Global Climate Losses Report 2026

Assessing Economic Losses from Climate Change

Authors: Bowen Wang, Tianpeng Wang, Jiyun Wang, Fei Teng* (*contact: tengfei@tsinghua.edu.cn*)
The Institute of Energy, Environment, and Economy, Tsinghua University

Executive Summary

Climate change is causing widespread economic losses, with impacts extending beyond directly affected regions through supply chains and trade networks. However, existing loss accounting remains fragmented, limiting its ability to support mitigation and adaptation decisions. This report assesses the direct and indirect economic losses from extreme events attributable to anthropogenic climate change. It also traces the long-term losses caused by historical emissions globally and at the national level, providing scientific evidence to inform climate change mitigation, adaptation, and international cooperation, with a focus on reducing losses.

Extreme climate events associated with anthropogenic climate change have already caused substantial economic losses. During 2010–2025, the global annual average direct economic losses attributable to anthropogenic climate change across six types of extreme events were estimated at approximately US$90.8 billion, accounting for around 41% of the direct economic losses caused by disasters. The geographical distribution of losses in absolute terms differs from that of relative economic burdens, with some smaller economies facing particularly disproportionate impacts relative to their economic size. In China, the corresponding annual average attributable direct economic losses across four types of extreme events reached approximately RMB81.8 billion between 2012 and 2022 (approximately US$11.45 billion).

Direct losses generate further indirect losses through supply-chain linkages, increasing both the scope and magnitude of climate losses. Using a flow-based accounting approach, global annual average direct and indirect economic losses attributable to anthropogenic climate change from droughts, floods, and storms amounted to approximately US$159.7 billion between 2010 and 2025, with indirect losses accounting for 52%. In China, annual average indirect economic losses attributable to climate change from domestic extreme events were estimated at approximately RMB89.6 billion (approximately US$12.54 billion) between 2012 and 2022. Meanwhile, China incurred annual average indirect economic losses of approximately US$4.99 billion between 2010 and 2025 as a result of extreme events occurring abroad.

As of 2022, climate change resulting from historical emissions had caused cumulative global losses of approximately US$67.27 trillion (2022 present value), of which about 85% was borne by developing economies. The losses that historical emissions from developed economies, including the United States and the European Union, have caused in other countries far exceed the losses these economies have borne as a result of other countries' historical emissions. Together, these developed economies have caused US$38.5 trillion in net losses to other countries. Conversely, developing countries such as China and India have borne far greater losses from other countries' historical emissions than their own historical emissions have caused in other countries. China bears approximately US$10.83 trillion in net cross-border climate losses, while India bears approximately US$10.46 trillion.

Looking ahead to COP31 and beyond, the report calls for translating loss accounting findings into climate action, with a focus on reducing climate losses: advance the implementation of developed countries' mitigation commitments and establish a clear pathway for achieving the climate finance goal of at least US$300 billion annually by 2035; make effective use of finance for adaptation and for responding to loss and damage, prioritizing particularly vulnerable developing countries; strengthen national disaster loss statistics, attribution research, and loss assessments to inform domestic adaptation planning in developing countries and cooperation on supply-chain resilience; and deepen international cooperation on adaptation and loss and damage to reduce climate-related losses and support climate-resilient development.

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Chapter 1. What losses does climate change cause?

Climate change is causing widespread losses that affect economic and social development around the world. Extreme weather and climate events damage assets and interrupt production. Long-term warming and sea level rise also affect livelihoods, health and ecosystems. These impacts can reach regions and sectors outside the disaster area through supply chains and trade. [1–3] Understanding and assessing these losses is essential to designing and implementing climate action. Knowing how large the losses are, where they fall and how they arise helps us assess how far mitigation can prevent future losses and support continued economic growth. It also helps us judge how far adaptation can reduce current and future climate impacts and protect development gains. Climate losses should therefore inform mitigation and adaptation decisions and their implementation, including how to set priorities, allocate resources and assess performance.

This chapter first defines climate losses, explains how they differ from the losses recorded in disaster statistics and examines why losses vary across countries and regions. It then describes losses from three perspectives: the source of risk, what is harmed and how impacts spread. On this basis, it sets out the scope of the report. Chapters 2 and 3 assess the share of extreme event losses attributable to anthropogenic climate change and the indirect impacts transmitted through supply chains. Chapter 4 examines the long-term losses caused by national emissions through impacts on agriculture, health and energy and through sea level rise. It also uses bilateral accounting to identify which countries cause these losses and which bear them. Chapter 5 summarizes the findings and offers recommendations on mitigation, adaptation, climate finance and loss accounting for COP31 and beyond.

1.1 What are climate losses

Climate losses are the adverse consequences of climate change for people and natural systems. They include damage to assets, lower production and income, loss of life, harm to health, and damage to ecosystems and cultural heritage.[4] The term covers losses that have already occurred and those that may occur in the future. Even with mitigation and adaptation, some losses may be unavoidable and some consequences irreversible.

Research and disaster statistics shed light on climate-related losses from different perspectives. A global study estimated that, from 2000 to 2019, anthropogenic climate change accounted for about US$2.8 trillion in health and economic losses from extreme weather events.[5] In China, weather disasters caused RMB397.1 billion in direct economic losses and affected 10.1 million hectares of cropland in 2024.[6] A health study estimated that deaths associated with heatwave exposure in China exceeded 20,100 that year, continuing an upward trend.[7]

Future climate losses depend on the degree of warming, economic and social development, and adaptation measures. The Organization for Economic Co-operation and Development (OECD) reports that, without further climate action, annual global GDP could be 1.0% to 3.3% lower by 2060 than in a baseline that excludes climate losses. The gap could reach 2% to 10% by the end of the century.[8] Another study estimates that at 3°C of global warming, losses would average 10% of GDP worldwide and reach 17% in some poorer countries at low latitudes.[9] Research on China suggests that under some scenarios, climate losses will exceed 3% of GDP by the end of the century, and gross output in industry and services could fall by more than 4%.[10]

Understanding climate losses requires a distinction between risk and loss. Climate risk describes the adverse consequences that a climate event or trend could cause and the likelihood of those consequences. Climate losses are the resulting harms, such as damaged assets, lower production and poorer health. Climate risk arises from the interaction of hazard, exposure and vulnerability.[11] A hazard is a climate event or trend that can cause harm. Exposure refers to the people, assets and ecosystems present in the area affected. Vulnerability describes how easily they can be harmed and the limits on their ability to cope and adapt. A flood or heatwave of the same intensity can therefore cause different losses in regions with different levels of exposure and vulnerability.

Disaster losses and climate losses should also be distinguished. Even without anthropogenic climate change, natural climate variability can cause extreme events and associated losses. Anthropogenic climate change can increase or reduce these losses by changing the likelihood or intensity of an event. Actual losses also depend on the exposure of people and assets, social and economic vulnerability, and the capacity to prevent and reduce disaster impacts. Estimating losses caused by anthropogenic climate change therefore requires identifying its contribution to recorded disaster losses.

Attribution analysis is a key method for making this distinction. It compares actual conditions with a counterfactual scenario without anthropogenic climate change to identify how human influence has changed the likelihood and intensity of an event. Combined with disaster loss data and impact models, it can also estimate the losses attributable to anthropogenic climate change. [12,13] However, there is still no consensus on which impact channels and types of losses to include in climate loss accounting. Differences in coverage and model choice create considerable uncertainty in loss estimates.[4]

1.2 Types of climate losses

Climate losses take different forms. They can be understood by examining the source of risk, what is harmed and how its value is measured, and how impacts arise and spread. These perspectives identify the event or change that causes the loss, the values at risk and the way impacts spread through economies and societies.

Losses can arise from extreme events such as floods, storms and heatwaves or build up through slow onset processes such as long-term warming, sea level rise and ocean acidification. Crossing a climate tipping point can also cause a major shift in the climate system or one of its parts, with widespread, long-lasting consequences that are hard to reverse (Table 1).[10,11] These processes can interact. For example, sea level rise makes coastal storm surges more dangerous, while crossing a tipping point in an ice sheet can further increase long-term sea level rise.

Table 1. Three sources of climate risk and their loss characteristics

	Extreme events	Slow onset processes	Climate tipping points
Definition	Weather or climate events that are rare in a given place and period, with unusual intensity, duration or conditions of occurrence.	Climate processes and related impacts that develop and build up over a long period.	Thresholds at which the climate system or one of its parts undergoes a major shift. Crossing a threshold can trigger nonlinear change.[14]
Examples	Heatwaves, floods, storms (including tropical cyclones), droughts and wildfires.	Long-term warming, ocean acidification, sea level rise, salinization, glacier retreat, and climate-related biodiversity loss and degradation of land and forests.	Destabilization of the Greenland or West Antarctic ice sheet, collapse of the Atlantic Meridional Overturning Circulation, and widespread decline of the Amazon rainforest.
Loss patterns	Losses tend to occur during the event. Production interruptions and recovery can prolong its impacts.	Losses build up over time and gradually weaken production capacity, livelihoods and ecosystem functions.	Losses can be widespread, long-lasting and difficult to reverse over the relevant timescales.

Climate losses can be classed as economic or non-economic according to what is harmed and how its value is expressed. Economic losses are adverse impacts whose costs can be expressed in price value, such as damage to homes and equipment, lower crop yields, business interruptions and lost income. Non-economic losses concern values that market prices cannot fully capture. Examples include loss of life and health, biodiversity loss, damage to cultural heritage, and weaker social ties and attachment to place. These losses are often

harder to compensate for or reverse.[15] Non-market valuation methods can assign a monetary value to some of them, but money still captures only part of their value. Economic and non-economic losses often overlap. The same asset or resource may have both kinds of value, and either kind of loss can lead to the other and set off further impacts.[16]

Climate losses can also be classed as direct or indirect according to how impacts arise and spread. In the disaster statistics of the United Nations Office for Disaster Risk Reduction (UNDRR), direct economic loss mainly refers to the monetary value of physical assets wholly or partly destroyed. Indirect economic loss is the further decline in economic value added resulting from damage to assets and impacts on people and the environment.[17] Indirect losses often emerge over time. They can occur within the disaster area or spread through supply chains, trade and infrastructure networks to other regions and sectors. Welfare loss measures how changes in consumption, health and living conditions reduce people's well-being compared with a scenario without the climate change. The monetary equivalent of this decline provides a way to measure and compare welfare losses.

These classifications describe different aspects of climate losses and can overlap. A flood, for example, can damage assets and interrupt production while also harming residents' health and damaging cultural heritage. Identifying the different losses gives a fuller picture of climate impacts and helps set priorities for mitigation, adaptation and responses to losses.

1.3 Which climate losses does this report assess

Given the limits of available data and methods, this report cannot quantify all the types of climate loss described above. It assesses climate losses from two main perspectives. First, it identifies the share of historical extreme event losses attributable to anthropogenic climate change and traces indirect impacts through supply chains and trade. Second, it assesses the long-term impacts of countries' historical emissions through agriculture, health, energy and sea level rise. It examines which countries cause and bear losses and how losses are distributed across borders.

Chapters 2 and 3 focus on extreme events. The global analysis of direct climate losses covers floods, storms, droughts, heatwaves, wildfires and cold waves from 2010 to 2025. The global analysis of indirect losses covers droughts, floods and storms. The China analysis covers droughts, floods, storms and cold waves from 2012 to 2022. In these chapters, “climate losses” means the share of disaster losses attributable to anthropogenic climate change. Differences in data sources, periods and event types limit direct comparison between the results for China in the global analysis and those based on domestic data.

Chapter 4 covers agriculture, health, energy and sea level rise impacts. It assesses the cumulative impacts of greenhouse gas emissions from 1850 to 2022 over that same period. Annual losses are converted to their 2022 present value using a method based on the Ramsey

formula, with an approximate annual discount rate of 4.5% in the baseline. The technical annex tests annual rates of 2% and 7%. In this chapter, we measure climate losses as changes in welfare expressed in monetary terms. It covers economic impacts on production and consumption, includes the estimated value of warming-related deaths, and accounts for both adverse and beneficial impacts covered by the model. Attribution to national emissions excludes future committed emissions and emissions from land use, land-use change and forestry. The sensitivity analysis in the technical annex shows that including these emissions has a limited effect on the main findings.

These estimates describe attributable losses from historical extreme events and how they spread, as well as the combined impacts of historical emissions over a longer period. The estimates differ in time period, metric and impact coverage, so adding them would not give a meaningful total for global climate losses. Accounting for direct and indirect losses also requires distinguishing capital stocks from economic flows. Direct economic losses in disaster statistics mainly measure losses of stocks, such as damage to assets. The input-output analysis in Chapter 3 converts damage to the capital stock into initial losses of economic flows in directly affected sectors. It then estimates indirect losses through links between sectors. Comparisons across chapters should therefore take account of the measure used and avoid comparing the value of damaged assets directly with economic flows.

Data and methods also limit the overall coverage of the climate losses estimates. Gaps in disaster records and attribution studies mean that the extreme event analysis does not fully capture deaths, injuries or lower labor productivity. Chapter 4 includes some health impacts, but coverage of climate tipping points, biodiversity, cultural heritage and social ties remains incomplete. The size and national distribution of losses also depend on the period used for accounting emissions, future development pathways, discount rates and model assumptions. The technical annex examines uncertainty and sensitivity. Further research on underrepresented impact channels and loss types would allow a more complete assessment. The aim is to support global action to reduce climate losses by identifying the regions and sectors most affected, assessing losses that mitigation can avoid, setting adaptation priorities and informing discussions on international climate responsibility and finance.

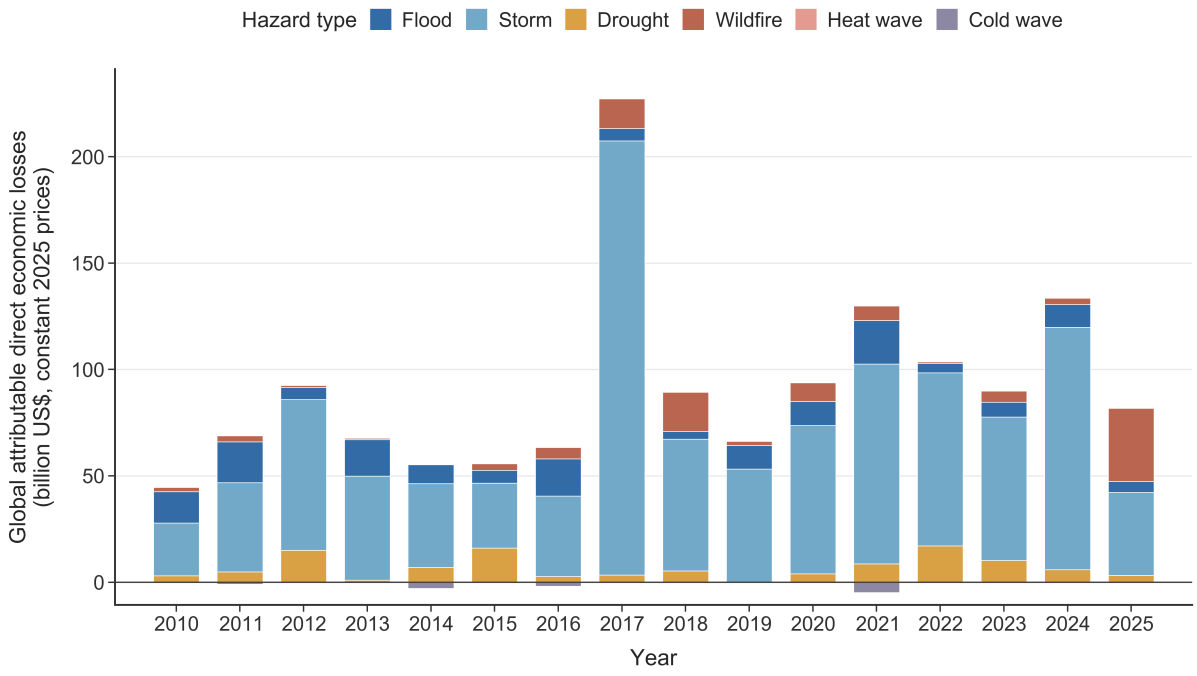
Chapter 2. What share of disaster losses is attributable to anthropogenic climate change?

This chapter examines extreme weather and climate events that have already occurred. It combines disaster loss records with existing extreme event attribution studies to estimate the share of direct economic losses attributable to anthropogenic climate change, referred to below as "attributable losses." The global analysis covers floods, storms, droughts, heatwaves, wildfires and cold waves from 2010 to 2025. The China analysis covers droughts, floods, storms and cold waves from 2012 to 2022.

After estimating total losses, the chapter compares losses across event types and years and examines the burdens borne by countries and regions. The findings identify major sources of climate losses and the areas most affected. They help explain the need for mitigation and guide adaptation priorities. The assessment uses direct economic losses in disaster records and captures only part of the economic and social losses from extreme events. Chapter 3 further examines indirect impacts transmitted through supply chains.

2.1 Direct climate losses from extreme events worldwide

(a) Annual composition of global attributable losses by hazard



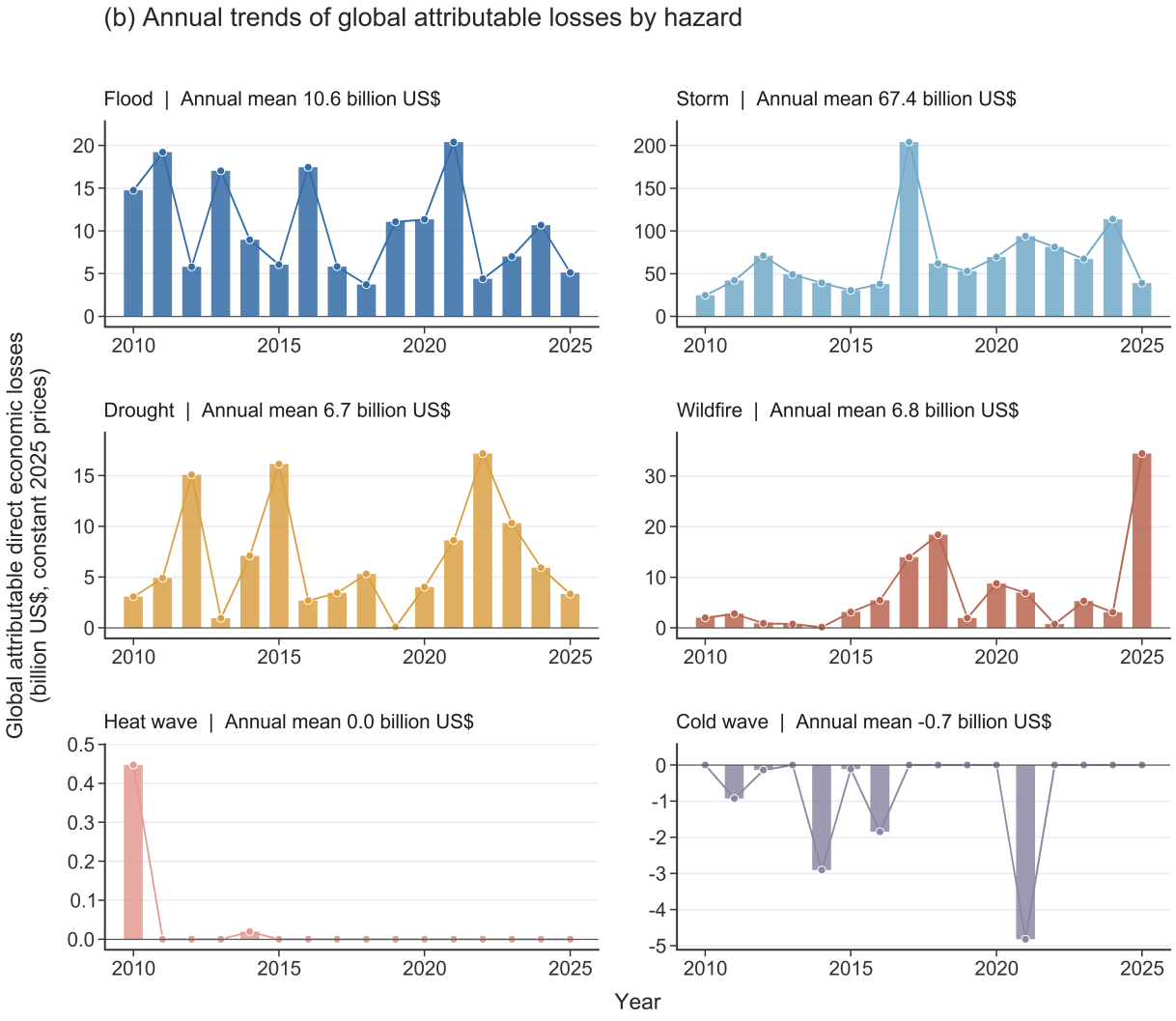


Figure 1. Annual attributable direct losses from extreme events worldwide, by event type, 2010 to 2025

Note. (a) Stacked bars show annual attributable direct losses for six event types, distinguished by color. Attributable cold wave losses are negative. (b) Each panel shows annual attributable direct losses for one event type. The six event types caused average annual direct economic losses of about US$221.8 billion worldwide, of which about US$90.8 billion (41%) was attributable to anthropogenic climate change. Annual attributable direct losses were lowest in 2010 (about US$45 billion) and highest in 2017 (about US$227 billion).

From 2010 to 2025, the floods, storms, droughts, heatwaves, wildfires and cold waves covered by this report caused average annual direct economic losses of about US$221.79 billion. An estimated US$90.82 billion, or 40.95%, was attributable to anthropogenic climate change. This shows that anthropogenic climate change is already a major source of economic losses from extreme events globally.

Both attributable losses and the attributable share vary widely by event type. Storms accounted for about three quarters of attributable direct losses, averaging US$67.38 billion a year. About 62% of direct economic losses from storms were attributable to anthropogenic climate change. Attributable flood losses averaged about US$10.55 billion a year, or about 19% of direct flood losses. Annual attributable losses averaged about US$6.79 billion for wildfires, US$6.75 billion for droughts and US$30 million for heatwaves. The estimate for cold waves was negative, averaging about –US$670 million a year. This indicates lower direct economic losses from cold waves than in a scenario without anthropogenic climate change.

A few costly events can strongly influence annual attributable losses, causing large swings between years. Estimated losses were lowest in 2010 at about US$45 billion and highest in 2017 at about US$227 billion, mainly due to storms. Hurricanes Harvey, Irma and Maria together accounted for about US$158.9 billion in attributable losses, a large share of storm losses that year. In 2024, Hurricane Helene alone caused about US$45.2 billion in attributable losses.

The mix of events changes from year to year, and the years with the highest losses differ by event type. Drought losses were particularly high in 2012, 2015 and 2022. Flood losses also varied sharply, with attributable losses reaching about US$15 billion to US$20 billion in several high-loss years. In 2025, particularly heavy losses from wildfires in Southern California drove a marked increase in attributable wildfire losses. Understanding annual changes in total losses therefore requires examining each event type's contribution over time and the influence of individual major events.

This section mainly captures direct economic losses covered by disaster records. Extreme events have wider economic and social impacts. For heatwaves, for example, more than 70% of the losses in the records used here were attributable to anthropogenic climate change. This share exceeded 80% in both the Americas and Asia. Yet annual attributable direct economic losses averaged only about US$30 million. The scope of the accounting explains much of this difference. Major heatwave impacts include deaths, harm to health and lower labor productivity, all of which fall outside this section's estimates.

Box 1. From extreme event attribution to impact attribution

Extreme event attribution identifies how anthropogenic climate change affects the likelihood or intensity of an extreme event. Researchers generally compare the actual climate with a counterfactual scenario without human influence. For a heavy rainfall event, for example, they can estimate how much anthropogenic climate change increased its likelihood or intensity. World Weather Attribution (WWA) regularly conducts rapid attribution studies. Its website provides details of events, methods and findings.

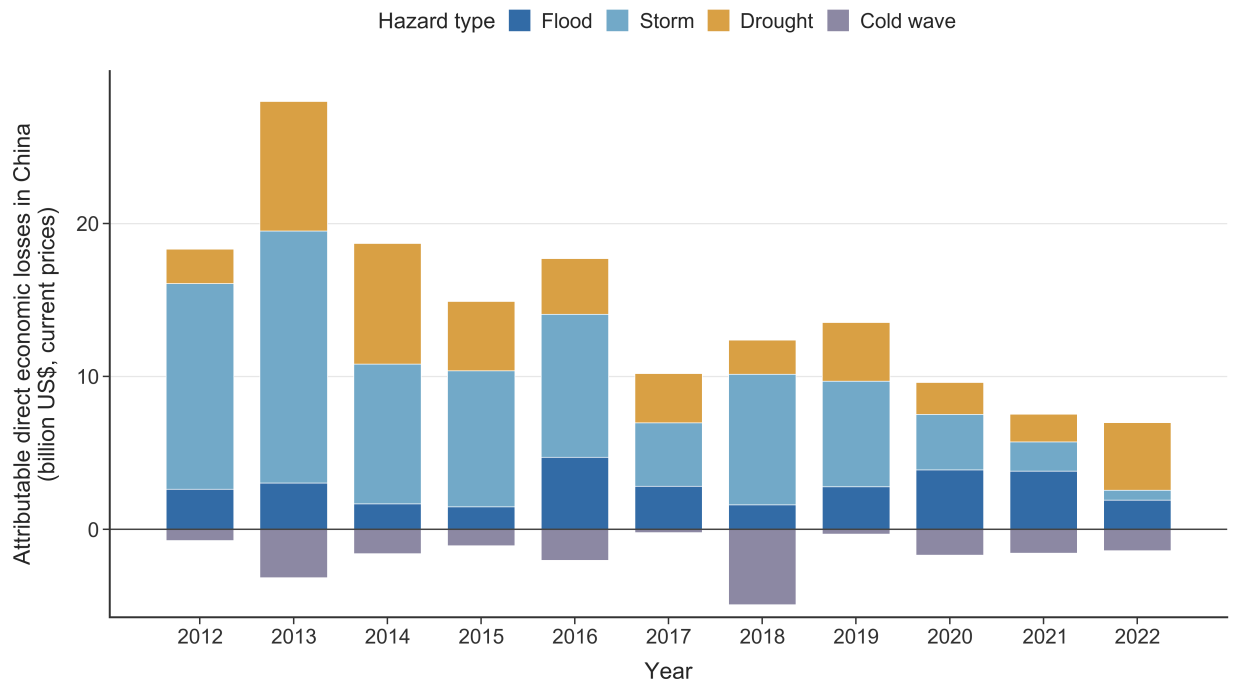
Impact attribution goes further by estimating how much of the economic loss, how many people affected or how many deaths can be attributed to climate change. Losses also depend on the distribution of people and assets, protective infrastructure and the capacity to respond. Translating a change in event risk into a change in actual losses therefore requires assumptions. The Climate Damage Tracker at Imperial College London combines event attribution with data on social and economic impacts to rapidly assess economic losses from tropical cyclones and deaths associated with heatwaves.

This report combines the fraction of attributable risk from existing studies with disaster loss records to estimate attributable direct losses under the relevant assumptions. For events without a separate attribution study, it uses approximations such as regional average attribution estimates for the same event type. The results depend on how representative the attribution evidence is, how complete the loss records are and the assumptions linking risk to loss. The technical annex describes the methods and limitations.

Reference: Newman, R. & Noy, I. The global costs of extreme weather that are attributable to climate change. Nat Commun 14, 6103 (2023)

2.2 Direct climate losses from extreme events in China

(a) Annual composition of China's attributable losses by hazard



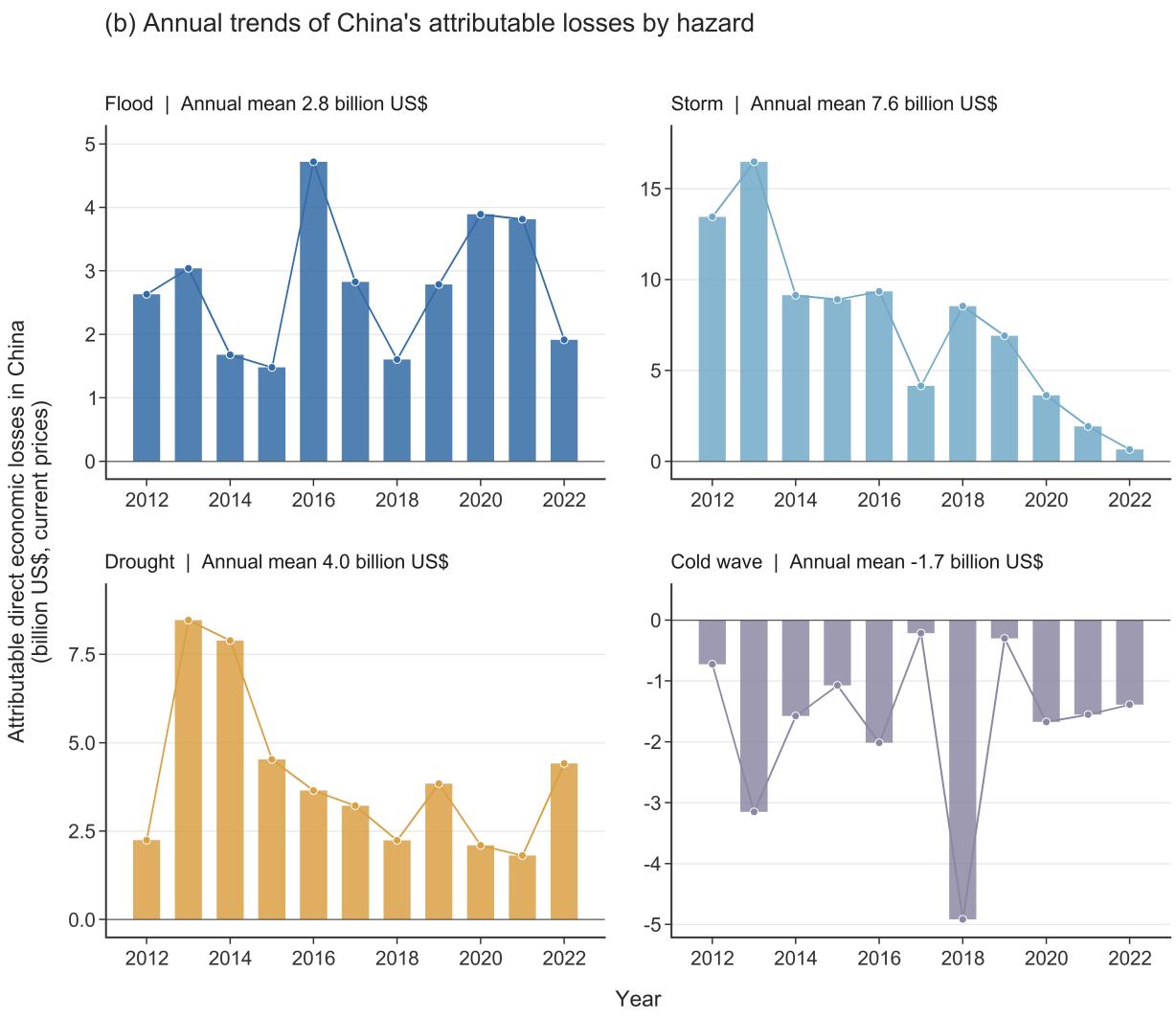


Figure 2. Annual attributable direct losses from extreme events in China, by event type, 2012 to 2022

Note. (a) Stacked bars show total attributable direct losses for four event types. Floods, storms and droughts make positive contributions, while cold waves make a negative contribution. (b) Panels show annual losses and the average for each event type from 2012 to 2022. Chinese disaster statistics put average annual direct economic losses from these events at about RMB301 billion, of which about RMB81.8 billion (27%) was attributable to anthropogenic climate change.

Provincial loss records from the China Meteorological Disaster Yearbook, combined with Chinese extreme event attribution studies, indicate that droughts, floods, storms and cold waves caused average annual direct economic losses of about RMB300.99 billion in China from 2012 to 2022. An estimated RMB81.8 billion, or about 27.2%, was attributable to anthropogenic climate change.

Storms were the largest source of attributable direct economic losses, averaging about RMB48.6 billion a year, followed by droughts at RMB26.0 billion and floods at RMB18.1 billion.

These amounts represent about 59%, 32% and 22%, respectively, of net attributable losses across all four event types. The estimate for cold waves was negative. Direct economic losses from cold waves averaged about RMB11.0 billion less per year than in a scenario without anthropogenic climate change. Subtracting this reduction from the losses for the other three event types gives the annual net loss of about RMB81.8 billion.

Attributable losses varied considerably from year to year and were highest in 2013. Typhoons including Usagi, Utor and Fitow caused heavy losses that year. Related attributable losses reached about RMB49.3 billion in Zhejiang and RMB34.2 billion in Guangdong. Hunan and Hubei suffered severe drought losses in the same year, while Sichuan and Heilongjiang experienced major floods.

The geographic pattern also varies by event type. Drought losses were concentrated in the three northeastern provinces (Liaoning, Jilin, and Heilongjiang), Inner Mongolia, Yunnan, Guizhou and Sichuan. Storm losses were especially high in coastal areas such as Zhejiang, Guangdong and Shandong. The concentration of people, assets and manufacturing in these areas means disasters can cause substantial direct damage to assets. Regional differences in losses reflect the characteristics of the hazard, asset exposure and disaster prevention capacity.

Agriculture and manufacturing suffered the largest direct climate losses, averaging about RMB38.9 billion and RMB27.0 billion a year, or 48% and 33% of the total. Water infrastructure accounted for 13% and transport for 3.5%. These sectors face direct exposure to extreme events and provide essential support for production and daily life. Adaptation priorities should take account of local hazards, the people and assets exposed, and the further impacts that direct losses can cause through links between sectors.

2.3 Comparing direct climate losses from extreme events across countries

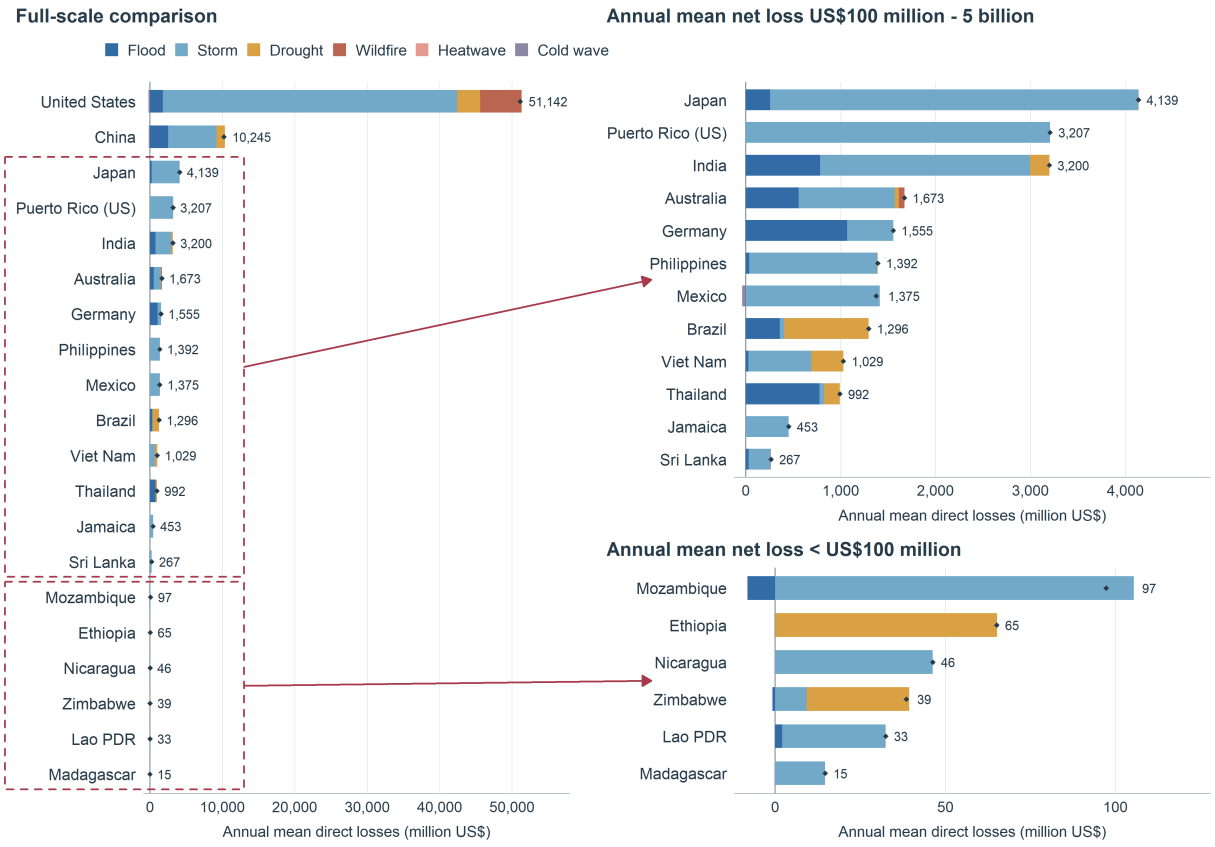


Figure 3. Attributable direct losses from extreme events in selected countries and regions, by event type

Note. The figure shows the 20 countries with the highest average annual attributable direct losses from 2010 to 2025. Losses in the United States far exceeded those in other countries. Storms accounted for 79% of US losses, followed by wildfires. The two panels on the right show economies with average annual net losses of US$100 million to US$5 billion and those with less than US$100 million, respectively. Droughts accounted for most losses in Brazil, Ethiopia and Zimbabwe, while floods accounted for most losses in countries such as Thailand and Germany.

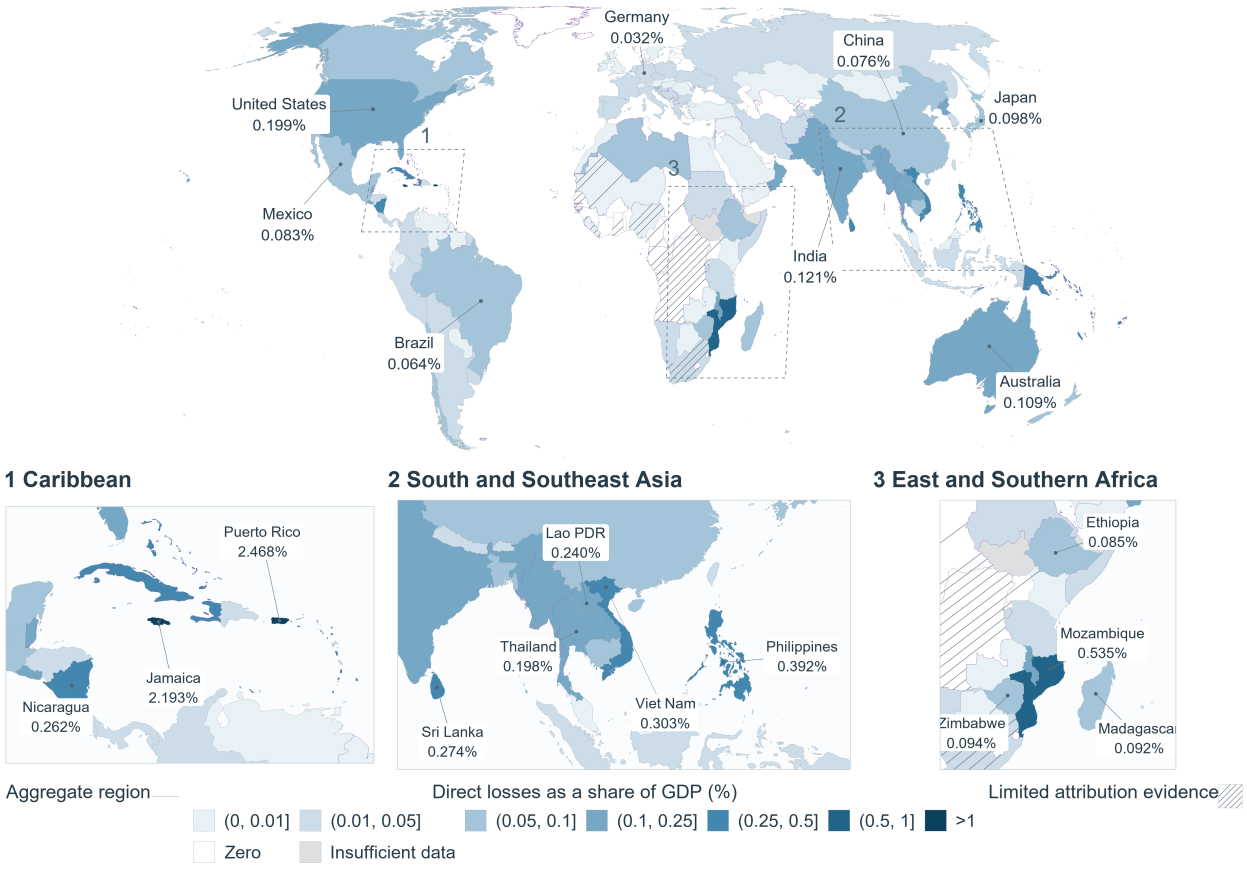


Figure 4. Attributable direct losses from extreme events as a share of GDP

Note. The relative loss burden is average annual attributable direct losses divided by average annual GDP for 2010 to 2025. Darker colors indicate a greater burden. Hatching marks areas in Africa with limited attribution evidence. Estimates for these areas cover only selected event types and exclude results for floods where the evidence is unclear. White indicates zero recorded losses and gray indicates insufficient data. Disasters may have caused losses in either case. The three insets show the Caribbean, South and Southeast Asia, and eastern and southern Africa.

The countries and regions with the largest direct climate losses differ from those with the heaviest relative burdens. Using the same method as Section 2.1, average annual attributable direct losses from 2010 to 2025 were particularly high in the United States (about US$51.142 billion) and China (US$10.245 billion). Japan recorded about US$4.139 billion, Puerto Rico US$3.207 billion and India US$3.200 billion. These figures depend on the amount and value of exposed assets, the completeness of disaster records and the coverage of insurance data. Larger recorded losses alone do not establish greater climate vulnerability.

Some economies with smaller absolute losses bear a heavier burden relative to GDP. By the measure in Figure 4, US losses were about 0.2% of GDP. Jamaica's average annual attributable direct economic losses were far smaller, at about US$453 million, but reached about 2.2% of GDP. Losses were also relatively high in Mozambique, the Philippines and Viet

Nam, at about 0.5%, 0.4% and 0.3% of GDP, respectively. The corresponding shares in Germany and Brazil were about 0.03% and 0.06%. Thus, to understand the impacts on economies with small absolute losses, it is particularly important to consider their economic size and capacity to respond.

Storm losses were especially high in the Caribbean and in some coastal economies, including Puerto Rico, Mozambique, the Philippines and Viet Nam. Within the scope of this report, the United States, Canada and Mexico together accounted for about 63% of global attributable direct economic losses from storms. Storm losses are concentrated in economies with large amounts of exposed assets, while also placing a heavy relative burden on some small island and coastal economies.

Droughts and floods show different patterns. Drought losses were particularly high in economies such as Viet Nam, Zimbabwe and Ethiopia. Their impacts depend on how exposed agriculture is and how much it contributes to the local economy and livelihoods. Flood losses were concentrated in Asian economies such as Thailand, Pakistan, Cambodia and Nepal and in economies in the Americas such as Peru and El Salvador. Identifying specific adaptation needs requires distinguishing the main hazards and the people, assets and sectors exposed in each country.

These comparisons also depend on the coverage of disaster records and attribution studies. Economies with more exposed assets and more complete records are more likely to show high absolute losses. Low estimates for some African countries may reflect incomplete records and limited attribution research. Figure 4 shows attributable losses for only some extreme events in these regions and marks them as having limited attribution evidence. The technical annex gives the original estimates and their research basis.

Absolute losses, relative burdens and the mix of event types can guide adaptation priorities. Economies with large absolute losses need to protect key assets and infrastructure. Those with heavy relative burdens and limited resources need international financial and technical support. Specific measures should reflect local hazards, economic structures and data gaps.

2.4 Main findings and implications

Anthropogenic climate change is already a major factor in economic losses from extreme events. Across the six event types covered globally from 2010 to 2025, attributable direct economic losses averaged about US$90.8 billion a year, or about 41% of direct economic losses from disasters. Storms made the largest contribution. In China, about 27% of losses from the extreme events studied were attributable to anthropogenic climate change. Storms, droughts and floods were the main sources of direct climate losses. Losses for each event type varied considerably across years, regions and sectors.

Both absolute losses and relative burdens matter when comparing countries and regions. Some large economies bear high absolute losses, while losses in some small island and developing economies account for a greater share of their economies. These findings help explain the value of mitigation in avoiding future losses and identify priority regions, people and assets for adaptation. Adaptation resources should reflect the main hazards, the burden of losses and the capacity to respond, with particular attention to economies facing heavy relative burdens and limited resources.

The findings depend on disaster records, the coverage of attribution studies and methodological assumptions. Estimates for some regions rely on a small number of studies and on applying their findings more broadly. The estimates also exclude impacts on health and labor productivity. Besides, economic shocks can spread through supply chains and trade to regions and sectors outside the disaster area. Chapter 3 examines these indirect losses.

Chapter 3. Indirect climate losses from extreme events and their transmission through supply chains

The economic effects of extreme events extend beyond damaged assets and lost production in disaster areas. Affected sectors influence other sectors and regions through supply chains and interregional trade. Firms and regions outside the disaster area can therefore bear indirect losses. Identifying these links helps extend adaptation from protecting individual people or assets to managing risks in key supply chains and across regions.

Building on the attribution results in Chapter 2, this chapter converts attributable disaster losses into initial shocks to the economy and uses input-output relationships to estimate the indirect losses that follow. The global analysis covers droughts, floods and storms from 2010 to 2025. The China analysis covers droughts, floods, storms and cold waves from 2012 to 2022. The chapter first compares the size and sectoral distribution of global direct and indirect losses. It then examines how losses from domestic disasters spread across Chinese sectors and provinces and how overseas disasters cause indirect losses in China through supply chains.

Box 2. From asset damage to indirect losses through supply chains

Extreme events damage assets and affect production over time. To assess how these impacts spread through supply chains, this report draws on previous research and distinguishes three types of impact.

Direct damages are physical damage to buildings, equipment and infrastructure. They represent losses of capital stock, a measure commonly used in disaster statistics and for attributable losses in Chapter 2.

Direct economic flow losses are reductions in output over a given period in directly affected sectors. Examples include production stoppages due to damaged equipment and lower farm output due to drought. The input-output analysis in this chapter uses this measure for direct losses.

Indirect economic flow losses (higher-order effects) are further reductions in output as the initial shock spreads through sector links and regional trade. They can occur both within and outside the disaster area.

Direct and indirect flow losses over the same accounting period can be added. Asset damage is recorded separately. For example, if RMB100 million in equipment damage reduces direct output by RMB20 million in one year and causes a further RMB10 million in indirect output losses, the combined output loss for that year is RMB30 million.

Reference: Okuyama, Y. & Santos, J. R. (2014). Disaster Impact and Input–Output Analysis. Economic Systems Research, 26(1), 1–12.

3.1 Size and distribution of direct and indirect climate losses worldwide

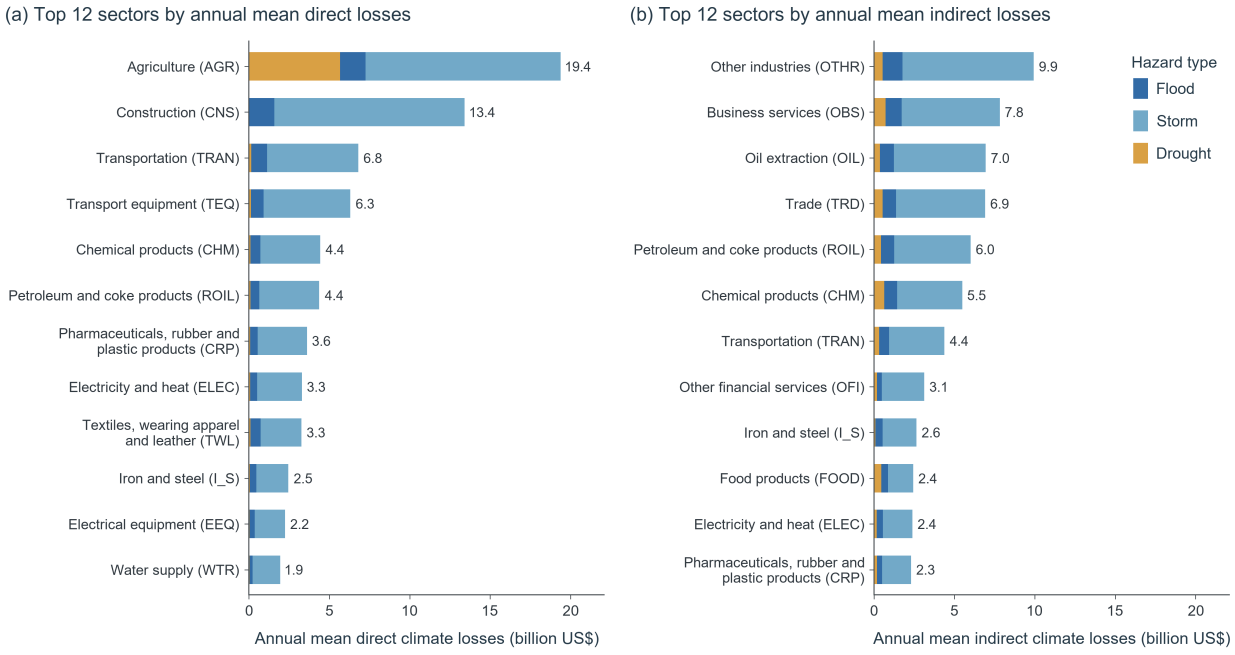


Figure 5. Global direct and indirect climate losses from extreme events by sector

Note. Panels (a) and (b) show the 12 sectors with the highest average annual attributable direct and indirect losses, respectively, from droughts, floods and storms from 2010 to 2025. They cover 93.2% of direct losses and 72.8% of indirect losses. Numbers give the average annual total across the three event types for each sector. Direct and indirect losses averaged about US$159.7 billion a year worldwide, with indirect losses accounting for about 52%. Direct losses were concentrated in sectors such as agriculture, construction and transport. Indirect losses also fell heavily on other industry, business services, oil extraction and trade.

Links between sectors spread the economic impacts of extreme events beyond those directly affected. An input-output analysis covering 141 regions and 33 sectors estimates that attributable direct and indirect losses from droughts, floods and storms averaged about US$159.7 billion a year from 2010 to 2025. Indirect losses accounted for 52%, exceeding direct losses under the flow-based approach used in this chapter. Considering only directly affected sectors would therefore leave out substantial losses transmitted through supply chains.

Under the broad industry classification, a few sectors accounted for most losses. Manufacturing accounted for 34% of combined direct and indirect losses, agriculture for 13%, and construction and transport for 9% each. Together, these four industries accounted for about 65%. The distribution of direct losses was different. Manufacturing accounted for 39%

and agriculture for 25%. Agriculture, construction, and transport together accounted for more than half of direct losses. Agriculture's higher share of direct losses than of combined losses shows how including supply-chain effects changes the distribution across sectors.

Indirect losses reached a wider range of sectors. Manufacturing, which faced both direct shocks and supply-chain impacts, accounted for 30% of all indirect losses. Under the sector allocation used in this report, industries such as finance and real estate were outside the directly affected sectors but still suffered average annual indirect losses of about US$4.15 billion, or about 5% of all indirect losses. Direct exposure alone therefore gives an incomplete picture of a sector's climate losses.

Loss patterns also varied by income group. The ratio of direct to indirect losses was about 1.5 in low-income economies and 1.3 in lower-middle-income economies, where direct losses were larger. The ratio was about 0.68 in upper-middle-income economies, where indirect losses were larger, and about 0.96 in high-income economies, where the two were similar. Manufacturing accounted for about 35% to 41% of total losses in the middle- and high-income groups. Mining accounted for a relatively large share of indirect losses in low-income economies, while finance, real estate and business services accounted for larger shares in high-income economies.

India, the Association of Southeast Asian Nations (ASEAN) and small island developing states (SIDS) illustrate the differences across sectors. Agriculture accounted for 51% of drought losses in India and 59% in ASEAN. Other major sectors affected by domestic disasters in India included construction, petroleum refining and coking, electricity, transport and trade. In ASEAN they included construction, textiles, chemicals, transport and petrochemicals. In SIDS, local losses were concentrated in transport, construction, oil and petrochemicals, and electricity.

Overall, including indirect impacts roughly doubles estimated climate losses and changes how they are distributed across sectors and regions. Adaptation should therefore address both directly affected sectors and those that bear losses through economic links.

3.2 Direct and indirect climate losses from domestic extreme events in China

Under the flow-based approach used in this chapter, annual attributable direct and indirect climate losses from floods, storms, droughts and cold waves in China averaged about RMB171.4 billion from 2012 to 2022. Direct losses were about RMB81.8 billion and indirect losses about RMB89.6 billion. Indirect losses accounted for about 52% of the total, showing that supply-chain effects substantially increased the economic losses from extreme events in China.

Average annual direct and indirect losses were RMB18.1 billion and RMB23.5 billion for floods, and RMB48.6 billion and RMB56.6 billion for storms, respectively. The loss multiplier, calculated as combined losses divided by direct losses, was about 2.3 for floods and 2.2 for storms. Both event types directly affected many sectors, particularly capital-intensive manufacturing with its close links to suppliers and customers. Droughts caused about RMB26.0 billion in direct losses and RMB21.0 billion in indirect losses, giving a multiplier of about 1.8. Drought losses fell mainly on agriculture, whose links to suppliers in other industries are relatively stable. The indirect impacts of an initial shock thus varied by event type.

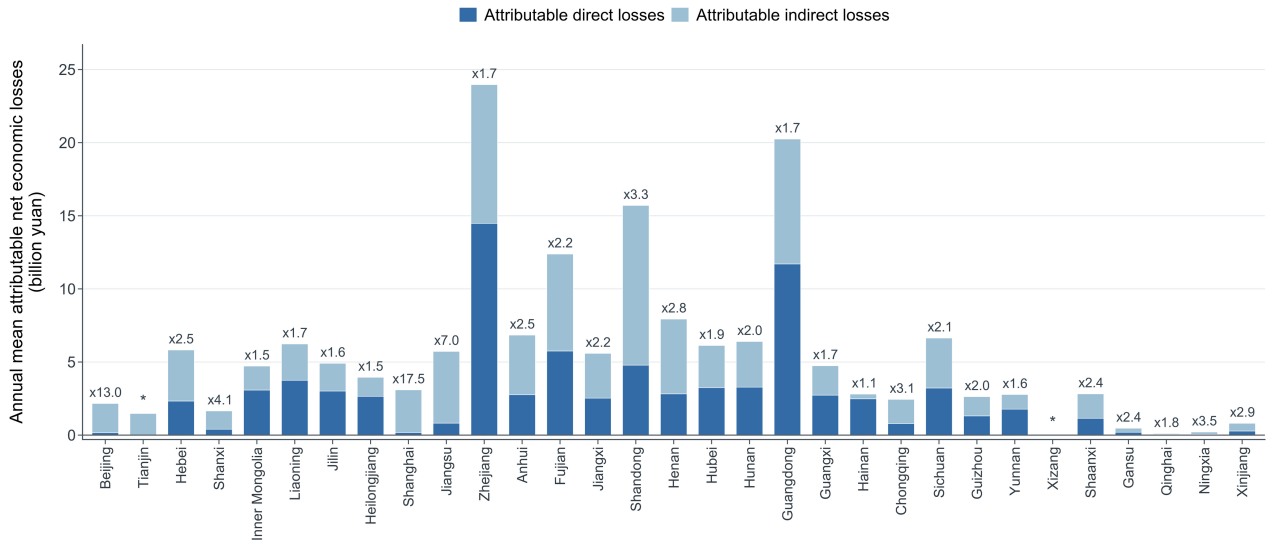


Figure 6. Average annual direct and indirect climate losses from extreme events by province in China

Note. The figure shows average annual attributable direct and indirect losses for 31 provincial-level regions from 2012 to 2022. Data availability limits coverage to regions other than the Hong Kong and Macao Special Administrative Regions and Taiwan Province. Numbers above the bars show the loss multiplier, calculated as the sum of direct and indirect losses divided by direct losses for the year. An asterisk (*) marks cases without a displayed multiplier. In Tianjin, almost all attributable losses were indirect effects transmitted through supply chains. In Tibet, cold waves drove direct losses, and losses were small once indirect losses were included. National attributable losses totaled about RMB171.4 billion a year, of which RMB89.6 billion

(52%) was indirect. Multipliers were highest in developed regions where services dominate. Apart from Tianjin, the multipliers were 17.5 in Shanghai, 13.0 in Beijing and 7.0 in Jiangsu. Hainan had the lowest multiplier and mainly direct losses.

Manufacturing accounted for 60.6% of all indirect losses, averaging about RMB54.3 billion a year. Once indirect losses were included, agriculture's share fell to 45.6% of total drought losses and 22.7% of combined economic losses across all event types. Compared with the distribution of direct losses, supply-chain effects spread more losses to other sectors. Electricity and gas accounted for 6.8% of indirect losses, transport for 6.8%, wholesale and retail for 6.0%, finance and real estate for 5.7%, and mining for 4.9%. Finance, real estate, wholesale and retail, and business services together bore about RMB13.9 billion in indirect losses annually, or about 15.4% of all indirect losses. These results illustrate the effects on economic activity outside the sectors initially hit.

Zhejiang, Guangdong and Shandong had the highest combined direct and indirect climate losses, averaging about RMB24.0 billion, RMB20.2 billion and RMB15.7 billion a year, respectively. Water infrastructure and transport were especially affected in Zhejiang and Guangdong, and agriculture in Shandong. Indirect losses dominated in Beijing, Shanghai, Tianjin and Jiangsu, where direct losses accounted for about 0.3% to 14.3% of the respective totals. In Beijing, indirect impacts fell mainly on manufacturing and electricity. In Shanghai they affected manufacturing, finance, transport and business services, among others. Direct losses dominated in Hainan, Heilongjiang, Jilin and Yunnan, generally accounting for more than 60% and reaching almost 90% in Hainan.

Geographic patterns also differed by event type. Drought losses mainly affected Inner Mongolia, the three northeastern provinces (Liaoning, Jilin, and Heilongjiang), Shanxi, Shandong, Henan and Hubei, among other areas. Agriculture was the main sector directly affected. The 11 provinces and municipalities of the Yangtze River Economic Belt accounted for 53.5% of China's direct flood losses, and nine of them accounted for 88.0% of the belt's direct flood losses. Direct climate losses from floods in Sichuan's water infrastructure averaged about RMB560 million a year, while manufacturing losses were more prominent in some provinces along the middle reaches. Storm losses were mainly coastal. Zhejiang, Guangdong and Fujian together accounted for 63.7% of national direct storm losses, averaging about RMB14.1 billion, RMB11.7 billion and RMB5.3 billion a year, respectively. Shandong, Hainan and Guangxi were also heavily affected. The provincial and sectoral patterns together identify the main assets and activities at risk in each region and the impacts transmitted through supply chains.

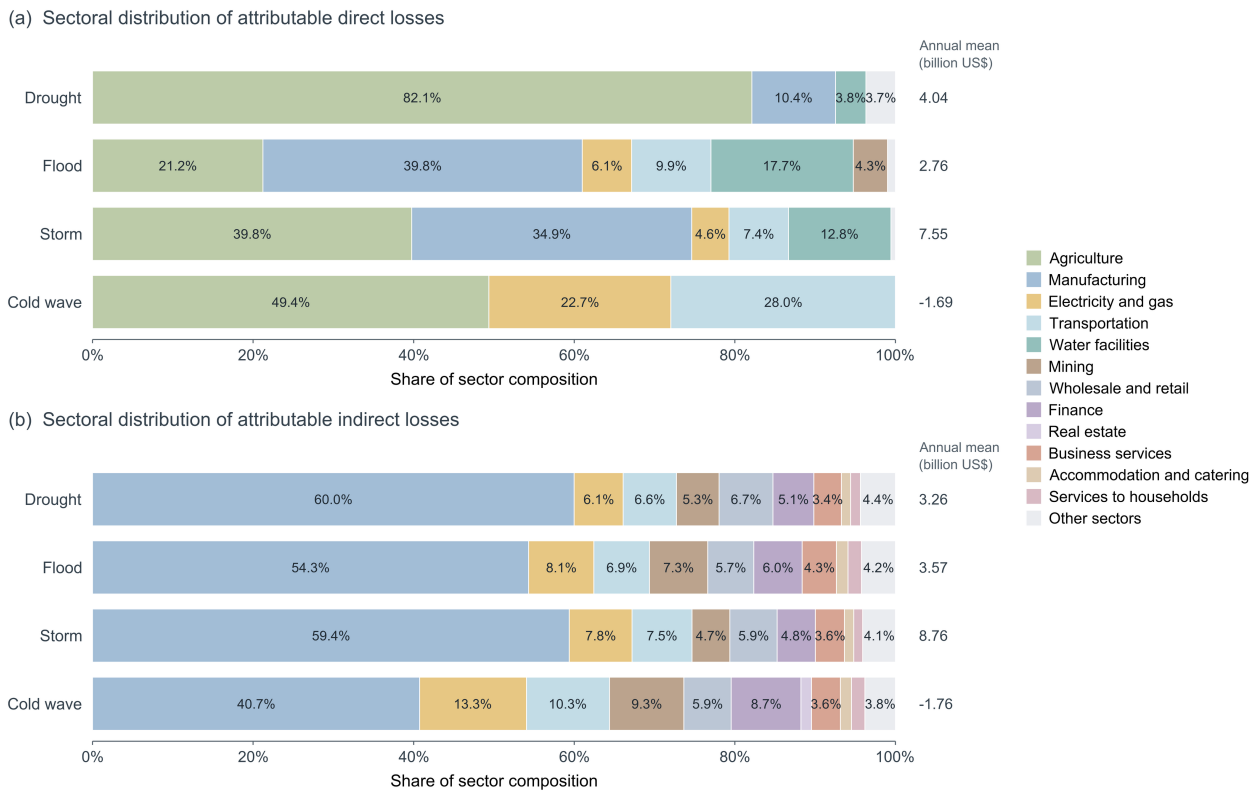


Figure 7. Sector shares of direct and indirect climate losses from extreme events in China

Note. Panels (a) and (b) show sector shares of attributable direct and indirect losses, respectively, for four event types from 2012 to 2022. Average annual amounts are on the right. Economic losses from cold waves were lower than in a scenario without anthropogenic climate change, giving negative attributable losses. Agriculture suffered high direct losses, while floods and storms also had major direct impacts on manufacturing. Indirect losses were concentrated in manufacturing.

Domestic adaptation in China should consider both direct exposure and the links through which impacts spread. Alongside protection for agriculture, manufacturing and infrastructure, risk management should cover key production inputs, transport and service links. Stronger coordination across provinces can reduce the effects of local disasters on economic activity elsewhere.

3.3 Indirect climate losses in China from extreme events abroad

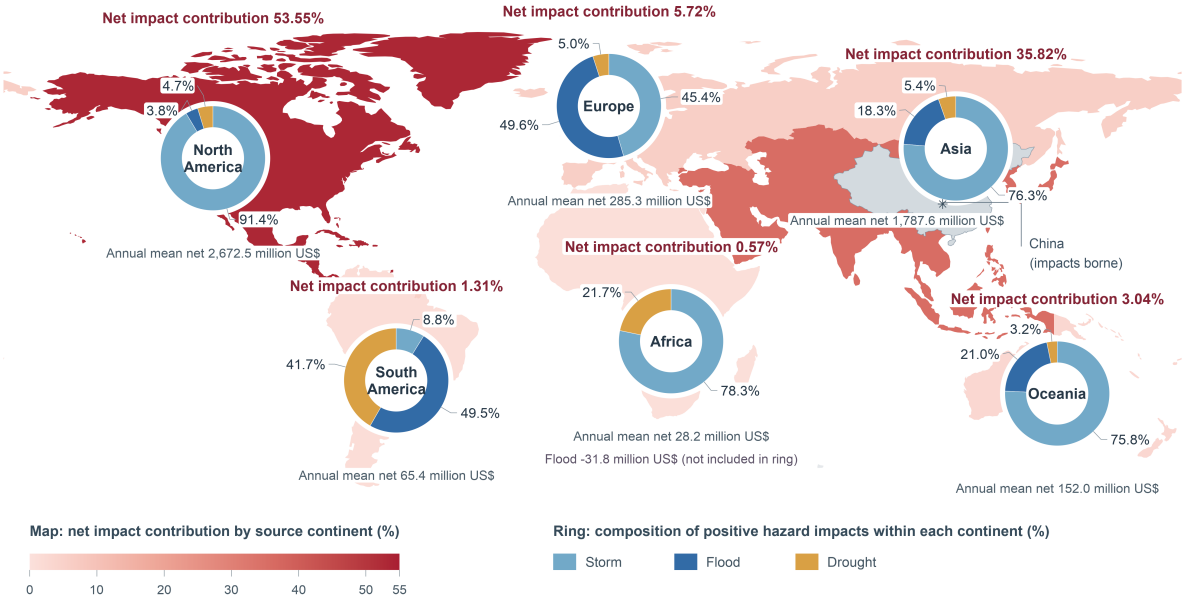


Figure 8. Indirect climate losses in China from extreme events abroad

Note. The map shows indirect climate losses in China from extreme events on six continents. Darker red indicates a larger contribution to the global net impact. Ring charts show the shares of positive impacts from storms, floods and droughts on each continent. Storms generally dominated, accounting for 91.4% of positive impacts from North America, 76.3% from Asia and 75.8% from Oceania. In South America, floods (49.5%) and droughts (41.7%) dominated. In Europe, floods (49.6%) slightly exceeded storms (45.4%). Based on limited attribution evidence, attributable flood losses for Africa as a whole were negative and are shown separately.

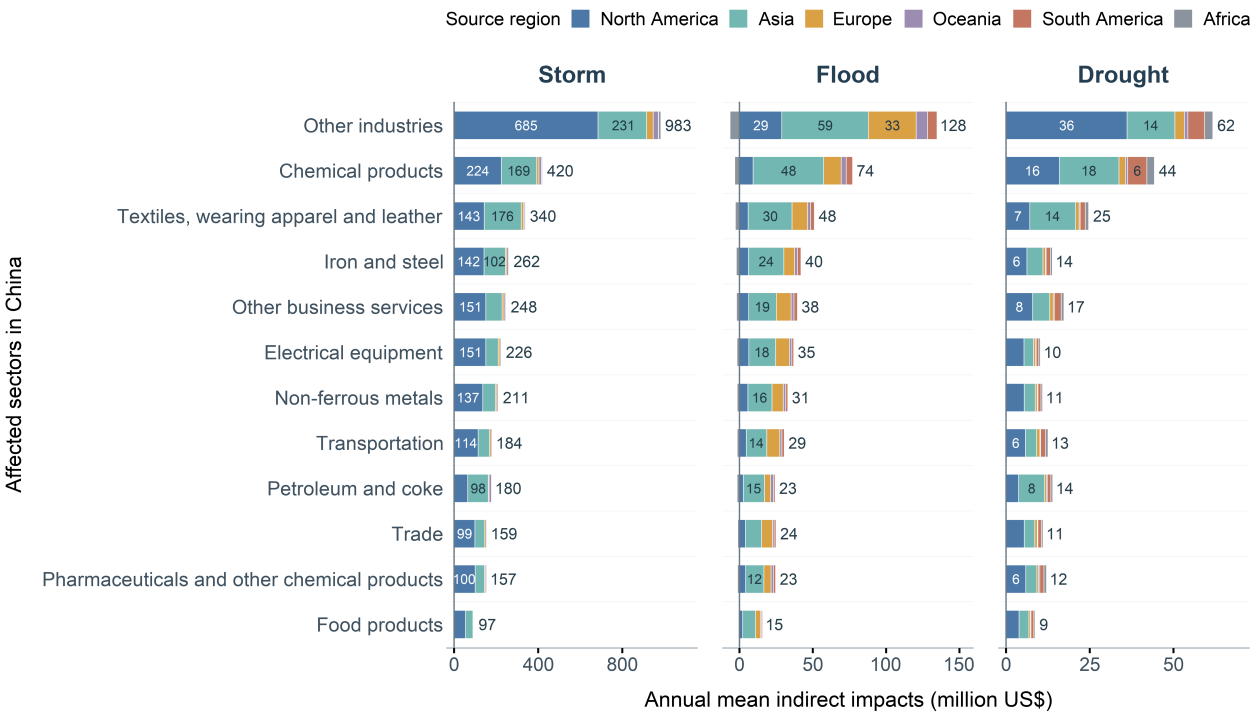


Figure 9. Indirect climate losses in China by source region, event type and affected sector

Note. The main chart shows the 12 Chinese sectors with the largest combined average annual net impacts from three event types across six source continents from 2010 to 2025. They accounted for 84.5% of the net impact across all 33 sectors. The three columns show storms, floods and droughts. Colored segments distinguish source continents. Storms in North America and Asia were the main sources of impact.

Extreme events abroad also caused indirect climate losses in China. Under the global input-output framework, droughts, floods and storms abroad caused average annual indirect climate losses of about US$4.99 billion in China from 2010 to 2025. This was about 20% of China's combined direct and indirect climate losses under this accounting approach. Storms accounted for 82.2%, floods for 12.1% and droughts for 5.7%.

North America and Asia together accounted for nearly 90% of China's indirect climate losses from overseas events, contributing 53.5% and 35.8%, respectively. North American storms caused about US$2.44 billion in average annual indirect losses and Asian storms about US$1.36 billion, making these the two largest sources. Europe accounted for 5.7% of indirect losses from abroad and Oceania for about 3.0%. Africa and South America together accounted for less than 2%. The effects of overseas disasters on China were thus concentrated in a few source regions and event types.

Losses in China fell mainly on manufacturing and related sectors. Average annual indirect losses were about US$1.17 billion in “other industry,” US$540 million in chemicals, US$410 million in textiles, US$320 million in iron and steel and US$270 million in electrical equipment

manufacturing. Chemicals, textiles and iron and steel together accounted for 25.4% of indirect losses from abroad. Services were also affected through supply chains. Business services, for example, suffered average annual indirect losses of US$303 million.

The sectors affected depended on where the disaster occurred. North American and Asian storms caused average annual indirect losses of about US$224 million and US$169 million, respectively, in China's chemical industry. Together they accounted for 73.1% of that industry's indirect losses from abroad. Asian storms also had a marked impact on China's petroleum refining and coking sector. Textiles accounted for 9.2% of indirect losses in China from Asian floods and 12.9% from Asian storms. Iron and steel were also affected. Agriculture, construction and services accounted for smaller shares of overseas indirect losses in this assessment.

Typhoon Hagibis happened in Japan in 2019, illustrates how these links work. Li and Otto (2022) estimated that about US$4 billion, or 40%, of roughly US$10 billion in insured losses was attributable to anthropogenic climate change. This report allocates the attributable losses across Japanese sectors and uses input-output relationships to model indirect impacts on China. The initial shock to Japanese transport reached China along several paths. One passed through Japan's petroleum refining and coking sector to China's transport and petroleum refining and coking sectors. Another passed through Japanese business services to other manufacturing, electrical equipment and textiles in China. Subsequent changes in Japanese storage and postal services, transport and trade had further effects through successive rounds of economic links. The specific links through which an overseas disaster spreads therefore shape the indirect losses each sector bears.

China's adaptation efforts should address both domestic disasters and risks transmitted from abroad. Analysis of climate risks to key industries, suppliers and logistics nodes should include major trading partners and the sectors linking them. Business risk management, coordination across regions and international cooperation on adaptation can help reduce the effects of overseas disasters on domestic production.

3.4 Main findings and implications

Supply chains spread the economic effects of extreme events beyond the sectors directly affected and change the distribution of losses across sectors and regions. From 2010 to 2025, direct and indirect climate losses from droughts, floods and storms averaged about US$159.7 billion a year worldwide, of which 52% was indirect. Manufacturing faced both direct shocks and large indirect losses. Finance, real estate and business services were also affected through supply chains.

The China analysis shows how domestic disaster losses spread and how overseas events create risks at home. From 2012 to 2022, four types of domestic extreme events caused

average annual indirect climate losses of about RMB89.6 billion, of which manufacturing accounted for 60.6%. The balance of direct and indirect losses differed markedly across provinces. From 2010 to 2025, overseas extreme events caused average annual indirect climate losses of about US$4.99 billion in China. Storms accounted for 82.2%, with North America and Asia the main sources. China's climate risk management should therefore consider domestic exposure, supply chains across provinces and economic links with other countries.

Identifying indirect losses gives a fuller measure of the future economic impacts that mitigation can avoid and helps broaden adaptation priorities. Alongside protecting agriculture, manufacturing and infrastructure, risk management should cover key production inputs, logistics nodes and related services. Building business resilience, coordinating across regions and cooperating internationally on adaptation can reduce the impact of local disasters on wider economic activity.

Chapter 4. Who is responsible for climate losses?

Chapters 2 and 3 examine losses from extreme events attributable to anthropogenic climate change and the indirect losses that arise as economic shocks spread through supply chains to other sectors and regions. Direct and indirect losses from extreme events capture only part of climate losses. A broader set of impact channels is needed to examine how losses have built up over time and how they are distributed across countries. This chapter covers agriculture, energy, health and sea level rise. It assesses the cumulative climate losses by 2022 caused by historical emissions from 175 economies from 1850 to 2022. Bilateral accounting identifies where losses occurred and where the emissions originated. The estimates include adverse impacts as well as gains that some economies may experience. Reported cumulative losses are net of these gains. Linking historical emissions to losses across countries provides a quantitative basis for mitigation, investment in adaptation and international climate cooperation.

4.1 Long-term climate losses from historical emissions

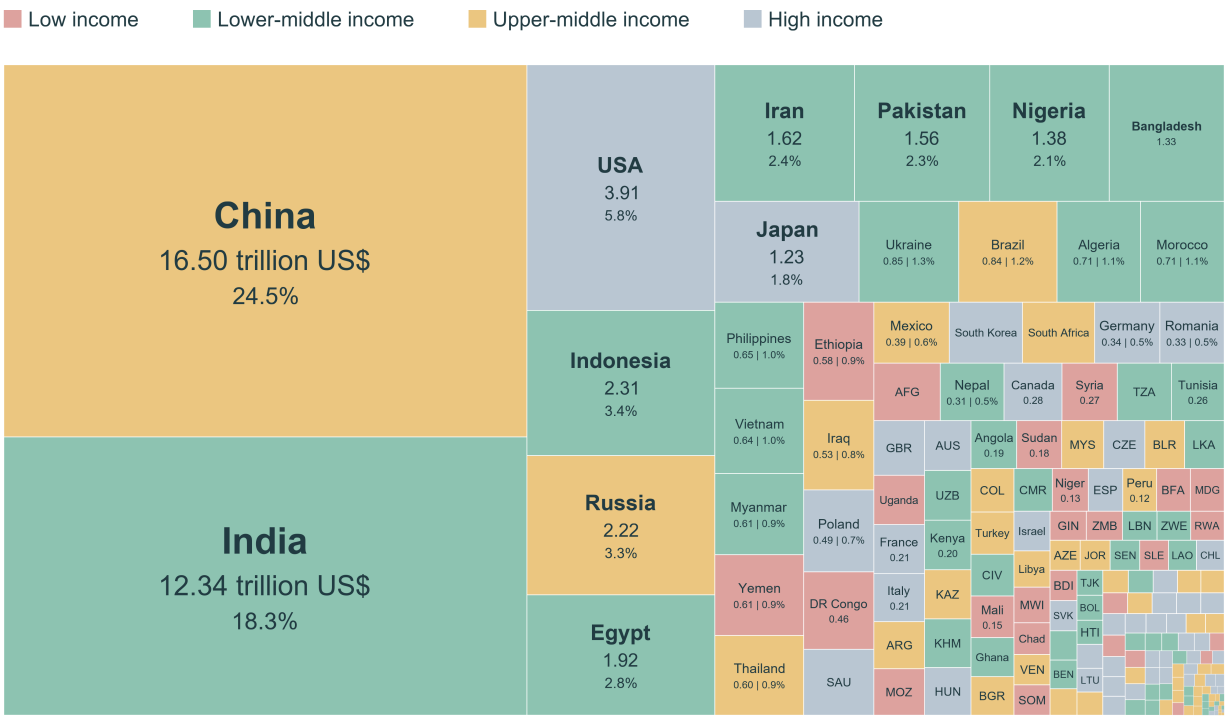


Figure 10. Cumulative climate losses borne by country

Note. The area of each rectangle represents the cumulative climate losses borne by an economy. Colors indicate income groups. The estimates cover the cumulative impacts of historical emissions from 1850 to 2022 on agriculture, energy, health and sea level rise over the same period. Amounts are in 2022 prices and

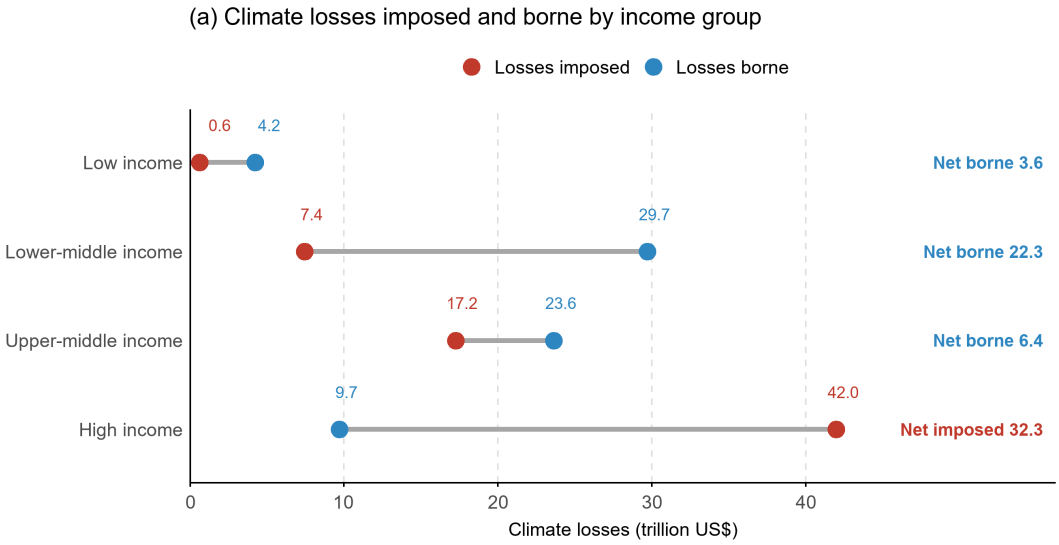
are expressed as 2022 present values. Percentages show shares of global losses. The technical annex describes the income groups and discounting method.

The climate impacts of historical emissions persist for many years, and losses build up over time. This report estimates that national emissions from 1850 to 2022 caused cumulative losses of about US$67.27 trillion through agriculture, energy, health and sea level rise during that period. This estimate covers impacts already experienced through 2022. Historical emissions will continue to cause losses after 2022, which fall outside this estimate. Annual losses are measured at 2022 prices and converted to their 2022 present values.

China and India bore the largest cumulative losses, about US$16.50 trillion and US$12.34 trillion, respectively. Their shares of global losses were 24.5% and 18.3%, together exceeding 40%. The United States bore about US$3.91 trillion (5.8%). Next were Indonesia (US$2.31 trillion, 3.4%), Russia (US$2.22 trillion, 3.3%), Egypt (US$1.92 trillion, 2.8%), Iran (US$1.62 trillion, 2.4%), Pakistan (US$1.56 trillion, 2.3%), Nigeria (US$1.38 trillion, 2.1%) and Bangladesh (US$1.33 trillion, 2.0%). Together, these ten economies bore about 67% of global losses, showing how heavily cumulative losses were concentrated in a few countries (Figure 10).

Lower-middle-income economies bore 44.2% of global losses and upper-middle-income economies 35.1%, together accounting for almost 80%. High-income economies bore 14.4% and low-income economies 6.3%. Under the income classification used here, economies outside the high-income group bore about 85.6% of losses.

4.2 Which countries impose or bear net climate losses?



(b) Major net imposers and major net bearers of climate losses

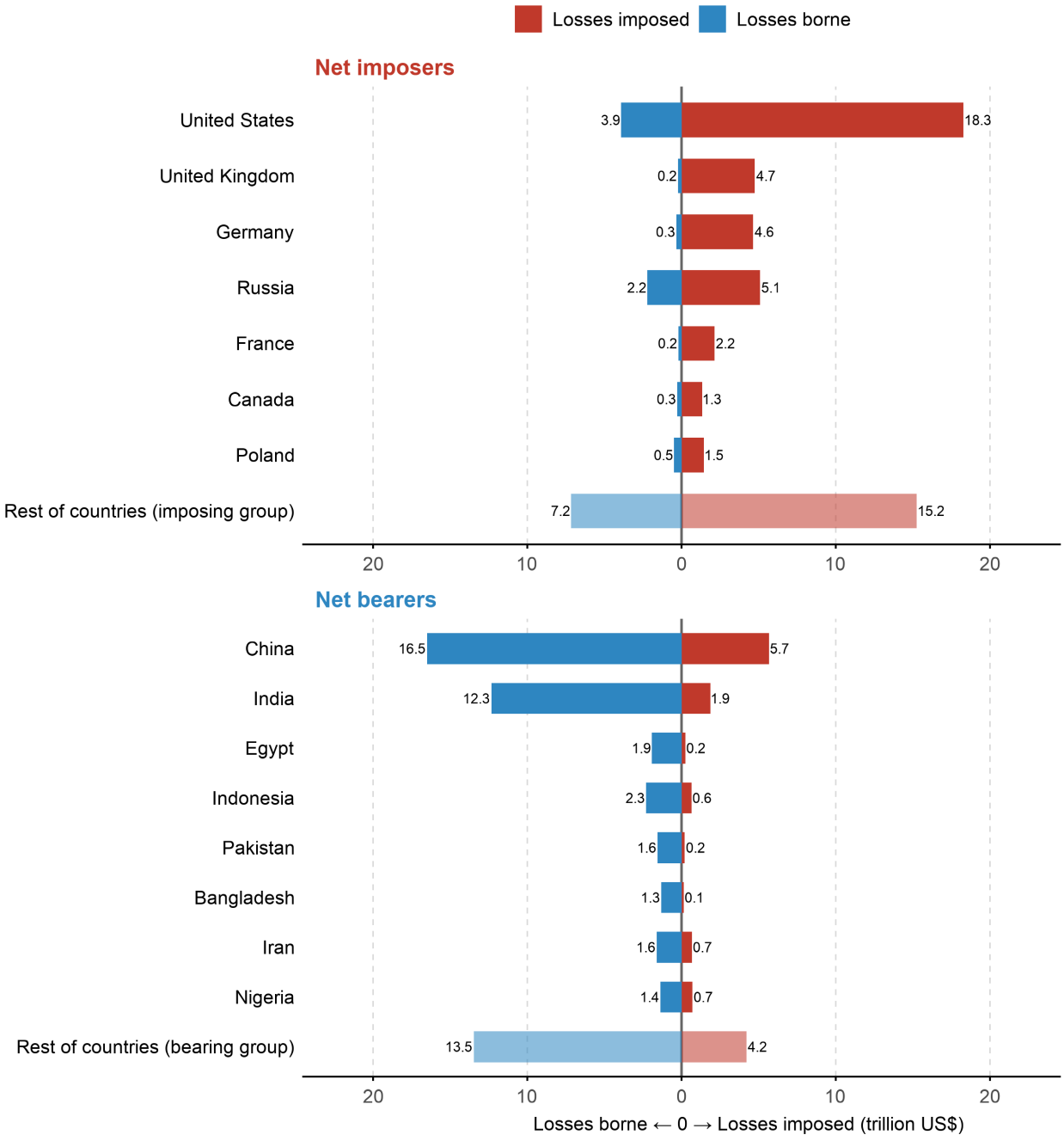


Figure 11. Climate losses caused and borne by income groups (a) and by countries (b)

Note. (a) For each income group, the figure compares cumulative climate losses caused by its historical emissions with the cumulative losses it bore. (b) The main economies that imposed or bore net losses. An economy imposes net losses if its emissions cause greater losses abroad than it bears from foreign emissions. It bears net losses if the reverse is true. The amounts shown include the domestic impacts of each economy's own emissions.

Emissions and losses can occur in different places. A country's emissions affect its own economy and can cause losses abroad. The country also bears impacts from foreign emissions and indirect effects transmitted from other countries. In this report, a country "imposes net losses" if its emissions cause greater losses in other countries than it bears from foreign emissions. A country "bears net losses" if it suffers greater losses from foreign emissions than its own emissions cause abroad. It shows the link between national historical emissions and the burden of cross-border losses (Figure 11), without determining legal liability.

The countries that imposed net losses were mainly high-emitting economies that industrialized early. Cross-border losses caused by the United States exceeded those it bore by about US$14.4 trillion, the largest net amount. The corresponding amount for the 27 EU member states combined was about US$10.8 trillion. The United Kingdom, Russia and Canada imposed net losses of about US$4.5 trillion, US$2.9 trillion and US$1.0 trillion, respectively. Oil-producing countries including Saudi Arabia, the United Arab Emirates and Qatar also imposed net losses. Eight of the ten countries that imposed the largest net losses were OECD members.

Countries bearing net losses were mainly developing countries. India and China bore the largest net losses. In Egypt, Indonesia and Pakistan, among others, losses borne also exceeded those their own emissions caused abroad. The vast majority of African countries and small island states likewise bore net losses. Many countries therefore face climate losses driven mainly by emissions from abroad while also meeting their own development and adaptation needs.

Countries that imposed net losses caused about US$42.0 trillion in cumulative losses in countries that bore net losses. Losses in the reverse direction totaled about US$3.5 trillion. The difference of about US$38.5 trillion measures the net cross-border loss burden between the two groups. The United States accounted for about 37.7% of total net losses imposed, the EU for 28.4%, other OECD members together for 18.9%, and Russia for 8.5%. Of total net losses borne, India accounted for 27.5%, China for 28.5% and the remaining countries together for about 44.1%.

International climate finance remains limited relative to these losses. The new collective quantified goal on climate finance, agreed in 2024, calls for developed countries to take the lead in providing and mobilizing at least US$300 billion annually for developing countries by 2035, to support mitigation, adaptation and other climate action. The Fund for responding to Loss and Damage aims to help developing countries that are particularly vulnerable to the adverse effects of climate change respond to economic and non-economic loss and damage. A large gap remains between available funding and the needs reflected in project applications. By the end of July 2026, the Fund had received pledges of about US$823 million, of which

about US$486 million had been paid. Applications entering the first project pipeline requested US$2.8 billion, far exceeding the US$342 million available for allocation at the time.

These results show a marked imbalance between the losses countries' historical emissions caused abroad and the losses those countries bore. Linking emission sources to loss burdens gives international climate cooperation a more specific basis for action. Given the large cross-border losses caused by their historical emissions, developed countries should step up mitigation to reduce future losses and provide finance, technology and capacity-building support to help developing countries adapt, improve early warning systems and strengthen risk management. Developing countries that bear net climate losses, particularly economies with heavy burdens and limited capacity to adapt, should receive sustained and increased international support to cope with climate shocks and reduce future losses.

4.3 Which countries' emissions caused climate losses in China

China bore net cross-border climate losses. For historical emissions from 1850 to 2022 and their cumulative impacts over the same period, China bore about US$15.14 trillion in climate losses from other countries' emissions. After accounting for the impacts of its own emissions abroad, China bore net cross-border losses of about US$10.83 trillion. Historical emissions from major developed economies were an important source. US emissions caused about US$4.54 trillion in cumulative losses in China, or 30.0% of all cross-border losses China bore. Emissions from the EU's 27 member states and other OECD members caused about US$3.34 trillion (22.1%) and US$2.60 trillion (17.2%), respectively. Together, these economies caused about US$10.48 trillion in losses in China, or about 69% of the cross-border losses it bore. Their historical emissions have therefore caused substantial cumulative losses to China's economic development and people's livelihoods.

While bearing net climate losses and facing the adverse impacts of climate change, China continues to pursue its own sustainable development goals. It is working to peak carbon emissions and achieve carbon neutrality, improve its energy mix, shift industry towards greener and lower-carbon production, and strengthen adaptation and risk management. China is cutting greenhouse gas emissions while investing in responses to climate impacts to protect development and livelihoods, pursuing mitigation and adaptation together. The net losses borne by China and other developing countries, and the sources of the emissions that caused them, help explain their needs and positions in international climate governance. International cooperation should give greater weight to developing countries' loss burdens and adaptation needs. Alongside stronger global mitigation, cooperation on finance, technology and capacity building should support climate-resilient development and reduce future losses. Major developed countries need to deliver their mitigation commitments faster to limit additional losses from continued emissions and increase support for adaptation and responses to loss and damage in developing countries.

4.4 Main findings and implications

Historical emissions cause long-lasting climate losses that are unevenly distributed across countries. For agriculture, energy, health and sea level rise, emissions from 1850 to 2022 caused cumulative losses by 2022 of about US$67.27 trillion. Developing economies bore about 85%. All amounts are measured at 2022 prices and expressed as 2022 present values.

The losses countries caused differed sharply from the losses they bore. The cumulative net difference between the two groups of countries was about US$38.5 trillion. The United States and the EU together accounted for more than 60% of total net losses imposed. China bore about US$10.83 trillion in net cross-border climate losses, with historical emissions from major developed economies an important source. These results provide quantitative evidence on responsibility for historical emissions and the loss burden borne by developing countries.

Historical emissions have already caused losses and will continue to affect national development. This makes the gap between finance and the burden of losses especially clear. By the end of July 2026, pledges to the Fund for responding to Loss and Damage totaled only about US$823 million. These figures highlight the urgent need to expand dedicated finance for loss and damage and turn pledges into payments.

Looking ahead to COP31, international cooperation should turn mitigation and finance commitments into action under the principle of common but differentiated responsibilities. Developed countries should increase mitigation efforts, set a timetable and a clear path to the climate finance goal of at least US$300 billion annually by 2035, and increase support for adaptation and responses to loss and damage in developing countries. China also needs to continue mitigation and adaptation, build domestic climate resilience and work with other countries to reduce future losses. Connecting historical responsibility and actual losses with support for action can help global climate governance serve countries' sustainable development more effectively.

Chapter 5. Main findings and recommendations for action

Assessing climate losses provides a benchamrk for setting priorities, allocating resources and measuring policy outcomes. This report starts with losses from extreme events that have already occurred, traces indirect impacts through supply chains and assesses the long-term losses caused by historical emissions and their distribution across countries. The analysis identifies current loss burdens and provides evidence to guide efforts to reduce future losses, strengthen climate resilience and foster international cooperation.

The report has three main findings.

First, anthropogenic climate change has already caused substantial economic losses from extreme events. Across the six event types assessed globally from 2010 to 2025, attributable direct economic losses averaged about US$90.8 billion a year, or about 41% of direct economic losses from disasters. Storms made the largest contribution. For the four event types assessed in China from 2012 to 2022, attributable direct economic losses averaged about RMB81.8 billion a year, or about 27.2%. The economic impacts of climate change are already a burden that requires a sustained response.

Second, supply chain transmission increases climate losses and extends them beyond the regions and sectors directly affected. Under flow-based accounting, global direct and indirect climate losses from droughts, floods and storms averaged about US$159.7 billion a year from 2010 to 2025. Indirect losses accounted for 52%. In China, domestic extreme events caused average annual indirect climate losses of about RMB89.6 billion from 2012 to 2022. Under global input-output accounting, extreme events abroad caused average annual indirect losses of about US$4.99 billion in China from 2010 to 2025. Climate risk management should therefore consider local exposure, regional economic links and cross-border supply chains together.

Third, countries differ markedly in the balance between the climate losses their historical emissions have caused abroad and the losses they have suffered from other countries' historical emissions. In terms of agriculture, energy, health and sea level rise impacts, emissions from 1850 to 2022 caused cumulative global climate losses of about US$67.27 trillion over that period. Developing economies bore about 85%. Historical emissions from developed economies, including the United States and the EU, caused far greater losses abroad than those economies bore from other countries' historical emissions. Together they imposed about US$38.5 trillion in net losses abroad. Developing countries such as China and India bore far greater losses from other countries' historical emissions than their own emissions caused abroad. China and India bore about US$10.83 trillion and US$10.46 trillion in net cross-border climate losses, respectively. International climate cooperation should take full account of the burdens borne by developing countries, strengthen global mitigation and

expand support for adaptation and loss reduction through finance, technology and capacity building.

Data, methods and coverage still limit the assessment. Disaster records have gaps across countries, event types and years, and some affected areas and loss types are poorly documented. Uncertainty remains in extreme event attribution and the losses estimated from it. Estimates of the long-term impacts of historical emissions also depend on development scenarios, discount rates and model assumptions. Chapter 4 covers agriculture, energy, health and sea level rise. Its coverage of other economic and non-economic losses is incomplete, and it does not systematically assess the potentially catastrophic losses from crossing climate tipping points and the chain of impacts that could follow. The results therefore give estimates within the available data and the stated scope. Climate change poses a wider range of losses and risks.

For COP31 and future climate action, the report makes five recommendations.

First, deliver on mitigation commitments to protect long-term development gains from climate losses. The lasting impacts of historical emissions show that delaying mitigation will increase future losses.[19] COP31 should encourage all parties to translate their nationally determined contributions into concrete action in energy, industry, infrastructure and other areas. Developed countries should strengthen mitigation in light of their responsibility for historical emissions. Future policy assessments should compare the losses to economies, health and livelihoods that different mitigation pathways can avoid, so that growing climate losses do not erode countries' long-term development gains.[20,21]

Second, establish a clear roadmap for developed countries to meet climate finance goals and provide sustained and enhanced international support for developing countries. COP31 should encourage developed countries to specify the timetable, sources of finance and arrangements for reviewing progress towards the goal of at least US$300 billion annually by 2035. It should also advance the goal of increasing adaptation finance. For the Fund for responding to Loss and Damage, existing pledges should be provided promptly, further contributions secured, and the steps from application and approval to payment made more efficient. Support should give public finance and grants a greater role and make funding more predictable, so affected countries can recover and develop without adding to their climate loss burdens.

Third, use climate loss and risk assessments to guide domestic adaptation priorities and investment. Countries should set priorities and sequence adaptation measures according to their main hazards, affected sectors and regional differences. UNEP's Adaptation Gap Report 2025 estimates that developing countries will need about US$310 billion to US$365 billion a year for adaptation by 2035. International public adaptation finance to developing countries reached only about US$26 billion in 2023. Increasing investment in adaptation remains a long-

term task.[22] China should continue to give equal weight to mitigation and adaptation. It should incorporate climate loss and future risk assessments into development planning, major projects, and fiscal and financial decisions, with particular attention to resilience in agriculture, water management, transport, manufacturing and critical infrastructure.[23] Project selection should consider losses avoided, implementation costs and protection of livelihoods. The actual results of adaptation measures should be assessed over time.

Fourth, deepen regional and cross-border cooperation on adaptation to improve supply-chain resilience. Local and sectoral adaptation plans should identify direct shocks to key production sites, energy facilities and logistics nodes, along with the effects on their suppliers and customers. Regions should share early warnings and coordinate emergency response and recovery. Firms should consider climate risks at suppliers' locations when making business decisions and improve arrangements for securing key inputs and maintaining operations. Through South-South and regional cooperation, China can support early warning, resilient infrastructure and post-disaster recovery in line with the needs of trading partners and other developing countries. This can help partners reduce losses and make shared supply chains more stable.

Fifth, improve data and methods underpinning climate losses accounting to inform domestic climate action and international cooperation with a view to reduce losses. Countries and international organizations should strengthen disaster records, extreme event attribution and data on links between industries. They should progressively improve the assessment of losses affecting health, livelihoods and ecosystems, as well as other non-economic losses. Clearly stating the scope, methods and key assumptions will provide a body of evidence that can be updated over time.[24] Countries can use the results to explain their loss burdens, inform international discussions on cooperation and finance for loss reduction, and select domestic adaptation and international cooperation projects.

About the authors

Fei Teng is a professor, deputy director and doctoral supervisor at the Institute of Energy, Environment and Economy, Tsinghua University. He holds a bachelor's degree in engineering and master's and doctoral degrees in management science and engineering from Tsinghua University. He was a lead author of the Fifth and Sixth Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC). From 2007 to 2017, he took part in multilateral climate negotiations as a member of China's delegation. He also chaired the Consultative Group of Experts on Non-Annex I Parties under the United Nations Framework Convention on Climate Change. His research covers integrated assessment models, energy systems analysis, and global and domestic climate policy and governance. He has published nearly 100 papers in Chinese and international journals, including Science and Nature Climate Change.

Tianpeng Wang is an assistant research professor at the Institute of Energy, Environment and Economy, Tsinghua University. He holds a bachelor's degree in science and a doctorate in management from Tsinghua University and conducted joint research as a visiting scholar at the University of California, Berkeley. His research focuses on integrated assessment models, the economics of climate change, and energy and climate policy analysis.

Bowen Wang is a doctoral candidate at the Institute of Energy, Environment and Economy, Tsinghua University. She participated in the 2026 Young Scientists Summer Program at the International Institute for Applied Systems Analysis. Her research focuses on the attribution of extreme event impacts, climate losses and adaptation.

Jiyun Wang is an undergraduate student at the School of Ecology and Environment, Renmin University of China. She contributed to a key research project under China’s National High-End Think Tank Program in 2026. Her research focuses on the economics of climate change and global climate governance.

Acknowledgments and statement of responsibility

The authors thank Dr Yongxiang Zhang of the National Climate Center, Professor Minpeng Chen of Renmin University of China, Dr Xiang Gao of the National Center for Climate Change Strategy and International Cooperation, Professor Fanxu Zeng of the School of Journalism and Communication at Tsinghua University, Professor Jiutian Zhang of Beijing Normal University, and Ms Jiangwen Guo of Chatham House. Their review, comments and suggestions helped improve the report. The analysis, judgments and conclusions are the authors' own. They do not represent the positions of the authors' institutions, the reviewers or their institutions. The authors are responsible for any errors or omissions.

Glossary[1]

Climate change

A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. [25]

Climate extreme (extreme weather or climate event)

The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classified as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., high temperature, drought or heavy rainfall over a season). For simplicity, both extreme weather events and extreme climate events are referred to collectively as climate extremes. [4]

Disaster

A situation or event which overwhelms local capacity, necessitating a request to the national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction, and human suffering. [26]

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 (coastal flooding) and in lakes or reservoirs as well as ponding of water at or near the point where the rain fell (flash floods).

Storm

A broad category of hazardous weather events associated with intense atmospheric disturbances, including tropical cyclones, extra-tropical storms, thunderstorms, tornadoes, hail, sand or dust storms, winter storms, and storm surges. These events can cause damage through strong winds, precipitation, lightning, or coastal inundation.

Drought

An extended period of unusually low precipitation that produces a shortage of water for people, animals, and plants. Drought is not solely a physical phenomenon because its impacts can be exacerbated by human activities and water supply demands. Operational definitions of drought, i.e., the degree of precipitation reduction that constitutes a drought, vary by locality, climate, and environmental sector.

[1]Main references: IPCC AR6 WG2 glossary, EM-DAT document, UNFCCC

Heatwave

A period of abnormally hot and/or unusually humid weather. Typically, a heat wave lasts for two or more days. The exact temperature criteria for what constitutes a heat wave may vary by location.

Cold wave

A period of abnormally cold weather. Typically, a cold wave lasts for two or more days and may be aggravated by high winds. The exact temperature criteria for what constitutes a cold wave may vary by location.

Wildfire

Any uncontrolled and non-prescribed combustion or burning of plants in a natural setting such as a forest, grassland, brushland or tundra, which consumes natural fuels and spreads based on environmental conditions (e.g., wind, or topography). Wildfires can be triggered by lightning or human actions.

Hazard

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.

Exposure

The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Impact

The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/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 can be adverse or beneficial.

Risk

The potential for climate change to cause adverse consequences for human or ecological systems. Risk arises from interactions among climate-related hazards, exposure, and

vulnerability, and evolves with changes in climate, socioeconomic conditions, and response measures.

Adaptation

In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.

Attribution

Attribution is defined as the process of evaluating the relative contributions of multiple causal factors to a change or event with an assessment of confidence.

Extreme event attribution

The science of identifying and quantifying the role that human-caused climate change plays in the frequency, intensity, duration, and impacts of individual extreme weather events.

Impact attribution

The process of identifying and assessing the contribution of climate change to observed impacts on natural and human systems.

Loss and Damage, and losses and damages

Research has taken Loss and Damage (capitalised letters) to refer to political debate under the United Nations Framework Convention on Climate Change (UNFCCC) following the establishment of the Warsaw Mechanism on Loss and Damage in 2013, which is to 'address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change.' Lowercase letters (losses and damages) have been taken to refer broadly to harm from (observed) impacts and (projected) risks and can be economic or non-economic.

Direct damages

Physical destruction of capital assets—such as buildings, infrastructure, and machinery.

Direct losses

Impairment of the capacity of affected sectors to produce and consume, caused by stock damage.

Indirect losses

Direct losses propagate through input–output linkages, causing cascading effects along upstream and downstream supply chains.

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