = [3/5 × (Absolute number of fatalities) + 2/5 × (Absolute number of people affected)] × 1/6 + [3/5 × (Relative number of fatalities) + 2/5 × (Relative number of people affected)] × 2/6 + (Absolute economic losses) × 1/6 + (Relative economic losses) × 2/6

12 European Commission 2024.

Figure 2: CRI indicators and weighting



5 Time frames

The CRI ranking addresses two time frames.

The **short-term ranking** considers impacts of extreme weather events that occurred 1 year before publication.

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 makes it possible to see extreme-weather events' long-term degree of effect on countries. It shows this degree of effect from unusually extreme events and recurring extreme weather events.

Table 3: Climate Risk Index time frames

Short-term CRI	Most impacted countries in last year (2024 for CRI 2026)
Long-term CRI	Most impacted countries over the preceding 30 years (1995–2024 for CRI 2026)

6 CRI countries and country groups

The CRI was designed to cover as many United Nations countries as possible, with the current version including 174 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 of data 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 should be seen as an analysis that helps explain the degree to which countries are affected by climate-related impacts and risks, based on the best publicly available historical dataset on extreme weather events' impacts and on other analysis.[13] The CRI does not provide an all-encompassing analysis of countries' realised or future risks of anthropogenic climate change.

This index uses data that represent current and past natural climate variability and climate change to the extent of its impact 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
- State of emergency declared
- 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] 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 slow-onset processes and rapid-onset events in accordance with the temporal scale over which they occur and the differing speed of their impacts' manifestation.

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, desertification, decreasing precipitation, and loss of biodiversity (see IPCC 2022, UNFCCC 2012, UNU 2017). Such processes cannot be included because of limited data available on their economic and human effects. Geological events, including earthquakes, volcanic eruptions, and tsunamis, which are weather-independent, are also excluded 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 example, it 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

13 Notre Dame Global Adaptation Initiative 2024.
14 EM-DAT Project 2022.
15 Sapir and Misson 1992.
16 Schaefer et al. 2023.

significant development factors, such as agricultural output and drinking water availability.

Impacts covered

Lagged impacts that manifest substantially later than when an event occurred (e.g. a person's death due to injuries resulting from 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 CRI calculations. Climate change-related extreme weather events can cause both economic (including [a] physical assets and [b] income) and non-economic L&D (including [a] material and [b] non-material forms).[18] The index covers a broad range of economic and non-economic L&D. Measuring non-economic L&D is particularly challenging; therefore, the index does not cover some forms of this L&D (e.g. loss of heritage, identity, or culture).

Data updates and time-lag

EM-DAT is continuously updated as new information becomes available. These updates include corrections and filling of data gaps, and sometimes include revisions to events that occurred many years ago. The current analysis, therefore, represents a snapshot of extreme weather events' economic and human effects based on the database at the time of this publication. Future updates may slightly alter historical values, but such revisions do not affect the overall validity of the long-term trends and findings presented here.

Data gaps as challenges to determining climate risks and impacts

A vast amount of data must be analysed in preparing an index; therefore, 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. Nonetheless, several challenges persist regarding data availability. Data challenges for the CRI are as follows:

1. Variation in data quality across and within countries. This situation may incur geographical bias in EM-DAT due to 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] The 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, in fact, experienced several heat waves.[22] EM-DAT lists only two heat waves in the region since 1900, which have led to 71 recorded premature deaths. By contrast, 83 heat waves were recorded in Europe over since the beginning of the 20th century.[23] 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, the United Kingdom, Spain, and Germany.

The existence of data gaps is well known and acknowledged. The Sendai Framework, for example, aims to 'promote the collection, analysis, management and use of relevant data' and notably, includes mortality data improvement as a high priority.[24] There are numerous reasons for data gaps, including the following.

a. Distribution of meteorological stations: Meteorological stations, which are essential for recording extreme weather events, are very unevenly distributed worldwide. This condition leads to substantial data gaps for developing countries in particular (see, for example, UNDRR 2023b).[25] Meteorological stations provide a wealth of high-quality data for observing global

17 See, for example, Sauer et al. 2023.
18 Serdeczny 2018.
19 EM-DAT Project 2022.
20 Dinku 2019.
21 Otto and Harrington 2020c.
22 Otto and Harrington 2020b.
23 Ibid.
24 United Nations Office for Disaster Risk Reduction 2015.
25 United Nations Office for Disaster Risk Reduction 2023b.

meteorological changes and are needed for registering extreme weather events. Zhan et al. (2023)[26] showed that GDP and government spending were the main factors influencing the number of active stations in each country. They also summarised that most stations are in developed countries. The World Meteorological Organization (2024) similarly highlighted that, despite progress, significant gaps persist 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.[27] The number of weather stations in the United States, European Union, and Africa clarifies the great difference between Global South and Global North. 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.[28] Otto (2023) 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.' As Otto (2023)[29] also noted, weather observations alone will not save lives, but without them we can neither understand the past nor plan for the future. Evidently, without reliable data, researchers cannot understand how weather is changing, and without knowing what 'normal' weather looks like, it becomes more difficult to determine what is 'extreme.'

b. Insufficient systematic data collection and cataloguing: Data quantity and quality and the coverage of disaster events are insufficient in some areas.[30] 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.[31] This shortcoming results in a severe lack of collated data that could accurately show economic 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.[32,33]

c. Database collection techniques: Disaster loss databases (including EM-DAT, which is used for the CRI) are continuously updated as new information becomes available. These updates includes corrections, filling of data gaps, and sometimes revisions to events that occurred many years ago. All analyses of extreme weather events' impacts, therefore, represent a snapshot based on the database as it stood at the time of download. Future updates may slightly alter historical values, but such revisions do not affect the overall validity of the long-term trends and findings presented here.

d. Use of different data collection techniques: Countries use different techniques to collect data on extreme weather events, and this practice might distort index results. For instance, some countries use 'excess mortality rate' to determine heat wave-related fatalities (rather than 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 versus the baseline.[34] Moreover, indirect and long-term consequences, such as disease outbreaks or excess mortality linked to post-disaster sanitary conditions, are generally often underestimated or overlooked. Similarly, insured damage is more accurately covered than non-insured or indirect economic losses.[35]

e. 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. The CRI-employed database EM-DAT itself notes that for heat waves, 'the actual human impact is likely underreported and not fully reflected in

26 Zhan et al. 2023.
27 World Meteorological Organization 2024b.
28 Otto 2023b.
29 Ibid.
30 Osuteye et al. 2017.
31 Otto and Harrington 2020c.
32 Otto and Harrington 2020b.
33 Ritchie and Rosado 2024.
34 Eurostat 2020.
35 Alderman, K., Turner, L. R., & Tong, S. 2012.

EM-DAT.'[36] One reason for this outcome is that climate research is largely carried out by research institutes in Global North countries, creating a bias toward events in these countries.[37] Virgüez et al. (2024)[38] found that 75% of the most highly cited climate science papers' authors are based in North America and Europe, and that most climate models have been developed in the Global North. Such asymmetries are perpetuated by systemic barriers such as the disparities in funding opportunities, bias in peer review systems, and dominance of English-language publishing. Huge geographical differences also exist in attribution science (see chapter 4).[39] Large attribution knowledge gaps are especially notable in Global South countries because of a lack of good-quality weather data and well-evaluated climate models.[40] Therefore, current attribution studies 'provide very little information about those events and regions where the largest economic damages and socio-economic losses are incurred.'[41] 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.[42] Besides research, countries that benefit from substantial media coverage are also more likely to be better represented in disaster loss databases.[43]

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 an older person died during a heat wave because of the extreme temperature or their advanced age).

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

CRI sensitivity analysis including HDI as a correcting factor is used for missing data to balance out the potential misrepresentation of Global South countries due to data gaps. The HDI is used as a proxy for data availability because studies concluded that data gaps correlate with GDP and government spending.[44] However, this correlation has yet to be fully consistent across all assessed countries. There are instances, for example, of SIDS with high HDI rankings but that still exhibit substantial 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

36 EM-DAT 2024.
37 Otto and Harrington 2020c.
38 Virgüez et al. 2024.
39 Clarke et al. 2022.
40 Friederike et al. 2020a.
41 Ibid.
42 McSweeney and Tandon 2024.
43 Delforge et al. 2025.
44 Zhan 2023.

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.' A conservative weighting of 10% is used for the correction so as not to overcorrect the factual data calculations in the CRI. Countries with a very high HDI score (≥0.8) also are excluded under the assumption that data gaps are less likely within them.

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

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

10 Terminology

Key concepts for the CRI components and indicators are defined as follows, 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

These are realised risks' consequences for **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 refers 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 in accordance with 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 implemen-*

tation, effectiveness or outcomes of climate policy, climate-related investments, technology development or adoption, and system transitions.' (IPCC AR6)

Hazard: This term 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 L&D of property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. The CRI includes the following hazards, following the 2014 IRDR Peril Classification and Hazard Glossary.[45]

1. Hydrological: Caused by the occurrence, movement, and distribution of surface and subsurface freshwater and saltwater.

2. Meteorological: Caused by short-lived, micro-scale to meso-scale extreme weather and atmospheric conditions lasting from minutes to days.

3. Climatological: Caused by long-lived, meso-scale to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal climate variability.

Table 5: Definitions of Hazards

Hazard definitions in EM-DAT[46]	
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 flood).**
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: (1) cold debris avalanches that usually result from an unstable slope suddenly collapsing and (2) hot debris avalanches that result 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	
Extra-tropical storm	A type of low-pressure cyclonic system in the middle and high latitudes (also called a mid-latitude cyclone) that primarily receives its energy from the horizontal temperature contrasts (fronts) existing in the atmosphere. Extratropical cyclones may be particularly damaging when associated with cold fronts (e.g. European winter/windstorm).
Tropical cyclone	Originates over tropical or subtropical waters and 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).

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

46 https://www.emdat.be/sites/default/files/adsr_2016.pdf. These definitions have been established by IRDR Disaster Los Data (DATA group): IRDR (2014). Peril Classification and Hazard Glossary (IRDR DATA Publication n°1). Beijing: IRDR.

Hazard definitions in EM-DAT[46]	
Term	**Definition**
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 3+ 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. Derecho damage 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.
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 wind strength and 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 2+ 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 2+ 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 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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