

WHITE PAPER

The True Cost of Global Warming

Measuring what a hotter planet is already costing the world economy — in lost labor, higher energy bills, disaster losses, rising prices and retreating insurance.



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About this paper

This white paper examines the economic consequences of a warming planet from a single vantage point: rising temperatures are already imposing measurable costs on households, businesses, and governments. It asks one question — **at what cost?** — and answers it with the most recent published evidence available as of October 2026. All monetary figures are in US dollars unless otherwise stated. Superscript numbers refer to the numbered sources listed at the end.

Executive Summary

The planet's average temperature is rising, and the evidence is no longer confined to thermometers. Warming now shows up in payroll data, electricity load curves, reinsurance balance sheets, grocery prices, and the solvency of insurance markets. This paper assembles that evidence into a single accounting of what global warming is costing the world today, and what it is likely to cost tomorrow.

The answer depends on what is counted. We present it in three tiers, from most conservative to most expansive:

Tier	What it measures	Order of magnitude
1. Strictly attributable	Extreme-weather damage that event-attribution science assigns specifically to human-caused warming (2000–2019 average) ⁸	~US\$143 billion per year — a floor the authors themselves consider understated
2. Observable heat-and-weather burden	Income lost to heat stress on workers plus direct weather-disaster losses, as measured in the most recent full years ^{4,9}	~US\$1.3–1.6 trillion per year , roughly 1.2–1.5% of world output
3. Long-run growth drag	Macroeconomic models of how sustained warming depresses output over decades ¹⁸	Conventional estimates of ~1–3% of GDP per 1°C; newer work suggests far more

Key findings

- **Heat is the largest single line item.** Extreme heat cost the world a record 639 billion potential labor hours in 2024, equal to about US\$1.09 trillion in lost income — almost 1% of global GDP.⁹
- **Disaster losses are high and structurally rising.** Natural catastrophes cost US\$224 billion in 2025 and US\$368 billion in 2024; weather events made up 92% of 2025 losses. Losses from floods, wildfires and storms ran at US\$98 billion insured, against a 10-year average of US\$60 billion.^{4,5}
- **Cooling is now a major claim on the power system.** Electricity for space cooling has grown about 50% since 2015 to roughly 2,900 TWh — more than the entire European Union consumes — and drives around 30% of peak demand.¹¹
- **Weather is feeding inflation.** Heatwaves and droughts preceded a 280% jump in cocoa prices in 2024 and a 55% rise in coffee prices.¹⁴
- **Insurance is retreating.** More than 2 million US homeowner's policies were not renewed in 2024, and research finds local retail sales fall 8.6% where insurers withdraw.¹⁶
- **2026 is a warning year.** The August 26 glacier collapse on the Nepal–Tibet border killed more than 1,400 people; France recorded its worst wildfire season in modern records; and a record-strength El Niño is on course to make 2027 the hottest year ever measured.^{2,22,25}

- **The gap between cost and response is wide.** Developing countries need US\$310–365 billion per year for adaptation by 2035; international public adaptation finance was US\$26 billion in 2023.²⁰

The central conclusion is that the cost of warming is not a distant projection. It is a recurring, present-day expense of well over a trillion dollars a year, concentrated on outdoor workers, low-income households, and economies with the least insurance, and it rises with each increment of heat. Every credible pathway to lowering it combines faster emissions cuts with a large, rapid scale-up of adaptation investment.

1. Introduction: The Question of Cost

That the Earth is warming is established science. The more consequential question for policymakers, investors and citizens is economic: **what is warming costing, who is paying, and how fast is the bill growing?**

A hotter world raises costs through several reinforcing channels. Workers become less productive and less safe in extreme heat. More energy is needed to keep homes, hospitals, factories, and data centers cool. Droughts, floods, storms, and wildfires destroy property and interrupt production. Crop failures push up food prices. Insurers reprice or withdraw from risk, shifting costs onto households, lenders, and governments. Each channel is visible on its own; together they amount to a broad rise in the cost of living and doing business.

This paper takes those channels in turn, quantifies each with the latest available data, and then combines them into an annual cost ledger. It is deliberately conservative about attribution: not every flood or heatwave is caused by climate change, and the paper distinguishes between costs that are *attributable* to warming and costs that are *exposed* to a warming climate. It also flags where prominent estimates have been revised or withdrawn, because a credible case on the economics of warming must rest on evidence that survives scrutiny.

2. The Physical Baseline

The World Meteorological Organization reports that the global mean near-surface temperature for January–August 2025 was 1.42°C ($\pm 0.12^\circ\text{C}$) above the pre-industrial average, after roughly 1.55°C for 2024. Each of the eleven years from 2015 to 2025 ranks among the eleven warmest in the 176-year record.¹

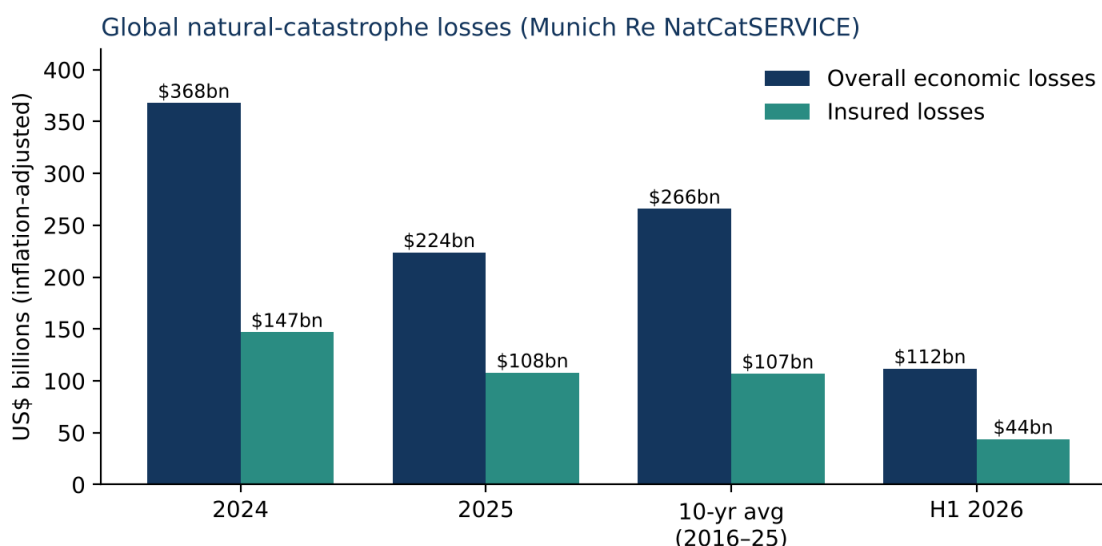
2026 has added a powerful amplifier. A rapidly strengthening El Niño, which forecast models expect to become the strongest in the modern record, has raised the odds that 2026 sets a new global temperature record; Carbon Brief projects that 2027 will reach about 1.7°C above pre-industrial levels, comfortably the warmest year ever measured.² Berkeley Earth put the probability of 2026 becoming the hottest year on record at 69% as of August.³

These are not abstract numbers. A world running persistently above 1.5°C is one in which heat extremes are more frequent, hotter, and longer; in which the atmosphere holds more moisture and delivers heavier downpours; and in which glaciers and permafrost lose stability. Each of those physical changes carries an economic price, which the following sections measure.

3. Channel One: Extreme Weather and Direct Losses

3.1 The global loss record

The most direct measure of the cost of a warming climate is the damage done by weather disasters. According to Munich Re, natural catastrophes caused around US\$224 billion in overall losses in 2025, of which about US\$108 billion was insured, down from inflation-adjusted totals of US\$368 billion and US\$147 billion in 2024. Weather-related disasters accounted for 92% of overall losses and 97% of insured losses.⁴ The single costliest event was the January 2025 Los Angeles wildfires, at roughly US\$53 billion overall and US\$40 billion insured.⁴



Weather-related events: 92% of overall and 97% of insured losses in 2025. H1 2026 covers January–June only.

Figure 1. Overall and insured natural-catastrophe losses. Source: Munich Re NatCatSERVICE.^{4,6}

Headline totals swing from year to year with the luck of hurricane landfalls; 2025 was below the 10-year average for overall losses largely because no hurricane struck the US mainland. The more telling trend sits underneath. Losses from floods, wildfires, and severe storms — the so-called non-peak perils most sensitive to warming — reached US\$98 billion insured in 2025, far above their inflation-adjusted 10-year average of US\$60 billion.⁵ Insured losses have now exceeded US\$100 billion every year since 2020.

The first half of 2026 offered what Munich Re called a breather: about US\$112 billion in overall losses and US\$44 billion insured, with the costliest event being the Venezuela earthquakes rather than a weather disaster.⁶ Swiss Re similarly reported first-half insured losses of about US\$42 billion, the lowest since 2020.⁷ Both reinsurers stressed that the respite reflected favorable circumstances rather than falling risk, and neither total yet includes the summer's European wildfires, the Nepal–Tibet disaster or the El Niño-driven second half.

3.2 How much is caused by warming?

Not every disaster is caused by climate change. Extreme-event attribution science estimates how much warming changed the likelihood of specific events. Combining every available attribution study with damage data, Newman and Noy estimate that **US\$143 billion per year** of extreme-weather costs over 2000–2019 was attributable to human-caused climate change, with about 63% of that figure reflecting loss of life.⁸ The authors note that many events lack attribution or damage data, making the figure an underestimate. It should be read as a floor.

3.3 The 2026 season: three warnings

Europe and North America: wildfire. France recorded its worst wildfire season in at least two decades by late July 2026, with cumulative burned area nearly 24,700 hectares above its previous record, while Spain's season ranked among the worst on record and EU-wide burned area by end-July was second only to 2022.²⁵ Notably, global burned area is falling, driven by reduced agricultural and savanna burning in Africa and Asia. The fires that are growing are those in Europe and North America, where research links them to climate-driven warming and drying — and where they meet high-value homes and infrastructure.²⁶

South and Southeast Asia: flooding. Floods across South and Southeast Asia from late 2025 into early 2026 killed more than 1,300 people and caused at least US\$20 billion in damage.²⁷ In September 2026, flooding across 41 Thai provinces, including Bangkok, affected more than 500,000 homes and over 1,200 businesses; private-sector estimates put the GDP drag at 0.1–0.3 percentage points.²⁸ Broker WTW warns that major regional floods in Southeast Asia can now cause losses above US\$10 billion, compared with the US\$1–2 billion typical of the past decade.²⁹

The Himalaya: glacier collapse. On 26 August 2026, part of a glacier high above the Lhende River on the Nepal–Tibet border collapsed, triggering an ice-rock avalanche that dammed the river and released a catastrophic flood downstream.²¹ By 21 September, Nepal's disaster authority had confirmed 1,451 deaths, with more than 6,000 people still missing.²² Hydropower facilities with a combined 430 MW of capacity — more than 12% of Nepal's total — were affected,²³ along with at least 19 bridges, about 40 km of roads, a major substation and two border crossings with China.²⁴ Scientists caution that a direct link between climate change and this specific collapse has not yet been established; satellite observations did show unusually warm conditions and reduced snow cover around the glacier beforehand.²¹ The broader trend is clear: glacier ice-loss rates across the Hindu Kush Himalaya have roughly doubled since 2000,³¹ steadily raising the hazard to the communities and infrastructure downstream.

Why the Nepal–Tibet disaster matters economically.

- A single mountain event removed roughly one-eighth of a country's hydropower capacity, severed trade corridors, and stranded hundreds of workers in tunnels.
- High-mountain infrastructure — dams, roads, border posts — is being built in terrain whose stability depends on ice that is warming.

- Losses of this kind fall almost entirely on uninsured public and household balance sheets.

4. Channel Two: Heat and Human Productivity

Heat is the most pervasive and least visible cost of warming. When temperatures and humidity rise, people work more slowly, take more breaks, make more errors, and suffer more injuries; in the most exposed jobs, work must stop altogether. These losses rarely appear in disaster statistics, but they are large.

The 2025 Lancet Countdown on Health and Climate Change found that heat exposure in 2024 caused a record **639 billion potential labor hours** to be lost worldwide, equivalent to **US\$1.09 trillion in lost income — almost 1% of global GDP.**⁹ The same report recorded weather-related extreme events causing losses of more than US\$304 billion.

Country	Labor hours lost to heat (2024)	Potential income lost	Most affected sectors
World	639 billion	US\$1.09 trillion	Agriculture, construction
India	247 billion (~420 per person)	US\$194 billion	Agriculture (66%), construction (20%)
Australia	~175 million	US\$5.4 billion	Construction (58%)
United Kingdom	5+ million	US\$103 million	—

Table 1. Heat-related labor losses. Sources: Lancet Countdown 2025 and national data sheets.^{9,10}

Two features make this channel economically important. First, it scales with temperature: each additional fraction of a degree pushes more hours of the working year past safe thresholds. Second, it falls hardest on economies built on outdoor labor. In India, the losses equal about 420 hours per worker per year,¹⁰ a burden concentrated on farmers and construction workers with little capacity to absorb lost wages. Heat also erodes productivity indoors where cooling is unavailable or unaffordable — which leads to the next channel.

5. Channel Three: The Energy Bill for Staying Cool

A warmer world must spend more to stay cool. The International Energy Agency (IEA) reports that electricity demand for space cooling has risen about 50% since 2015 to roughly **2,900 TWh**, more than the total electricity demand of the European Union. Cooling accounted for 14% of global electricity demand growth since 2015, and as much as 25% in the Middle East and North Africa.¹¹

The economic burden is concentrated at the peak. Cooling represents around 10% of annual electricity consumption but about **30% of peak demand**; in 2025, it contributed some 1,400 GW to peak load, equivalent to the entire installed generating capacity of the United States.¹¹ Power systems must be built for that peak, so hotter summers raise the capital cost of generation, transmission and distribution for

every consumer. IEA analysis finds that in India, each 1°C rise in outdoor temperature in 2024 added about 7 GW to peak demand, and that during the early-summer heatwaves of 2025 New York's evening peak ran 90% above its off-season average.¹²

Looking forward, the IEA projects cooling demand to grow by a further 1,600 TWh by 2035 under current policies, with a strong 2026–27 El Niño and recurring heat events potentially adding another 700 TWh.¹¹ Its outlook attributes around 170 GW of additional peak demand by 2035 to higher temperatures alone,³² on top of income-driven growth in air-conditioner ownership.

For illustration: at an assumed average retail price of US\$0.10 per kWh, today's cooling load implies annual spending in the order of **US\$290 billion**. Not all of that is caused by warming — much reflects rising incomes in hot countries — but the temperature-driven share is growing, and it is paid every year in household bills, business overheads, and grid investment. Access is also deeply unequal: around 40% of the world's population has air conditioning, while more than 80% experiences cooling needs for at least part of the year.¹¹

6. Channel Four: Prices, Food, and Insurance

6.1 Heat and inflation

Extreme weather is now a recurring source of price shocks. A 2025 study of 16 weather extremes linked a 2024 heatwave in Côte d'Ivoire and Ghana — which together grow about 60% of the world's cocoa — to a roughly 280% jump in cocoa prices, and a 2023 Brazilian drought to a 55% rise in arabica coffee prices.¹⁴ Broader research across 121 countries finds that abnormally high temperatures raise food prices and overall inflation; projected warming by 2035 could add 1.4–1.8 percentage points per year to food price inflation in North America.³⁰ For central banks, this makes climate a monetary-stability issue; for low-income households, which spend the largest share of income on food, it is a direct cut in living standards.

6.2 Regional economic output

The economic damage of a single hot summer can now be measured in near real time. Researchers at the University of Mannheim and the European Central Bank estimate that heat, drought, and floods in summer 2025 reduced gross value added across affected EU regions by **€43 billion** — about 0.26% of EU output — with cumulative losses rising to **€126 billion by 2029** as effects persist. Spain, France, and Italy each lost more than €10 billion, and the authors consider the figures conservative because wildfires and hail were excluded.¹³

6.3 The insurance retreat

Insurance is where climate risk is translated into a price. As that price rises, the costs shift. More than 2 million US homeowners insurance policies were not renewed by insurers in 2024, according to a national analysis by the National Association of Insurance Commissioners.¹⁶ Because mortgages require hazard

insurance, loss of coverage spreads into the housing and credit system: research from NYU Stern finds that where insurers withdraw, local retail sales fall by 8.6% and homeownership declines.¹⁶

Globally, the more serious problem is the absence of insurance in the first place. In the first half of 2026, around 60% of natural-disaster losses worldwide were uninsured,⁶ and in Africa, less than a fifth of 2025 disaster losses were insured.⁵ Uninsured losses do not disappear; they are absorbed by households, small businesses and public budgets, usually through lost savings, deferred investment and new borrowing.

7. The Macroeconomic View: What the Models Say

Beyond measurable annual losses lies the harder question of how warming affects long-run growth. Here the evidence is genuinely unsettled, and the range of published estimates is wide.

Conventional estimates. Studies that relate each country's local temperature to its economic performance have generally found damages of roughly 1–3% of world GDP per 1°C of warming.¹⁸

Higher estimates. A widely discussed working paper by Bilal and Känzig argues that local-temperature studies miss the global effects of warming — more storms, floods and droughts everywhere at once — and finds that 1°C of global warming reduces world GDP by about 12% at its peak, around six times earlier estimates.¹⁸ This result has not yet completed peer review and implies damages well above most of the literature; it should be treated as an upper-range scenario rather than a consensus figure.

A cautionary retraction. In December 2025, *Nature* retracted a prominent 2024 study that had projected a 19% reduction in global income by 2049 (about US\$38 trillion a year). Post-publication checks found the results were sensitive to flawed economic data for a single country, widening the uncertainty range from 11–29% to 6–31%; the authors judged the changes too substantial for a correction.¹⁷ The study had been incorporated into central-bank scenario tools. Its withdrawal does not show that climate damages are small — the corrected range is still large — but it underlines why cost estimates should rest on several independent lines of evidence, as this paper does.

Near-term central-bank scenarios. The Network for Greening the Financial System (NGFS), a network of central banks and supervisors, now publishes five-year scenarios. Its first short-term scenarios, released in May 2025, find that regional extreme-weather events can cause temporary but material GDP losses with spillovers to the global economy, and that delaying the transition raises its eventual cost.¹⁹ Applied to the euro area, the ECB notes that extreme weather could put up to 5% of economic output at risk within five years.¹⁹

Reading the range

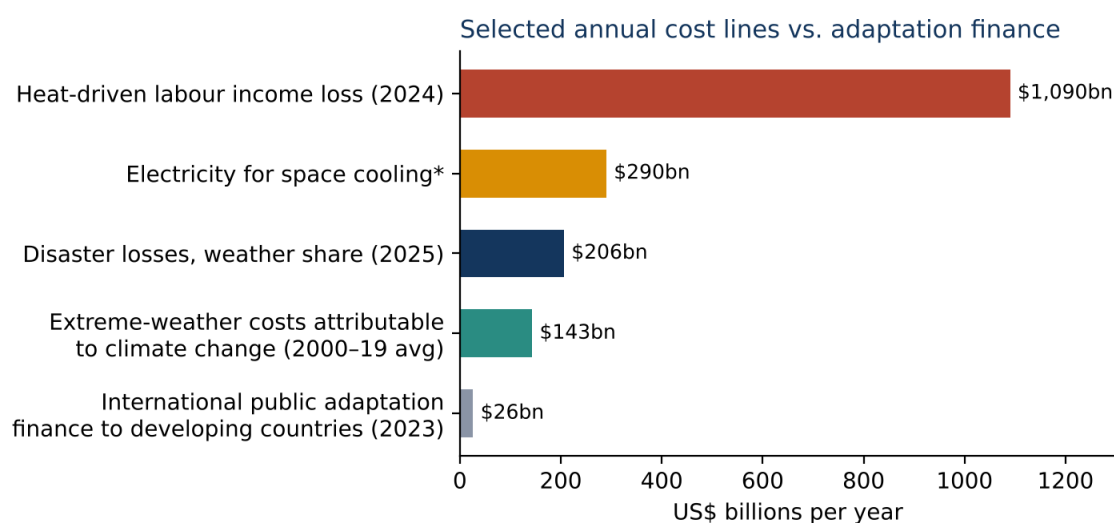
- The models disagree about the size of long-run damages, not about their direction.
- Every credible estimate rises with temperature, and most rise faster than linearly.
- Prudent planning should evaluate strategies against the upper range, because the costs of under-preparing are far larger than the costs of over-preparing.

8. Putting a Number on It: An Annual Cost Ledger

Table 2 gathers the most recent annual magnitude for each channel. The lines are measured on different bases and partly overlap, so they should not be summed mechanically. Read together, however, they show the scale of the burden.

Cost channel	Latest annual magnitude	Source basis	Link to warming
Heat-related labor losses	US\$1.09 trillion (2024); ~1% of world GDP	Lancet Countdown ⁹	Direct: rises with heat exposure
Weather-disaster losses	~US\$206 billion (92% of US\$224bn, 2025); US\$368bn total losses in 2024	Munich Re ⁴	Partial: attributable share estimated below
Attributable extreme-weather costs	US\$143 billion (2000–19 average)	Newman & Noy ⁸	Strictly attributed; understated
Electricity for cooling	~2,900 TWh; ~US\$290bn at an assumed US\$0.10/kWh	IEA; ¹¹ author's illustration	Growing temperature-driven share
Regional output loss (EU, one summer)	€43bn in 2025, rising to €126bn by 2029	Usman et al. ¹³	Heat, drought and flood
Food-price shocks	Cocoa +280%, coffee +55% after heat, and drought	Kotz et al.; ¹⁴ Climate Central ³⁰	Weather extremes, many attributed
Insurance withdrawal (US)	>2 million non-renewals (2024); local retail sales –8.6%	NAIC; NYU Stern ¹⁶	Climate-risk repricing
Unmet adaptation needs	US\$310–365bn/yr by 2035 vs US\$26bn provided (2023)	UNEP ²⁰	Cost of protection not yet paid

Table 2. Annual cost of ledger. Figures are the most recent available as of October 2026.



*Author's illustrative estimate: ~2,900 TWh at an assumed US\$0.10/kWh. Lines are not additive (see Section 8).

Figure 2. Selected annual cost lines compared with international public adaptation finance.

Combining only the two largest and best-measured lines — heat-related labor losses and weather-disaster losses — gives an observable heat-and-weather burden of roughly **US\$1.3 trillion** in a recent year. Allowing for the temperature-driven share of cooling costs and the regional output effects that disaster tallies miss raises the range to about **US\$1.3–1.6 trillion per year**, or roughly 1.2–1.5% of world output. This is not a claim that warming caused all of it; it is a measure of how much economic activity is now exposed to heat and weather each year, and therefore how much rides on how fast temperatures continue to climb.

Three conclusions follow. First, **the cost is already large**: even the strictly attributable floor exceeds US\$140 billion a year, and the observable burden runs above a trillion. Second, **heat dominates** lost labor productivity is several times larger than headline disaster losses yet attracts a fraction of the attention. Third, **the cost is growing**: each channel rises with temperature, and 2026–27 will test them all.

9. Who Pays: The Distribution of Costs

The cost of warming is not evenly shared. It falls hardest on those with the most exposure and the least protection.

- **Outdoor and low-wage workers** bear the heat-productivity losses directly, through lost hours, lost wages, and greater health risk. In India, agriculture alone accounts for two-thirds of lost labor hours.¹⁰
- **Lower-income households** spend a larger share of income on food and energy, so weather-driven price spikes and higher cooling bills cut deeper; many cannot afford cooling at all.^{11,30}
- **Developing economies** carry most of the uninsured losses. Africa's 2025 disaster losses were less than one-fifth insured,⁵ and adaptation finance covers only a small fraction of need.²⁰
- **Commodity producers** absorb the volatility of climate-exposed crops. West Africa's cocoa belt, for example, is at the center of the most dramatic recent price shocks.¹⁴
- **Public budgets** become the insurer of last resort, financing recovery after events such as the Nepal–Tibet flood through emergency spending and new debt.

This distribution matters for policy. Costs that fall on those least able to bear them compound into lower investment, weaker human capital, and slower development — a feedback loop that the annual ledger does not fully capture.

10. Recommendations

Lowering the cost of warming requires action on two fronts at once: limiting further temperature rise, and adapting to the warming already locked in. The following priorities follow from the evidence in this paper.

1. **Measure the cost every year.** Governments, central banks, and development institutions should publish annual heat-and-weather cost accounts covering labor hours lost, cooling peak load,

disaster losses, and the insurance protection gap, so that the burden is tracked as routinely as inflation or unemployment.

2. **Protect workers from heat.** Adopt enforceable occupational heat standards, shift outdoor work to cooler hours, and fund shade, water, and rest provision. Heat-health action plans and early-warning systems are among the highest-return adaptation measures available.
3. **Cool efficiently.** Minimum energy-performance standards for air conditioners, cool roofs, building insulation, shading and urban greening can sharply reduce cooling demand and peak load; the IEA estimates that efficiency standards alone could cut future growth in cooling electricity demand by more than 45%.¹⁵
4. **Close the protection gap.** Expand parametric insurance, sovereign catastrophe risk pools, and catastrophe bonds, particularly in Africa and South Asia, so that disaster losses are pre-financed rather than borne by households after the fact.
5. **Build for the climate that is coming.** Site and design dams, roads, and power assets for future, not historical, hazard — including glacier and permafrost instability in mountain regions, as the 2026 Nepal–Tibet disaster made plain.
6. **Invest in nature as infrastructure.** Restoring degraded land, forests, wetlands, and watersheds reduces flood peaks, cools local climates, and stabilizes soils, while generating jobs and, where verified, high-integrity carbon credits.
7. **Close the adaptation finance gap.** Developed economies, multilateral lenders and private capital should scale adaptation finance toward the US\$310–365 billion annual need, prioritizing grants and concessional instruments that do not add to the debt burdens of vulnerable countries.²⁰
8. **Cut emissions faster.** Adaptation has limits. Every credible estimate shows damages rising with temperature, and central-bank scenarios show that delay raises the eventual cost of transition.¹⁹ Mitigation remains the cheapest insurance policy available.

11. Conclusion

Global warming is often discussed as a future risk. The evidence assembled here shows it is a present cost. It is paid in lost working hours in Indian fields and Australian construction sites; in electricity bills and grid upgrades from New York to New Delhi; in burned homes in California and southern Europe; in flooded factories in Thailand; in the price of chocolate and coffee; in insurance policies that are no longer renewed; and, in the Himalaya this August, in more than a thousand lives and a substantial share of a nation's power supply.

At what cost is this happening? On the most conservative measure, well over US\$140 billion a year in damages scientists can attribute directly to warming. On the measure of what the economy actually experiences, more than a trillion dollars a year — over 1% of global output — lost to heat and weather. And on the long-run view, a drag on growth that could reach several percent of GDP for each additional degree.

The bill will rise with the temperature. The choice before governments, businesses and communities is not whether to pay, but whether to pay in advance — through emissions cuts, adaptation, and resilient investment — or to keep paying afterward, at a higher price and with the heaviest share falling on those least able to afford it.

About Our Mother Earth Foundation

Our Mother Earth Foundation (OMEF LLC d/b/a Our Mother Earth Foundation) is focused on climate resilience, environmental protection and programming aligned with the United Nations Framework Convention on Climate Change (UNFCCC).

About the author

Schad E. Brannon is CEO and Managing Director of Our Mother Earth Foundation. He leads origination and relationship development across climate finance, sovereign partnership and natural resource initiatives in West Africa and the Gulf.

Methodology and Limitations

- **Sources.** The paper relies on the most recent published data from reinsurers (Munich Re, Swiss Re), international organizations (WMO, IEA, UNEP, NGFS), peer-reviewed research and established news reporting, current to 20 October 2026. Reinsurer figures are inflation-adjusted as published.
- **Attribution versus exposure.** Except where stated (Newman and Noy), figures measure costs associated with heat and weather, not costs proven to be caused by human-caused warming. The ledger is therefore an exposure measure; the attributable floor is shown separately.
- **Overlap.** Cost lines are measured on different bases (income, asset damage, energy volume, value added) and may overlap. They are presented side by side, not summed, except for the explicitly described combination in Section 8.
- **Illustrative estimate.** The cooling-cost figure (~US\$290 billion) is the author's illustration using IEA volume data and an assumed average price of US\$0.10/kWh; actual tariffs vary widely by country.
- **Evolving events.** Casualty and damage figures for 2026 events, including the Nepal–Tibet glacier collapse and the Thai floods, were still being revised at the time of writing. Full-year 2026 disaster loss data were not yet available.
- **Contested research.** Bilal and Känzig's estimates are from a working paper; the 2024 Kotz, Levermann and Wenz study cited in Section 7 has been retracted and is discussed only for that reason.

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