

H HEURISTICS

Navigating a Changing World

The Weight of the Polycrisis

Human Suffering in a Warming, Polluted and Unequal World

How air pollution, heat, hunger and poverty harm the body and mind, how feedback loops make the suffering self-reinforcing, and why it will be prolonged for centuries in the regions where survival is most at risk

H Heuristics · Hunter Hughes

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Abstract

Most accounts of the global polycrisis count dollars, degrees and hectares. This report counts breaths, nights, meals and homes. It asks what the interlocking crises of pollution, heat, hunger, poverty and disaster do to the human body and mind, how those harms feed one another, and how long they will last once the physical climate has been committed to a warmer course. Its thesis is that the polycrisis is best understood as a single system of exposures that acts on people through a small number of biological pathways and that contains reinforcing feedback loops, which make the suffering self-sustaining and, on current trajectories, steadily worse.

The evidence for the present is already stark. Air pollution caused about 7.9 million deaths in 2023, 86 per cent of them from heart, brain and lung disease rather than respiratory infection; pollution of all kinds causes about nine million deaths a year, 92 per cent in low- and middle-income countries. Heat kills an estimated 546,000 people a year, exposes 2.41 billion workers, steals sleep and endangers pregnancy. Some 645 million people are chronically hungry, 2.1 billion lack safe drinking water and about 2.09 billion cook with polluting fuels. The report traces these harms through the lungs and heart, through core temperature and kidneys, through water, food and disease, and through mental health, displacement, conflict and poverty, and shows how they connect into six reinforcing loops (energy-poverty, heat-power, fire-smoke, poverty-disaster, carbon-cycle and conflict-food) together with a perverse balancing loop in which cleaning the air unmasking warming.

Looking forward, the harms grow non-linearly with warming: roughly 140 million more people are exposed to dangerous heat for every 0.1 °C, and the difference between rapid decarbonisation and high emissions is measured in about 74 million excess heat deaths this century and 170 million internal climate migrants by 2050. Over centuries, the persistence of carbon dioxide, the inertia of the sea and ice sheets and slow tipping elements prolong the damage: sea level rise by 2300 ranges from about 0.3 to 3.1 m under low emissions to 1.7 to 6.8 m or more under very high emissions. The report assesses ten survivability risk areas, led by the Indo-Gangetic Plain, the Sahel and Horn of Africa and Central America, where hazards overlap with limited adaptive capacity. A transparent stylised model suggests that, summed over 2025 to 2300, current policies produce about 4.4 times as much climate-sensitive suffering as rapid decarbonisation, and high emissions about 36 times as much. The report concludes that the pollution, climate and poverty agendas are one, that much suffering is preventable now, and that the long tail is a choice.

Keywords: polycrisis; human suffering; air pollution; heat stress; climate health; feedback loops; poverty; tipping points; sea level rise; survivability; climate justice; planetary health

JEL classification: Q54, Q53, I15, I14, O15; climate and natural disasters; air and water pollution; health and economic development; inequality and poverty

Data and method: This report synthesises primary and authoritative secondary sources through October 2026; every quantitative claim is linked inline. Figures 2, 3, 5, 7 to 9, 11, 12 and 14 report values from cited sources; Figures 1, 4, 6, 10, 13, 15 and 16 are conceptual schematics or H Heuristics renderings of cited results; Figures 17 and 18 are H Heuristics structured assessments; and Figure 20 is an illustrative stylised model whose assumptions are stated (Appendix A). Burden figures overlap and must not be summed. The report is analytical rather than predictive, and contains no investment or medical advice.

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1. Introduction: Counting Suffering in a Polycrisis

Most accounts of the global polycrisis count dollars, degrees and hectares. This report counts breaths, nights, meals and homes. It asks what the interlocking crises of pollution, heat, hunger, poverty and disaster actually do to the human body and mind, how those harms feed one another, and how long the damage will keep growing once the physical climate has been committed to a warmer course.

1.1 Why suffering is the right unit of account

A temperature anomaly of 1.4 degrees is an abstraction. A child who cannot sleep through a tropical night, a farm worker whose kidneys fail after a decade of cane cutting, a grandmother who dies in a heatwave in a flat with no cooling, a toddler whose lungs are scarred by the smoke of a cooking fire: these are the things the number stands for. Economic models translate such harms into a share of gross domestic product, and that translation is useful, but it hides who is harmed, how, and at what stage of life. It also hides the fact that the harms rarely arrive alone.

The thesis of this report is that the polycrisis is best understood as a single, interacting system of exposures that acts on human bodies and minds through a small number of biological pathways, and that the system contains reinforcing loops which make the suffering self-sustaining and, on current trajectories, steadily worse. The final sections of the report then look past 2100. They ask what it means for suffering to be *prolonged over centuries*, because the physical system that generates it, the atmosphere, the oceans and the ice sheets, responds on timescales far longer than any political cycle, and they identify the regions where survivability itself is at risk.

1.2 The polycrisis, briefly

The word *polycrisis* describes a condition in which crises in several global systems become causally entangled, so that their combined effect exceeds the sum of their separate effects. In the sense used by [Lawrence, Homer-Dixon and colleagues](#), the claim is not that the world faces an unusual number of problems. It is that the problems are coupled. Air pollution and climate change share a common source in fossil combustion. Heat raises the demand for the electricity that is still largely generated by burning fuel. Poverty keeps hundreds of millions of households cooking over smoky fires and living in places where hazards are worst. Hunger, displacement and conflict then feed back into poverty.

The physical backdrop is stark. The World Meteorological Organization reports that [2025 was between the second and third warmest year on record, about 1.43 °C above the 1850-1900 average, and that 2015 to 2025 were the eleven warmest years in the instrumental record](#). The 2025 update of the planetary boundaries framework found that [seven of nine boundaries are now transgressed](#), ocean acidification being the latest addition. The [Global Tipping Points Report 2025](#) concluded that warm-water coral reefs have already passed their tipping point. And UNEP's [Emissions Gap Report 2025](#) projects 2.8 °C of warming by the end of the century under current policies, falling to 2.3 to 2.5 °C if national pledges are fully implemented.

1.3 How the report is organised

Sections 2 to 6 build the evidence for the present: the scale of the burden today (Section 2), and then the pathways by which it falls on people, through the air (Section 3), through heat (Section 4), through water, food and disease (Section 5), and through mental health, displacement, conflict and poverty (Section 6).

Section 7 is the analytical core. It shows how these pathways connect into reinforcing loops. Sections 8 and 9 follow the system forward, first to 2100 and then across centuries. Section 10 maps the *survivability risk areas*, the regions where the combination of hazards and limited adaptive capacity makes continued habitation most precarious. Sections 11 and 12 ask who bears the weight and what would bend the curve, and Section 13 concludes.

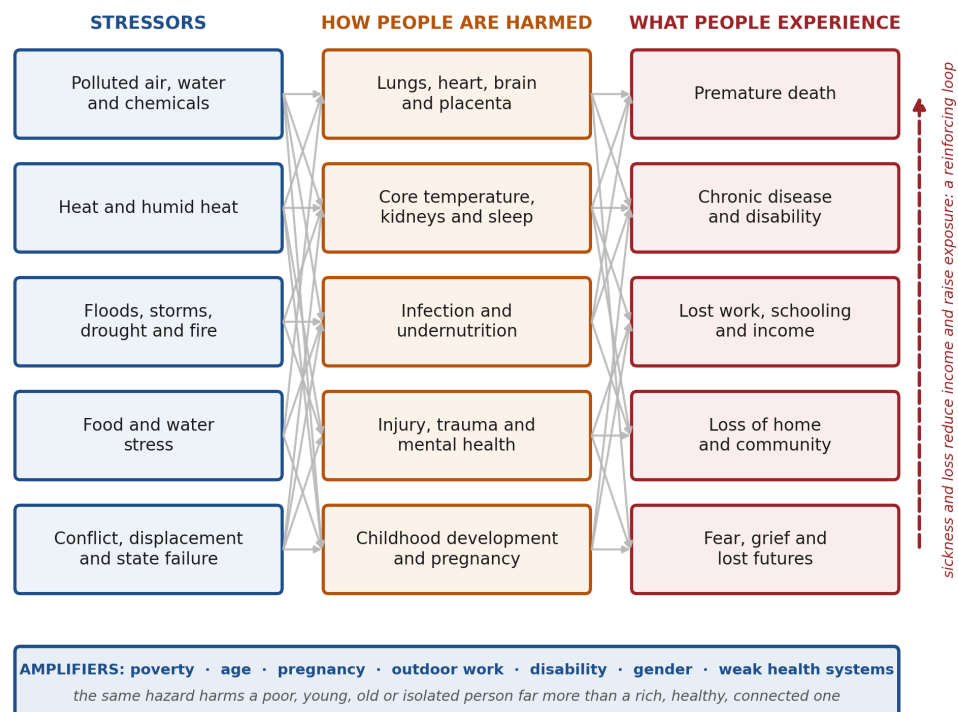


Figure 1. From stressors to suffering: the pathways through which the polycrisis harms people.

Source: H Heuristics, conceptual schematic synthesising the evidence reviewed in Sections 3 to 6. Pathway links are indicative of the principal documented connections, not an exhaustive map.

1.4 Method, evidence and cautions

The report synthesises primary and authoritative secondary sources through October 2026, and every quantitative claim is linked inline. It quantifies in three modes, which each figure caption identifies: values reported by cited sources; H Heuristics assessments on a stated scale; and illustrative calculations whose assumptions are disclosed in Appendix A. Where sources conflict, the text says so. Several estimates are modelled rather than counted. Deaths attributed to air pollution, for example, are derived from exposure-response functions applied to satellite and ground data, not from death certificates, and the same is true of most heat-mortality estimates. They are best read as well-founded orders of magnitude.

Two cautions govern the whole report. First, the burden figures below overlap and must not be summed: a person can live in poverty, cook with polluting fuel, lack safe water and work in the heat at once, and that overlap is precisely the point of the report. Second, the forward-looking sections describe *risks under stated scenarios*, not predictions. The long-run trajectory depends on decisions that have not yet been made, and Section 12 shows how large the difference between those decisions is. The report is analytical, contains no investment advice, and does not substitute for local public-health guidance.

2. The Present Burden: What the Polycrisis Already Costs

Before asking how the suffering will grow, it is necessary to say how large it already is. The answer, drawn from the most recent global assessments, is that pollution and heat alone account for roughly nine to ten million deaths a year, and that the deprivations which magnify them impose daily hardship on several billion people.

2.1 Counting the dead

The largest single category is pollution. The Lancet Commission on Pollution and Health, updated with 2019 data, [attributed about nine million deaths a year to pollution of all kinds, around one in six deaths worldwide](#), and found that [about 92 per cent occur in low- and middle-income countries](#). Air pollution is the dominant component. The Health Effects Institute's [State of Global Air 2025](#) puts air-pollution deaths in 2023 at about 7.9 million, roughly one in eight deaths worldwide, and the 2025 *Lancet* Global Burden of Disease risk-factor analysis [ranks particulate matter pollution as the second-leading risk factor for lost healthy life](#), behind only high blood pressure.

Heat is the second great category, and it is growing fastest. The [2025 report of the Lancet Countdown](#) estimates that heat caused about 546,000 deaths a year on average over 2012 to 2021, with the count of heat-related deaths about 63 per cent higher than in the 1990s ([WHO summary](#)). The same report recorded a [record 154,000 deaths from wildfire smoke in 2024](#), and found that [84 per cent of life-threatening heatwave days between 2020 and 2024 would not have occurred without climate change](#). Climate-sensitive infectious disease adds to the toll: [2024 was the worst dengue year on record, with 14.4 million reported cases and 11,201 deaths](#).

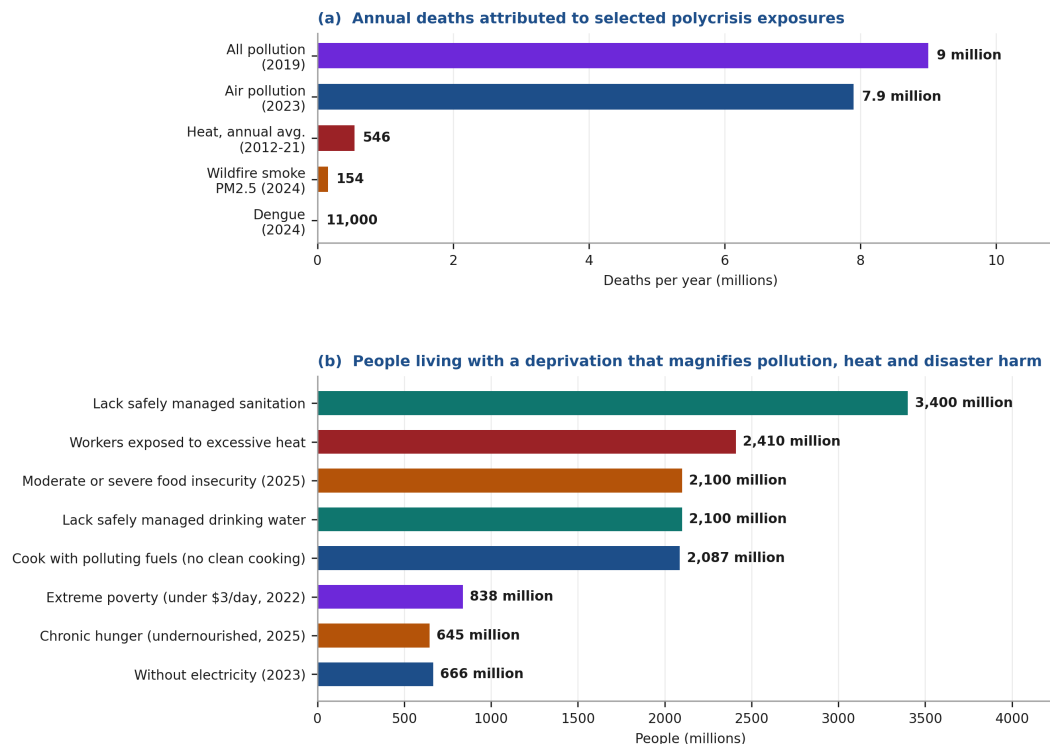


Figure 2. The present burden: (a) annual deaths attributed to selected exposures; (b) people living with deprivations that magnify the harm.

Sources: Lancet Commission on Pollution and Health; [State of Global Air 2025](#); [Lancet Countdown 2025](#); [WHO dengue update](#); [WHO/UNICEF JMP 2025](#); [Tracking SDG7 2025](#); [SOFI 2026](#); [World Bank](#); [ILO](#). Categories overlap and the two panels use different years.

2.2 Counting deprivation

Deaths are only the visible tip. Beneath them lies a much larger population living with the conditions that turn a hazard into a harm. According to the [2025 Tracking SDG7 report](#), about 2.09 billion people still lacked clean cooking in 2023 and 666 million lacked electricity. The [WHO and UNICEF Joint Monitoring Programme](#) reports that 2.1 billion people lack safely managed drinking water and 3.4 billion lack safely managed sanitation. The 2026 edition of the UN's flagship hunger report estimates that [about 645 million people, 7.8 per cent of humanity, were chronically undernourished in 2025, and that about 2.1 billion experienced moderate or severe food insecurity](#). Both numbers are falling, but slowly, and the report warns that its outlook may not fully reflect a strong El Niño or recent cuts to development and humanitarian financing. After the World Bank's 2025 revision of its poverty line to US\$3 a day, [about 838 million people were counted as extremely poor in 2022](#).

Each of these numbers is an exposure multiplier. A household without clean cooking breathes smoke on top of whatever the neighbourhood air contains. A household without safe water is more exposed when floods arrive. A hungry child is more vulnerable to heat, to infection and to the harm of polluted air. And the [International Labour Organization estimates that 2.41 billion workers, about 71 per cent of the global workforce, are exposed to excessive heat](#), a figure that rises to 92.9 per cent in Africa.

Table 1. A snapshot of the present burden.

Exposure	Headline number	Year	Source
Pollution, all types (deaths)	≈ 9 million a year; 92% in low- and middle-income countries	2019	Lancet Commission update
Air pollution (deaths)	≈ 7.9 million; 4.9 m ambient PM2.5, 2.8 m household, 0.47 m ozone	2023	State of Global Air 2025
Heat (deaths)	≈ 546,000 a year on average	2012-21	Lancet Countdown 2025
Wildfire smoke (deaths)	≈ 154,000, a record	2024	Lancet Countdown via Grist
Chronic hunger	645 million (7.8%)	2025	SOFI 2026
Cooking with polluting fuels	≈ 2.09 billion people	2023	Tracking SDG7 2025
Unsafe drinking water / sanitation	2.1 billion / 3.4 billion	2024	WHO/UNICEF JMP
Workers exposed to excessive heat	2.41 billion (≈ 71%)	2024	ILO
Extreme poverty (\$3 a day)	≈ 838 million	2022	World Bank
Children with blood lead at or above 5 µg/dL	≈ 1 in 3, up to 800 million	2020	UNICEF and Pure Earth
Disaster displacements	45.8 million movements, a record	2024	IDMC via UN News

Notes: Figures are the most recent available at the time of writing and use different base years; they overlap and should not be added together.
Sources: see text and linked entries.

2.3 What the numbers leave out

Three things lie beneath every figure above. The first is non-fatal suffering. For each death there are many more cases of chronic illness: asthma and emphysema, heart failure, kidney damage, stunted growth, disrupted pregnancy. Air pollution alone, the 2025 State of Global Air report estimates, [contributed to 626,000 deaths from dementia and 11.6 million healthy years of life lost to it](#) in 2023. The second is the unrecorded. When more than a thousand pilgrims died of heat during the 2024 Hajj, [more than half were unregistered worshippers](#), and Saudi authorities published no official toll. Heat deaths in informal settlements, among migrant workers and in remote areas are routinely uncouncted.

The third is psychological and social loss, to which Section 6 returns: fear, grief, displacement from home and the erosion of the prospect of a secure future. The burden of suffering is not only the sum of clinical outcomes. It is also the pervasive anxiety of young people, the disruption of schooling, the break-up of communities that have lived in the same place for generations. These are harder to count, but they are as real as the mortality tables.

3. Breathing the Polycrisis: Air Pollution and the Body

Air pollution is the most thoroughly measured way in which the polycrisis enters the body. It shows, in compact form, the logic of the whole report: a hazard produced by the same combustion that warms the planet, borne unequally, harming not one organ but many, and falling hardest on the very young and the very old.

3.1 What the particles do

The pollutant that causes most of the harm is fine particulate matter, PM2.5: particles less than 2.5 micrometres across, a fraction of the width of a human hair. They are produced by burning coal, oil, gas, wood and crop residue, and are also formed in the atmosphere from gases such as sulfur dioxide and nitrogen oxides. Particles of this size are not filtered out by the nose and throat. They reach the deepest parts of the lungs, and the smallest pass across the thin walls of the air sacs into the bloodstream. There they trigger inflammation and oxidative stress, damage the lining of blood vessels, and promote the build-up of arterial plaque. The result is that the diseases most strongly associated with air pollution are not only respiratory but cardiovascular and neurological.

The World Health Organization tightened its guideline in 2021 to an annual mean of 5 micrograms per cubic metre of air. By its own data [99 per cent of the world's population lives in places where pollution exceeds WHO guideline limits](#). The guideline is an aspiration rather than an average: IQAir's 2025 global survey found that [only 13 of 143 countries and territories met it, and just 14 per cent of cities](#).

3.2 The geography of dirty air

The distribution of exposure is extremely unequal. In the IQAir 2025 data, annual mean PM2.5 was highest in [Pakistan \(67.3 µg/m³\), Bangladesh \(66.1\), Tajikistan \(57.3\), Chad \(53.6\) and the Democratic Republic of the Congo \(50.2\), with India sixth at 48.9](#). Those levels are ten to thirteen times the WHO guideline. The pattern combines the three major sources of the polycrisis: industrial and power-sector combustion, vehicle traffic and biomass burning, and the household use of solid fuels for cooking and heating. It is compounded by climate-driven dust and smoke. The year-to-year ranking can shift with data coverage, as the Chad figures show, but the central fact does not: the populations least responsible for global emissions breathe the most polluted air.

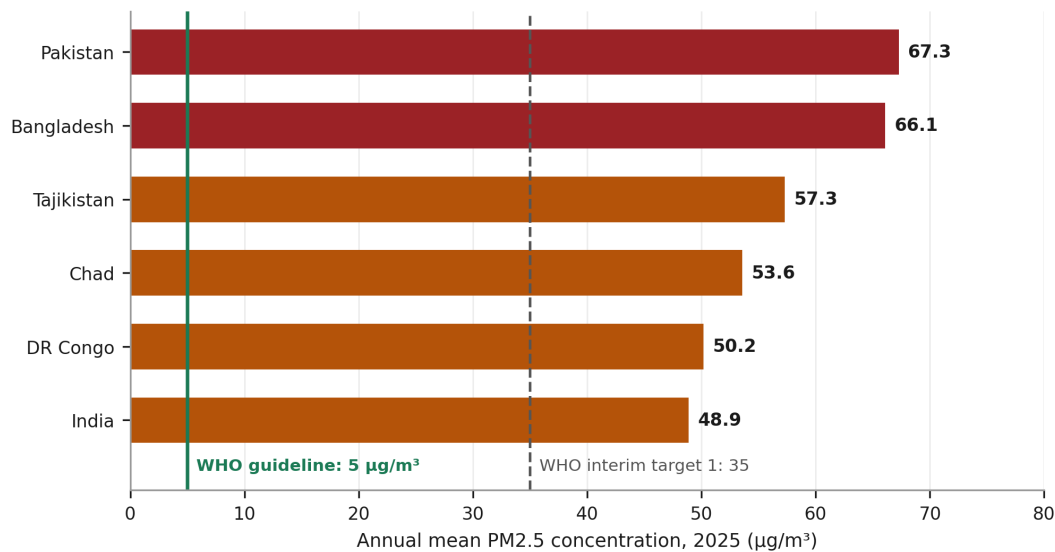


Figure 3. The most polluted countries, 2025: annual mean PM2.5 against WHO guidance.

Source: IQAir 2025 World Air Quality Report, as reported by [Anadolu Agency](#); WHO [Global Air Quality Guidelines](#). Chad ranked first in 2024; its lower 2025 position is attributed to incomplete data.

3.3 Heart, brain and lungs

The most important recent shift in understanding is that air pollution is mostly a disease of the heart, brain and vascular system. Of the roughly 7.9 million deaths attributed to it in 2023, [6.8 million, 86 per cent, were from non-communicable diseases](#): ischaemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, diabetes and, as noted, dementia. By source, ambient PM2.5 accounted for 4.9 million deaths, household air pollution for 2.8 million and ozone for 470,000 (the categories overlap, so they exceed the total when added). India and China each recorded more than two million attributable deaths. The State of Global Air authors caution that the 2023 estimate is not evidence of cleaner air: it reflects improved modelling, and the figure for 2021 was revised downward from 8.1 to 7.6 million.

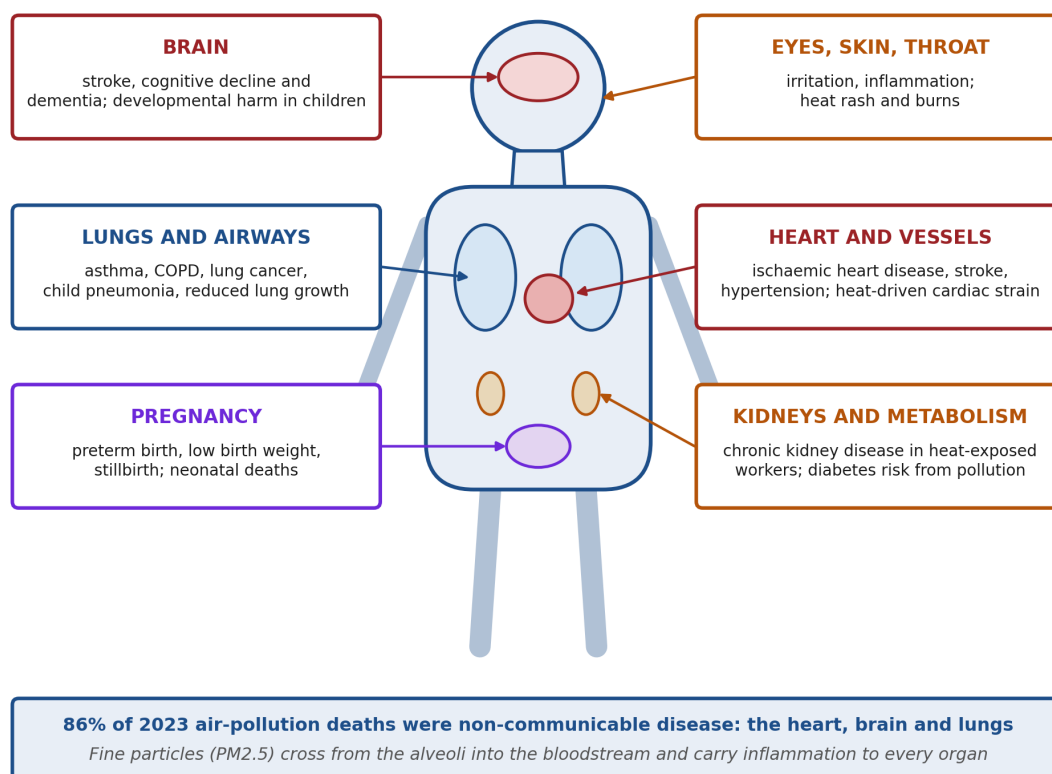


Figure 4. How polluted air harms the body: organ-level effects.

Source: H Heuristics, schematic synthesis of effects documented in the [State of Global Air 2025](#) and WHO Global Air Quality Guidelines. Not a clinical diagram.

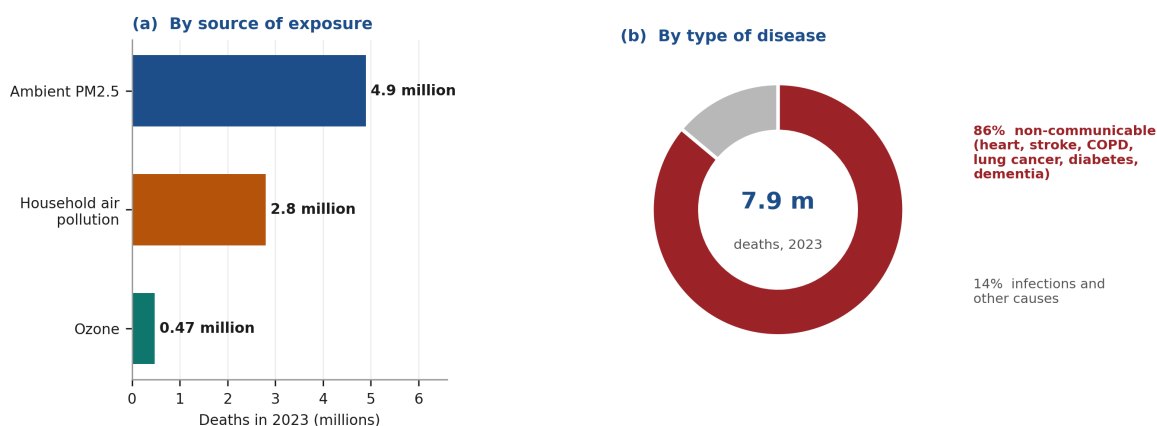


Figure 5. Air pollution deaths in 2023 by source and by type of disease.

Source: [State of Global Air 2025](#). Source categories overlap and are shown as reported.

3.4 Children and the unborn

The youngest are most exposed and least protected. The 2024 State of Global Air report, produced with UNICEF, linked air pollution to over 700,000 deaths of children under five in 2021, making it the second-leading risk factor for death in this age group after malnutrition. About 500,000 of those deaths were

associated with household air pollution from cooking, concentrated in Africa and Asia, and more than 570,000 were neonatal. Air pollution was also associated with 34 per cent of preterm births globally in that year. These are not distant statistics. They are the first-year deaths and lifelong disabilities of children born into houses where the hearth is the only available stove.

3.5 Beyond the air: water, lead and the chemical load

Pollution is not only atmospheric. The same [Lancet Commission](#) found that reductions in deaths from poverty-linked pollution, such as indoor air and unsafe water, had been offset by rising deaths from industrial pollution, including toxic chemicals, and its lead author considers the nine million figure likely to be an underestimate because many emerging chemicals remain unassessed. A [UNICEF and Pure Earth analysis](#) estimated that about one child in three, up to 800 million, has blood lead at or above 5 micrograms per decilitre, a level associated with lower intelligence and behavioural problems, with informal recycling of lead-acid batteries a leading source and almost half of affected children in South Asia. The first [Lancet Countdown on Health and Plastics](#), published in 2025, put the health-related economic burden of plastics exposure above US\$1.5 trillion a year, falling disproportionately on low-income and at-risk populations.

The significance of this chemical load for the polycrisis is that it lowers the body's resilience to everything else. A child with a high lead burden, anaemia from poor nutrition and a chest scarred by repeated respiratory infection enters a heatwave or a flood already depleted. Pollution, in other words, is both a source of suffering in its own right and a *vulnerability amplifier* for the climate shocks examined in the next sections.

4. Heat: The Body at the Limit

Heat is the most direct physical expression of a warming world, and the one that most plainly shows the limits of the human body. It kills outright, it quietly damages the heart and kidneys, it steals sleep and wages, and it is already harming infants, older people and outdoor workers on a scale that is still routinely under-counted.

4.1 How the body copes, and how it fails

The human body must keep its core temperature within a narrow band around 37 °C. It does this by moving blood to the skin and by sweating: evaporation of sweat carries heat away. Both mechanisms have costs. Diverting blood to the skin raises heart rate and cardiac output and reduces flow to the gut and kidneys; sweating depletes water and salts. The mechanism fails when the environment stops permitting heat to escape. In hot, dry air, sweat evaporates freely. In hot, humid air it does not, and the body can only lose heat by conduction and radiation, which cease to work once the air is as warm as the skin. The relevant measure is therefore not air temperature but the *wet-bulb temperature*, which combines heat and humidity.

For years the limit of human tolerance was taken to be a wet-bulb temperature of 35 °C, sustained for around six hours. Laboratory work has since shown the real limit to be lower. In a study led by Penn State's HEAT Project, young, healthy adults doing only light activity lost the ability to hold a stable core temperature at wet-bulb values as low as 30 to 31 °C in warm-humid conditions and 25 to 28 °C in hot-dry conditions, and the authors note that older adults and people with medical conditions are likely to have lower limits still ([Vecellio et al., 2022](#)). A wet-bulb of 31 °C is reached on the Persian Gulf coast for a few days a year today, and a wet-bulb of 35 °C has already been observed briefly at a number of subtropical coastal stations, with extreme humid heat more than doubling in frequency since 1979.

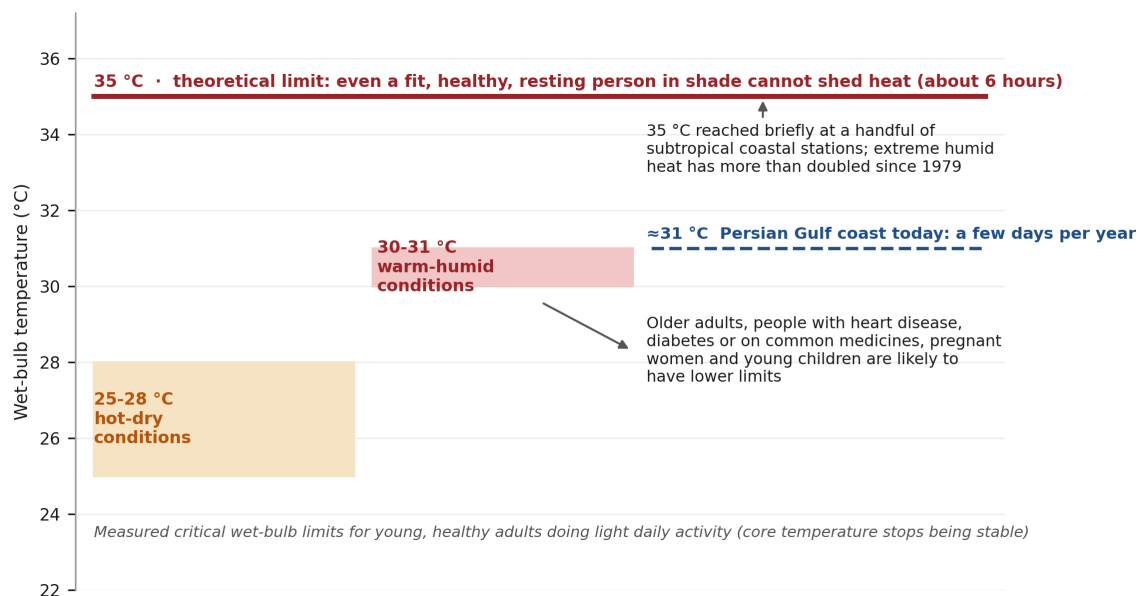


Figure 6. The humid-heat ladder: measured and theoretical limits of human heat tolerance.

Sources: [Vecellio et al. 2022](#) (critical limits for young, healthy adults); [Pal and Eltahir 2016](#) (Persian Gulf); [Raymond, Matthews and Horton 2020](#) (observed extremes). Schematic presentation by H Heuristics.

4.2 The toll: from statistics to streets

The consequences are measured in the mortality records. The [Lancet Countdown 2025](#) estimates 546,000 heat-related deaths a year on average over 2012 to 2021. It reports that, in 2024, [infants under one experienced 389 per cent more heatwave days than the 1986-2005 average, and adults over 65 experienced 304 per cent more](#). Heat attacks the cardiovascular and respiratory systems of older people first, but it is dangerous to infants too, whose bodies regulate temperature less well and who depend on caregivers to cool them.

The record of recent summers shows how this plays out. During the 2024 Hajj, temperatures at the Grand Mosque in Mecca reached 51.8 °C and [more than a thousand pilgrims died](#), many of them after walking in the open. In the spring of 2026, a pre-monsoon heatwave across South Asia that, according to a [World Weather Attribution analysis](#), human-induced climate change made about three times more likely, drove record electricity demand and agricultural drought across the region and exposed hundreds of millions of people to dangerous temperatures. Heatwave death tolls in the first days are almost always a fraction of what mortality records later show, because most heat deaths are not diagnosed as such.

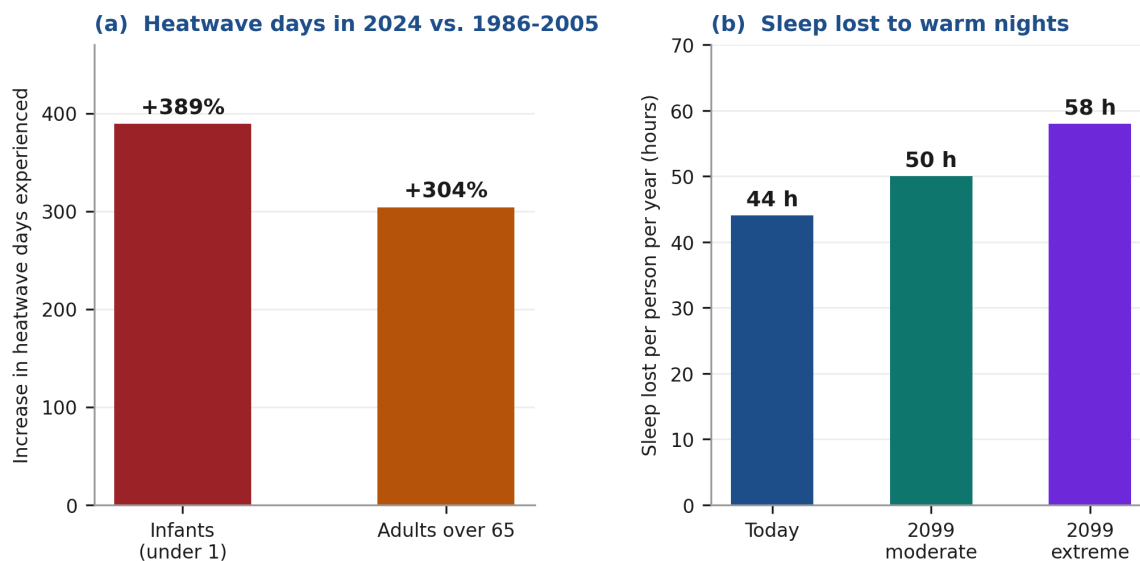


Figure 7. The reach of heat: (a) extra heatwave days experienced by the most vulnerable in 2024; (b) sleep lost to warm nights.

Sources: [Lancet Countdown 2025](#); Minor et al. 2022, [One Earth](#). The sleep projection is for 2099 under moderate and extreme warming scenarios.

4.3 Heat at work

Heat harms workers disproportionately, because the people who must work outdoors or in uncooled spaces are typically the poorest. The ILO's 2024 analysis concluded that [excessive heat causes about 22.85 million occupational injuries and 18,970 deaths each year](#), and that 2.41 billion workers are exposed. The shares exposed are highest in [Africa \(92.9 per cent\)](#), [the Arab States \(83.6\)](#) and [Asia and the Pacific \(74.7\)](#). An earlier [ILO projection](#) found that 2.2 per cent of global working hours, equivalent to 80 million full-time jobs, would be lost to heat stress by 2030, with the heaviest losses in South Asia and West Africa.

A particularly cruel expression is chronic kidney disease among agricultural workers in Central America. Often called Mesoamerican nephropathy, it affects young, otherwise healthy men, above all sugarcane

cutters on the Pacific lowlands. Its cause is not fully settled, but [heat stress and repeated dehydration are thought to play a central role](#), and a [cross-shift study of 189 sugarcane cutters in El Salvador](#) tracked dehydration and kidney-function markers against workplace heat, work time and fluid intake. The ailment shows how heat converts into a lifelong disease and a family's loss of its main earner, and thus into poverty.

4.4 Sleep, pregnancy and the mind

The effects of heat extend into the quietest hours. A multi-country study using sleep-tracking devices found that [warm nights cost the average person about 44 hours of sleep a year, projected to rise to between 50 and 58 hours by 2099](#), with the losses greater for women, older people and residents of lower-income countries, and with little evidence that people are adapting. Poor sleep is not merely uncomfortable. It impairs cognition, mood and immune function and raises cardiovascular risk.

Heat in pregnancy carries risks to the next generation. A systematic review in the *BMJ* of 70 studies in 27 countries found that [the odds of preterm birth rose about 5 per cent for each 1 °C increase in temperature and about 16 per cent during heatwaves, with stillbirth odds also rising about 5 per cent per degree](#). The association was strongest among women of lower socioeconomic status. And Section 6 shows that heat also rises as a risk to mental health.

Table 2. Heat: who is harmed, how, and what the evidence shows.

Group	Principal mechanism	Evidence
Older adults	Reduced sweating and blood-flow response; heart and lung disease; medication effects	Lancet Countdown 2025 : 304% more heatwave days for over-65s in 2024
Infants and young children	Immature thermoregulation; dependence on caregivers; dehydration	Lancet Countdown 2025 : 389% more heatwave days for infants
Pregnant women and fetuses	Maternal heat strain; placental stress; dehydration	Chersich et al., BMJ 2020 : about 5% higher preterm-birth odds per 1 °C
Outdoor and manual workers	Sustained exertion; dehydration; repeated kidney injury	ILO 2024 : 22.85 million injuries and 18,970 deaths a year
Everyone, at night	Elevated night-time temperatures disrupt sleep	Minor et al. 2022 : 44 hours a year lost today
Poor households and informal settlements	Poor housing, no cooling, limited access to care, unrecorded deaths	Hajj 2024 : over half of the dead unregistered

Sources: as linked. Effect sizes are from observational studies and carry uncertainty; they indicate direction and rough scale.

5. Water, Food and Disease

The oldest forms of human suffering, thirst, hunger and infection, are being reshaped rather than replaced by the polycrisis. Droughts and floods intensify, crop systems are stressed by heat and by changing nutrition, and warmer, wetter conditions extend the range of the insects and microbes that carry disease.

5.1 Hunger in a hotter world

Global hunger has fallen as a share of the population, but not fast enough, and the aggregate hides sharp regional divergence. The 2026 edition of the State of Food Security and Nutrition in the World (SOFI) [estimates that about 645 million people, 7.8 per cent of the population, faced hunger in 2025, nearly 14 million fewer than in 2024 and 43 million fewer than at the 2022 peak](#). Moderate or severe food insecurity affected about 2.1 billion people, and nearly a third of humanity cannot afford a healthy diet. In Africa, hunger prevalence slipped from 20.3 to 20.0 per cent, the first break in a rising trend since 2017, but about 309 million Africans remain undernourished and population growth could push the absolute number up again. The report projects that around 520 million people could still be hungry in 2030, leaving the world off track for Zero Hunger, and cautions that this may understate the risk because it does not fully account for a strong El Niño or recent cuts in aid. The preceding edition had already found that the improvement leaned heavily on revised data from India, while hunger rose in Western Asia ([SOFI 2025 summary](#)).

Climate is a rising driver. The Lancet Countdown linked more severe droughts and heatwaves to [124 million more cases of moderate or severe food insecurity in 2023 than in the 1981 to 2010 baseline](#). Heat shortens crop growing periods, drought cuts yields, floods destroy stored grain and fields, and rising input costs, notably fertiliser and fuel, transmit shocks from energy markets to the household budget.

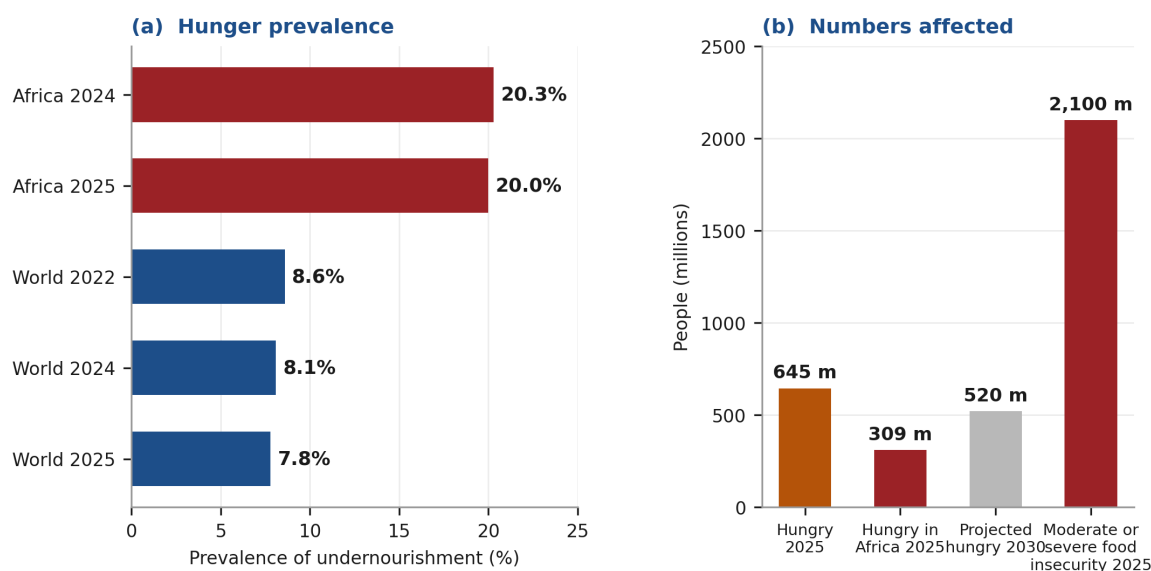


Figure 8. Hunger today: (a) prevalence of undernourishment, world and Africa; (b) the number of people affected and the 2030 projection.

Source: [SOFI 2026](#) (FAO, IFAD, UNICEF, WFP, WHO), including revisions to earlier years.

5.2 The hidden hunger of a high-carbon atmosphere

A less visible mechanism acts through nutrition, not quantity. When crops are grown at elevated carbon dioxide, many lose nutritional value. Experiments show lower concentrations of protein, iron and zinc in staple crops such as rice and wheat. Smith and Myers modelled the global consequences and found that, by 2050 under a high-emissions scenario, [about 175 million additional people could become zinc-deficient and 122 million protein-deficient, while some 1.4 billion women and children under five could see iron intake fall by 4 per cent or more](#) (Smith and Myers 2018). The effects are greatest in South Asia and Africa, where diets depend on cereals and legumes and little else. This is a form of hidden hunger: people who are not short of calories but who are short of what the calories contain, with consequences for child development, immunity and pregnancy.

5.3 Flood, drought and the collapse of water security

Water arrives as too much and too little. The 2022 floods in Pakistan, driven by exceptional monsoon rain on top of melting glacier water, [affected about 33 million people and killed more than 1,700](#); the government's post-disaster assessment put damage at about US\$14.9 billion and economic losses at US\$15.2 billion. The immediate dead were only the beginning. Contaminated water, destroyed health facilities, lost crops and crowded camps bring waves of diarrhoeal disease, skin infection, malaria and malnutrition in the months that follow. The drought side is slower but no less deadly: lost harvests and livestock, dry wells, and the displacement of pastoral and farming families.

These are events within a long background of unsafe water. The 2.1 billion people without safely managed drinking water and 3.4 billion without safely managed sanitation (JMP 2025) are the population in whom a flood becomes an epidemic. In coastal Bangladesh, rising sea level and tidal surge are pushing salt into rivers, groundwater and fields, [with a World Bank study projecting significant shifts in river salinity in the south-west by 2050, with likely drinking-water shortages and lost dry-season irrigation](#). Salt, as a slow pollutant of water and soil, is a good example of the way in which the climate and pollution agendas converge.

5.4 A warmer world for pathogens

Infectious diseases are sensitive to temperature, rainfall and humidity, because the mosquitoes, ticks and bacteria that carry them are. The Lancet Countdown reports that [the global average climate-defined transmission potential for dengue has risen by about 49 per cent since the 1950s](#). The outcome has been dramatic: in 2024 [WHO recorded 14.4 million dengue cases, including 7.7 million laboratory-confirmed, 52,738 severe, and 11,201 deaths, over 100 countries reporting, with Brazil accounting for most](#). A recent analysis by [Haider and colleagues](#) arrived at a similar scale, about 14.1 million cases.

WHO's own quantitative risk assessment, though dated and covering only some pathways, indicates the relative scale of climate-related health harm in the near future: [about 250,000 additional deaths a year between 2030 and 2050](#), from childhood undernutrition (95,000), malaria (60,000), diarrhoea (48,000) and heat stress in older people (38,000). The assessment is conservative: it omits floods, storms, wildfire, mental illness and the loss of health services, and it assumes continued economic growth and improvements in health systems.

6. The Mind, the Household and the Community

Suffering is not only physical. The polycrisis is also a crisis of mental health, of belonging and of security, and its effects on households and communities determine whether physical harms are survivable. Displacement, conflict and poverty are both consequences of the earlier pathways and causes of further harm.

6.1 Fear, grief and mental illness

Climate stress affects mental health through at least three routes: direct (heat, trauma from disasters), indirect (loss of livelihood, displacement, illness in the family) and existential (the anticipation of a worsening future). The first is documented in suicide statistics. Using county-level data from the United States and Mexico, Burke and colleagues found that [higher monthly temperatures raised suicide rates, and that unmitigated warming could produce between 9,000 and 40,000 additional suicides in the two countries by 2050 \(Burke et al. 2018\)](#), an effect comparable in size to that of an economic recession.

The existential dimension is increasingly visible among the young. A survey of 10,000 people aged 16 to 25 in ten countries found that [59 per cent were very or extremely worried about climate change, and 84 per cent were at least moderately worried](#), and that the distress was greater among those who felt their governments were failing to respond ([Hickman et al. 2021](#)). Such anxiety is not a pathology; it is a reasonable reaction to a real threat. But it is a cost, and for those who have also lived through floods, fires or the loss of a home, it is joined by trauma, depression and grief.

6.2 Leaving home

Displacement is where the physical and social pathways meet. In 2024, [disasters caused 45.8 million internal displacements, the highest figure since monitoring began in 2008 and more than double the decade average, with weather-related events accounting for 99.5 per cent](#). That count tallies movements, not individuals, and most were short-lived evacuations; at the end of 2024, 9.8 million people remained displaced by disasters, within a total of 83.4 million internally displaced from all causes. The forward-looking estimates are larger. The World Bank's *Groundswell* report projects that [climate change could force 216 million people to move within their own countries by 2050 under a pessimistic scenario](#): 86 million in Sub-Saharan Africa, 49 million in East Asia and the Pacific, 40 million in South Asia, 19 million in North Africa, 17 million in Latin America and 5 million in Eastern Europe and Central Asia. It also finds that decisive action on emissions and development could reduce the numbers by as much as 80 per cent.

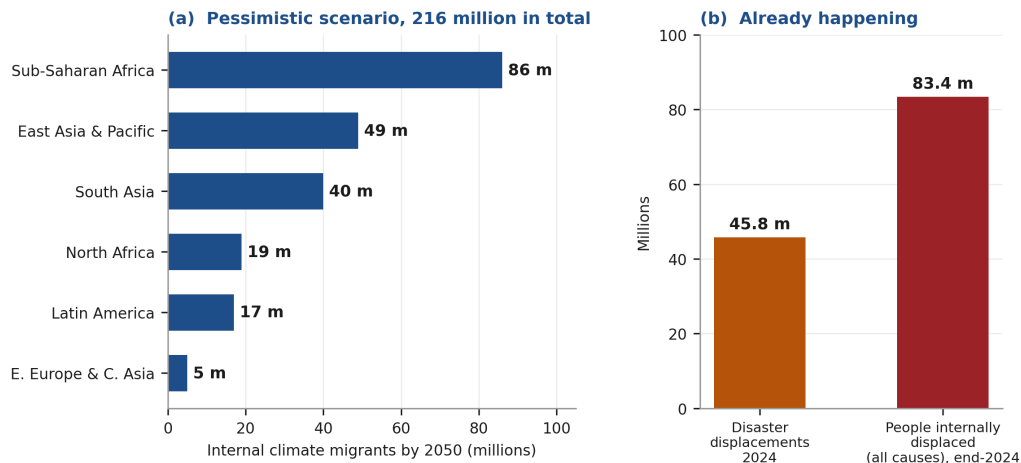


Figure 9. Leaving home: (a) projected internal climate migration by 2050 in the pessimistic Groundswell scenario; (b) displacement already recorded.

Sources: World Bank, [Groundswell](#) (2021); IDMC, [Global Report on Internal Displacement 2025](#). Disaster displacements count movements, not unique individuals.

The experience of displacement is not abstract. It means the loss of land, the break-up of kinship networks, a period in crowded and insecure housing, interrupted schooling, and the exposure of women and children to violence and exploitation. It is also a major cause of poverty, since displaced families seldom regain the assets they left. In low-income settings, people displaced by disasters often settle in the most hazardous parts of rapidly growing cities, where they are again exposed to flood, heat and pollution.

6.3 Conflict and the fraying of order

The link between climate and organised violence is contested and conditional, and it is easy to overstate. A structured expert elicitation of leading researchers in *Nature* concluded that [climate has influenced organised armed conflict within countries, but that other drivers, such as low socioeconomic development and weak state capacity, are substantially more influential](#), with experts' estimates of climate's contribution to past conflict risk ranging from a few per cent to as much as 20 per cent ([Mach et al. 2019](#)). The experts also judged that intensifying climate change would raise future risks.

The more robust finding is the reverse flow: conflict amplifies climate suffering. SOFI has repeatedly shown that [conflict zones are at the heart of the world's hunger crises](#), and the places with the most fragile institutions are the places least able to protect people from heat, floods and pollution. This is the mechanism by which the polycrisis closes into a loop: a stressed, hungry, displaced population in a weak state is both more vulnerable to the next shock and more likely to be caught in violence that destroys what is left of its capacity to cope.

6.4 Poverty as the common thread

Poverty is both the most powerful amplifier of harm and an outcome of it. The World Bank's 2025 update, which raised the international poverty line to US\$3 a day, found that [about 838 million people were living in extreme poverty in 2022](#), and that extreme poverty has risen in Sub-Saharan Africa and in fragile and conflict-affected states while falling in South Asia. The poor live in the most exposed places, work in the most exposed jobs and lack the savings, insurance and public services that cushion a shock. A single flood, a failed harvest or a prolonged illness can strip a household of the few assets that kept it above the line, and

the loss is hard to reverse. That is why poverty is the thread that ties together the pathways in Sections 3 to 6, and why Section 7 treats it as a node in the feedback loops of the system rather than as a mere background condition.

6.5 The household as shock absorber

When public services fail or are absent, the household absorbs the shock, and within the household the burden is not shared equally. Women and girls typically take on the extra work of fetching water and fuel, nursing the sick and feeding the family when harvests fail, and children are often withdrawn from school first when income falls or when a flood destroys the classroom. These adjustments are rational in the short term and costly in the long term: a child who leaves school during a drought, or who is stunted by a season of hunger, carries the loss for life. The same logic applies to the sleep, stress and illness that heat and pollution produce, which erode the capacity to work, learn and care.

The importance of this for the argument of the report is that household coping strategies are themselves a channel of the feedback loops of Section 7. Selling a productive asset to pay for medicine, taking a child out of school, borrowing against next year's harvest, or moving to an informal settlement on a flood plain all reduce a household's resilience to the next shock. Suffering at the household level therefore does not merely add up; it compounds, and it compounds fastest where there is the least to fall back on.

7. The Pollution, Climate and Poverty Cycle

The pathways described so far do not act in isolation. They are joined by feedback loops in which an effect of the crisis becomes a cause of it. Reinforcing loops make the system self-amplifying; a few balancing loops resist, and some, as the case of aerosols shows, work against the interests of the people they protect. Understanding these loops is the key to understanding why the polycrisis tends to worsen over time and why it cannot be addressed one problem at a time.

7.1 Why loops matter

In systems terms, a reinforcing loop is a chain of causes that returns to its starting point and strengthens it: more of A leads to more of B, more of B leads to more of A. A balancing loop does the reverse. A system dominated by reinforcing loops with a gain above one is unstable. Small initial differences grow, shocks leave lasting damage, and recovery becomes harder with each round. The central contention of this section is that the polycrisis contains at least six such reinforcing loops running through the pollution, climate and poverty domains, and that they interact. The loops are not hypothetical: each is grounded in documented mechanisms, summarised in Table 3 and illustrated in Figure 10.

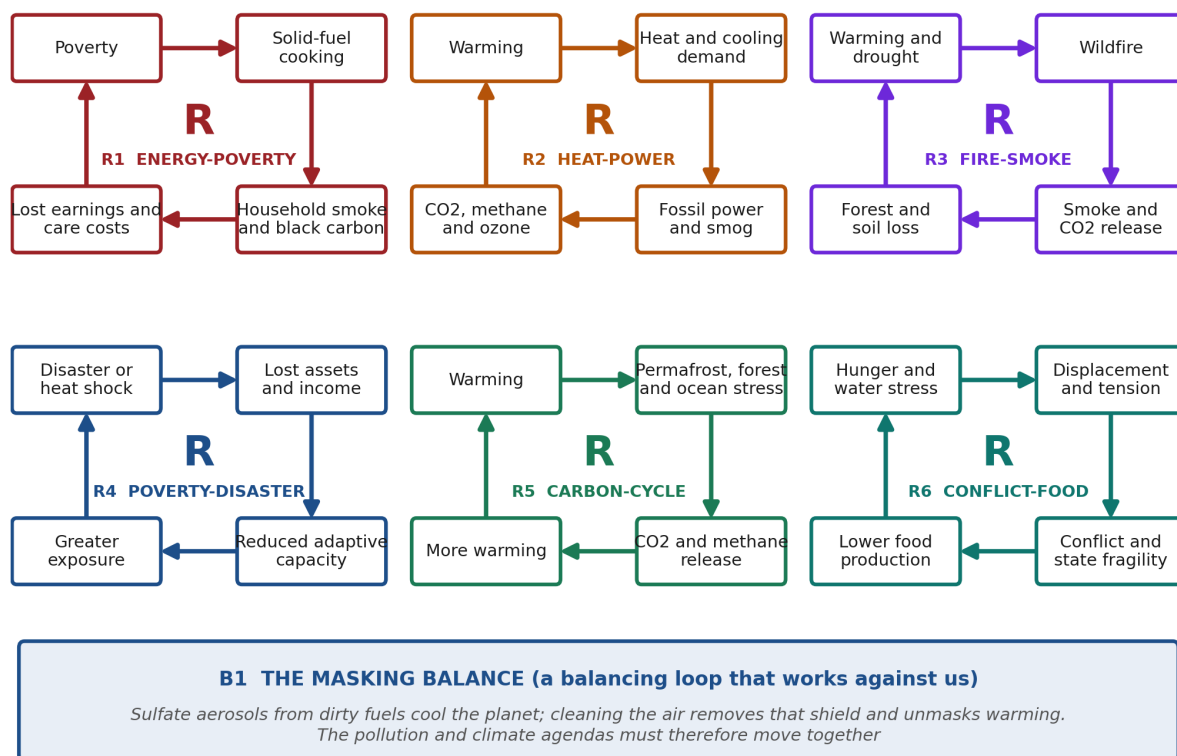


Figure 10. Six reinforcing loops (R) and one balancing loop (B) that carry the polycrisis forward.

Source: H Heuristics, causal-loop schematic. Arrows read clockwise; each loop is grounded in the evidence cited in Section 7.2. The masking balance (B1) is discussed in Section 7.3.

7.2 The six reinforcing loops

R1. The energy-poverty loop

Poverty keeps households dependent on solid fuels, which pollute their homes, harm their health and consume their time. [About 2.09 billion people still lacked clean cooking in 2023](#), and household air pollution caused [about 2.8 million deaths in 2023](#). Illness removes earners and adds care costs; time spent collecting fuel is time not spent on schooling or work; and the smoke and gathering of biomass add to emissions and to pressure on forests. The household stays poor and the stove stays lit. The loop is a reinforcing one at the level of the family and, because poor households are also the ones most exposed to climate shocks, it connects directly to the rest of the system.

R2. The heat-power loop

Heat increases demand for cooling, and cooling uses electricity that is in most countries still generated at least in part from fossil fuels, which emit both carbon dioxide and the precursors of smog. The 2026 South Asian heatwave illustrates the dynamic: the [World Weather Attribution analysis](#) recorded record-high electricity demand in India during the event. More fossil power means more warming and worse air, which means more heat and more disease. There is also a second-order effect on the poor: those who cannot afford cooling bear the heat, while those who can afford it contribute disproportionately to the demand that strains the grid.

R3. The fire-smoke loop

Warmer, drier conditions increase the area and severity of wildfires. Wildfires release carbon dioxide and burn forests that would otherwise have absorbed it, and they produce enormous quantities of fine particulate matter. The Lancet Countdown reported [154,000 deaths from wildfire-smoke PM2.5 in 2024, a record](#). The loop operates at ecosystem scale in the Amazon, where the [Global Tipping Points Report](#) notes that deforestation currently stands at about 17 per cent and that clearing just over a fifth of the forest (22 per cent) is enough to lower the dieback threshold to 1.5 °C of global warming. Forest loss, fire and drought reinforce one another, and at some point the forest may cease to be a sink and become a source.

R4. The poverty-disaster loop

Disasters destroy assets, interrupt incomes and push households into debt, and each of these reduces the household's capacity to prepare for or recover from the next. Pakistan's 2022 floods, which [affected some 33 million people and caused around US\\$15 billion in damage](#), pushed the economy and millions of households further down a path of vulnerability. The same applies on a smaller scale to every drought, cyclone and heat shock. Recurrent losses create a ratchet: poorer after each event, less able to protect against the next, and therefore more exposed.

R5. The carbon-cycle loop

This is the physical loop at planetary scale. Warming thaws permafrost, stresses forests and oceans and disrupts the natural sinks that have so far absorbed about half of human carbon dioxide emissions ([Global Carbon Project](#)); the weakened sinks release carbon or absorb less, which means more warming. Estimates of permafrost carbon release by 2100 [cluster between about 50 and 120 gigatonnes of carbon, with the high end tied to high-emissions pathways and most of the release occurring after 2100](#). The Global Tipping

Points Report finds that [warm-water coral reefs have already passed their tipping point](#) at about 1.2 °C, and that the permafrost, the subpolar gyre and the Greenland and West Antarctic ice sheets are near their thresholds at around 1.5 °C. The loop is slow, but it is the one that lengthens the tail of suffering into the centuries examined in Section 9.

R6. The conflict-food loop

Hunger and water stress raise tension and displacement, which feed conflict and state fragility, which in turn reduce food production and aid delivery. [SOFI](#) shows that conflict zones are at the heart of the hunger crisis, and the [expert elicitation in Nature](#) judged that climate raises conflict risk, albeit modestly compared with other drivers. As with the other loops, the importance is less in the size of any one link than in the closure of the circle.

Table 3. The reinforcing loops: mechanism, evidence and how they connect.

Loop	Mechanism	Key evidence	Strength
R1 Energy-poverty	Poverty → solid-fuel cooking → smoke and illness → lost income → poverty	2.09 billion without clean cooking; 2.8 million household-air deaths (SoGA 2025)	Strong
R2 Heat-power	Heat → cooling demand → fossil power → emissions and smog → warming	Record power demand in the 2026 South Asian heatwave	Moderate
R3 Fire-smoke	Warming and drought → wildfire → smoke and CO ₂ → warming and forest loss	154,000 smoke deaths in 2024; Amazon at 17% deforestation (Lancet Countdown ; GTP 2025)	Strong
R4 Poverty-disaster	Disaster → asset loss → lower adaptive capacity → greater exposure	Pakistan 2022: 33 million affected (PDNA)	Strong
R5 Carbon-cycle	Warming → permafrost, forest and ocean stress → CO ₂ and methane → warming	Permafrost 50-120 GtC by 2100; coral reefs past tipping point (GTP 2025)	Emerging
R6 Conflict-food	Hunger → displacement and tension → conflict → lower food production	Conflict at heart of hunger crises (SOFI 2025); Mach et al.	Moderate

Evidence strength: strong = quantified in multiple authoritative sources; moderate = documented mechanism with limited global quantification; emerging = mechanism established, magnitude uncertain. H Heuristics assessment.

7.3 The balancing loop that works against us: aerosol masking

The one significant balancing loop in the system is perverse. Burning fuels with sulfur releases sulfate aerosols, which reflect sunlight and cool the planet; the same particles are the pollution that kills. Cleaning the air therefore saves lives and, simultaneously, removes part of the cooling shield, revealing warming that had been hidden. The 2020 International Maritime Organization rule that cut the sulfur cap in marine fuel from 3.5 per cent to 0.5 per cent is a recent natural experiment. A [Carbon Brief analysis by Hausfather and Forster](#) estimated that the rule reduced sulfur dioxide emissions by about 8.5 million tonnes a year and would add about 0.05 °C to global temperature by 2050, while others, including James Hansen, have argued that the effect is larger.

The policy implication is neither to keep the air dirty nor to ignore the unmasking. It is to treat the two agendas as one. Air-quality policy that cuts sulfur must be matched by faster cuts to carbon dioxide and to short-lived warming agents such as methane. The UNEP and Climate and Clean Air Coalition [Global Methane Assessment](#) found that a 45 per cent reduction in human-caused methane emissions this decade

would avoid nearly 0.3 °C of warming by 2045 and prevent about 260,000 premature deaths a year, together with 775,000 asthma-related hospital visits, because methane is also a precursor of ground-level ozone. This is the clearest example of the double dividend that justifies treating the pollution and climate agendas together.

7.4 What loops do over time

Two properties of loops matter for the long run. The first is that they convert one-off shocks into persistent damage: a flood that destroys a household's savings changes the family's trajectory for a generation, and a drought that kills a herd changes a community's. The second is that the loops interact. A hot year raises power demand (R2), which raises emissions, which accelerates warming and strengthens the carbon-cycle loop (R5), which raises the probability of the next hot year. In the language of the [polycrisis literature](#), the coupling among loops, not the size of any individual crisis, is what produces the outsized impacts.

The result is a system in which, left unchecked, harm accumulates faster than the capacity to absorb it. The 2025 planetary-boundaries update, with seven of nine boundaries transgressed, is the macroscopic signature of that accumulation. The next two sections show what this means over time: first to the end of the century, then over centuries.

8. How the Suffering Grows: The Century Ahead

The suffering described in Sections 3 to 6 is the baseline. This section asks how it changes by 2050 and 2100 under different emissions paths. The central result is that the harms are strongly non-linear in warming: each additional tenth of a degree exposes more people to dangerous conditions than the last, and the difference between scenarios is measured in the hundreds of millions of lives.

8.1 The warming paths

The IPCC's Sixth Assessment Report gives best estimates of global warming for five shared socioeconomic pathways. For 2081 to 2100, the best estimates are about 1.4 °C for the lowest-emissions scenario, 1.8 °C for SSP1-2.6, 2.7 °C for SSP2-4.5, 3.6 °C for SSP3-7.0 and 4.4 °C for SSP5-8.5, above the 1850-1900 average ([IPCC AR6 WGI Summary for Policymakers](#)). Current policies are tracking about 2.8 °C according to [UNEP](#), close to the intermediate pathway. The world has already warmed by about 1.4 °C, and several tipping elements are near their thresholds. The pathways are close together at mid-century (best estimates of 1.7 to 2.4 °C for 2041 to 2060 across the four main scenarios) and far apart by the end of the century, which means that what is done in the next decade matters less for the next thirty years than for everything after them.

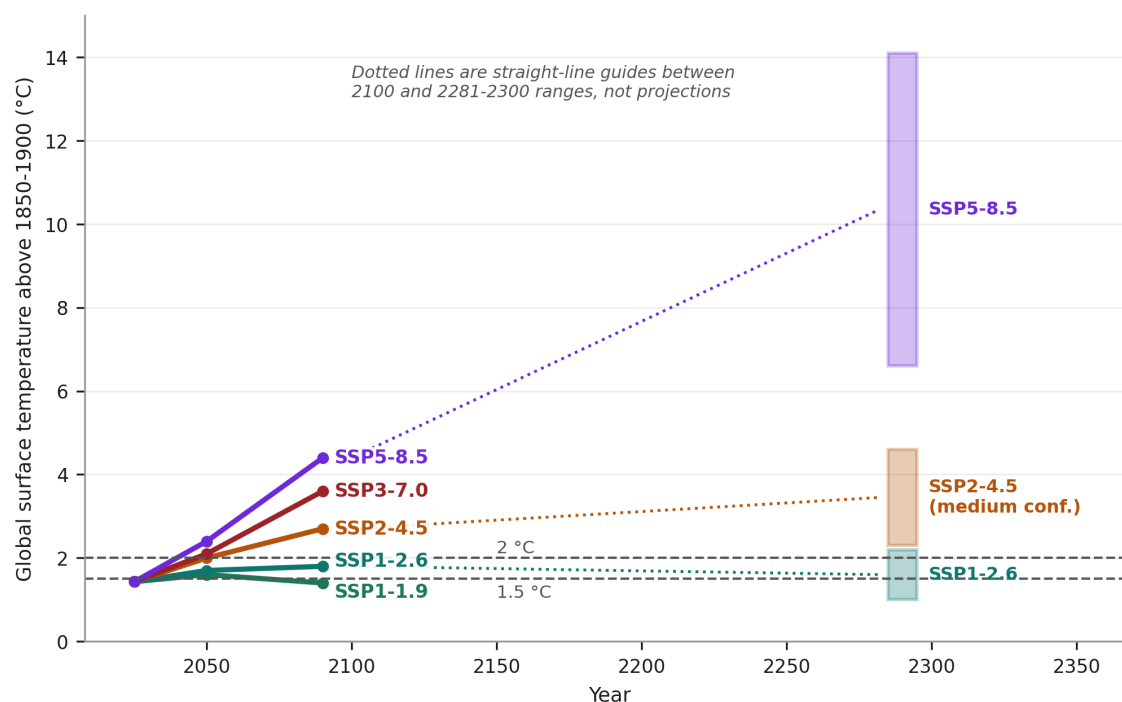


Figure 11. Warming above 1850-1900 under the IPCC's scenarios, to 2090 and to the 2281-2300 period.

Sources: [IPCC AR6 WGI SPM](#) (best estimates 2041-60 and 2081-2100); [IPCC AR6 Chapter 4](#) and Technical Summary (2281-2300 ranges). 2025 value from [WMO](#).

8.2 Heat and the number of people exposed

The most-cited quantification of the human cost of warming is the work of Lenton and colleagues, who count the number of people exposed to what they call *dangerous heat*: a mean annual temperature of 29 °C or above. They find that under current policies, which lead to about 2.7 °C by the end of the century, [around](#)

two billion people, 22 per cent of projected population, would be exposed, compared with about five times fewer at 1.5 °C, and that each 0.1 °C of warming above present levels exposes roughly 140 million more people (Lenton et al. 2023). An earlier analysis of the human climate niche by Xu and colleagues, which defined the niche as the range of mean annual temperatures in which humanity has flourished for millennia, found that 1 to 3 billion people could fall outside that niche within fifty years, depending on warming and population growth (Xu et al. 2020), and that without migration about a third of the world's population could face mean annual temperatures above 29 °C, a level found today on only about 0.8 per cent of land, mostly in the Sahara. The figures differ with the definitions and assumptions, and neither implies that all those people would move. But they are a measure of how large the population is that would live under conditions that humans have not historically inhabited at scale.

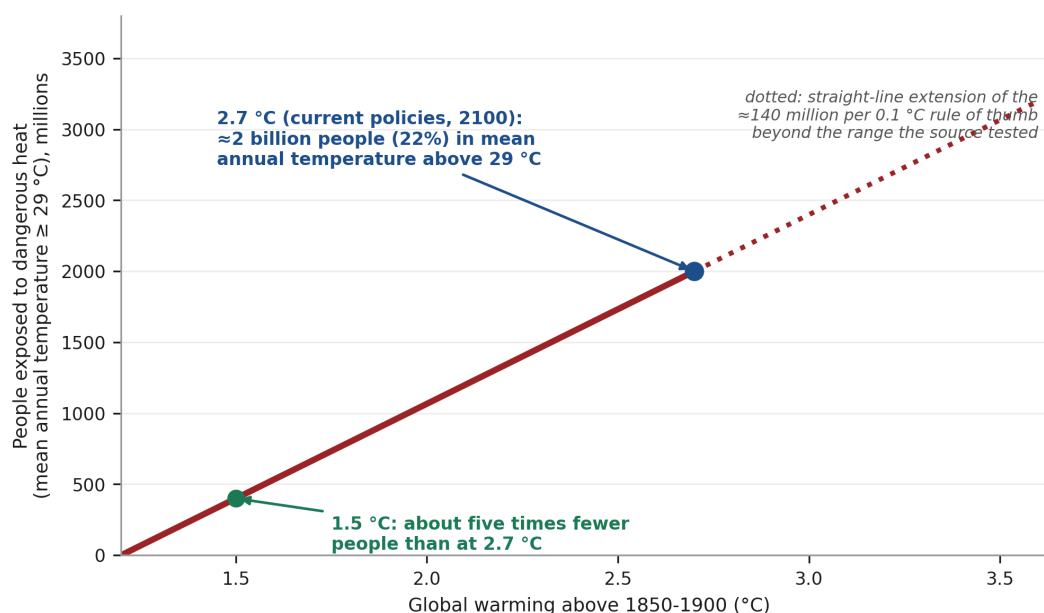


Figure 12. People exposed to dangerous heat rise roughly linearly with each added degree of warming.

Source: H Heuristics, drawn from the rule of thumb in Lenton et al. 2023 (about 140 million people per 0.1 °C above present, 2 billion at 2.7 °C). The dotted extension is illustrative and exceeds the range the source tested.

8.3 Deaths: the mortality cost of carbon

The most direct way to express the long-run consequence is in lives. Bressler's integrated assessment of the *mortality cost of carbon* found that, in a business-as-usual emissions scenario, cumulative excess heat-related deaths between 2020 and 2100 would reach about 83 million, compared with about 9 million if emissions were eliminated by 2050, a difference of roughly 74 million lives (Bressler 2021). The estimate covers only temperature-related mortality and the author considers it potentially a large underestimate. Carleton and colleagues, using data from 40 countries, found that the mean global increase in mortality risk due to climate change, accounting for the costs and benefits of adaptation, equals about 3.2 per cent of global GDP in 2100 under a high-emissions scenario (Carleton et al. 2022), and that the burden falls much more heavily on hot, poor places.

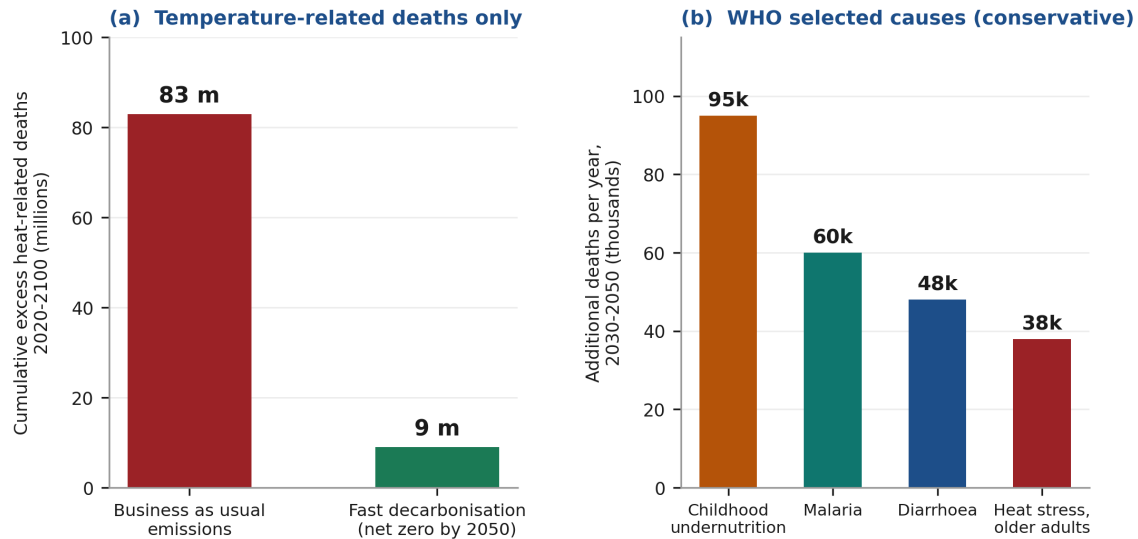


Figure 13. Projected deaths: (a) cumulative excess heat deaths 2020-2100 under two emissions paths; (b) WHO's conservative estimate of additional annual deaths from selected causes, 2030-2050.

Sources: [Bressler 2021](#) (Nature Communications); [WHO 2014 quantitative risk assessment](#). The two panels measure different things and are not additive.

8.4 Hunger, displacement and the other channels

The other channels grow in similar fashion. SOFI 2026 projects that [around 520 million people could still be chronically hungry in 2030](#); elevated carbon dioxide would remove nutrients from the crops that feed the poorest ([Smith and Myers](#)); Groundswell's 216 million internal migrants by 2050 are an order of magnitude greater than today's disaster displacement; and the [Kulp and Strauss reassessment of coastal elevation](#) found that 190 million people, under a low-emissions scenario, already live on land that will fall below high-tide lines by 2100, rising to up to 630 million on land below projected annual flood levels under high emissions. The sources use different methods, but they point in the same direction: the exposed populations increase as warming proceeds, and they are concentrated in the poorest regions.

Table 4. The century ahead under three emissions paths (indicative ranges from the cited sources).

Measure	Low emissions ($\approx 1.8^{\circ}\text{C}$)	Current policies ($\approx 2.7^{\circ}\text{C}$)	High emissions ($\approx 4.4^{\circ}\text{C}$)
Warming 2081-2100 (best estimate)	1.8°C (SSP1-2.6)	2.7°C (SSP2-4.5)	4.4°C (SSP5-8.5)
Global sea level rise by 2100	0.32-0.62 m	0.44-0.76 m	0.63-1.01 m
People in dangerous heat ($\geq 29^{\circ}\text{C}$ mean)	≈ 0.4 billion at 1.5°C ; more at 1.8°C	≈ 2 billion	Higher; beyond tested range
Excess heat deaths 2020-2100	≈ 9 million (net zero 2050)	Between the two	≈ 83 million
Internal climate migrants by 2050	≈ 44 million	Between the two	≈ 216 million
People on land below annual flood level, 2100	Lower	Intermediate	Up to 630 million

Sources: [IPCC AR6 SPM](#); [Lenton et al. 2023](#); [Bressler 2021](#); [Groundswell](#); [Kulp and Strauss 2019](#). Scenario labels are approximate matches between studies. Not additive.

8.5 Air quality: a mixed picture

Air pollution presents a more mixed trajectory than heat. Stricter regulation, the retreat of coal and cleaner vehicles have lowered exposure in parts of the world, and the 2025 planetary-boundaries update notes that aerosol pollution remains within its safe limit globally. But in the places where most deaths occur, population growth, urbanisation and continued reliance on solid fuels keep exposure high. And climate change itself works against air quality: warmer, drier conditions increase wildfire smoke (R3), and higher temperatures speed the chemistry that makes ground-level ozone. The net effect is that the *air-quality dividend* from clean energy, which could reduce deaths by millions, is partly offset by the climate penalty unless the two agendas move together, which is the lesson of the masking balance in Section 7.3.

9. Prolonged Over Centuries: The Long Tail of a Warming Planet

Everything so far describes a century. But the physical system that produces the suffering does not obey a century-long clock. Carbon dioxide persists for millennia; the deep ocean and the great ice sheets respond over centuries; and the tipping elements, once crossed, play out over timescales that dwarf political cycles. The suffering set in train in this generation will therefore be prolonged, and in some scenarios worsened, for hundreds of years.

9.1 Why climate outlives policy

Carbon dioxide behaves differently from other pollutants. Particulate matter falls out of the air in days; methane breaks down within about a decade. Carbon dioxide does not decay in any simple way. Fossil-fuel CO₂ equilibrates among the atmosphere, ocean and land over a few centuries, but a significant fraction remains in the air, awaiting removal by far slower geological processes. David Archer's widely used rule of thumb is that fossil-fuel CO₂ behaves like a lifetime of roughly 300 years plus a quarter that lasts essentially forever, and Archer and Brovkin report that published models place the fraction remaining airborne after a thousand years at 20 to 60 per cent, with full recovery taking hundreds of thousands of years. The practical implication is that net-zero emissions would stabilise warming rather than reverse it, and that warming already in the system will persist for centuries.

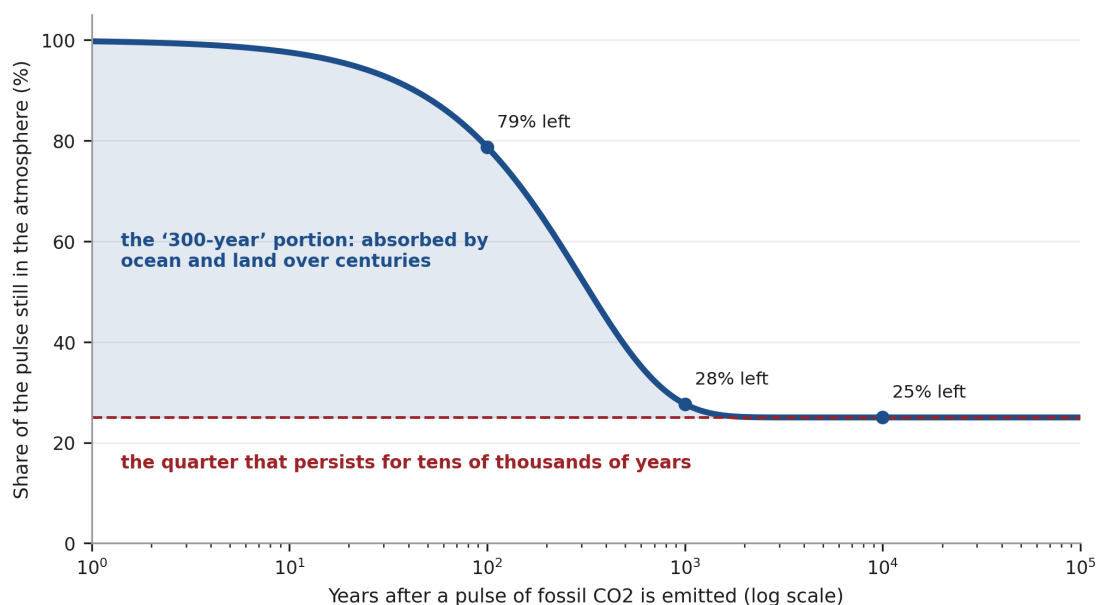


Figure 14. The long tail: share of a pulse of fossil CO₂ still in the atmosphere, using Archer's rule of thumb.

Source: H Heuristics rendering of the rule of thumb in [Archer 2009](#) (about 300 years plus a persistent 25 per cent). A simplification; real carbon-cycle models give a range of 20 to 60 per cent remaining after a thousand years.

9.2 Temperatures to 2300

Beyond 2100, the IPCC projects only two scenarios because simulations for the others are too few for robust results. The Chapter 4 assessment projects that by 2300 the likely warming is 1.0 to 2.2 °C under the low-emissions scenario SSP1-2.6, and 6.6 to 14.1 °C under SSP5-8.5, with a medium-confidence range of 2.3 to 4.6 °C for the intermediate pathway. These figures describe two entirely different human futures. At the

low end, the world has stabilised near the Paris range, with most of its coastal cities, agricultural regions and ecosystems still recognisable. At the high end, temperatures are far beyond anything in human history, and large parts of the tropics and subtropics may be unsurvivable without continuous engineered cooling (Figure 11).

9.3 The slow rise of the sea

Sea level responds more slowly than temperature, and that makes it a good proxy for committed damage. The IPCC's sea-level projections for 2100 are 0.32 to 0.62 m (SSP1-2.6) and 0.63 to 1.01 m (SSP5-8.5), but by 2300 they widen to 0.3 to 3.1 m and 1.7 to 6.8 m, with sea level rise beyond 15 m by 2300 *not ruled out* under very high emissions because of low-confidence ice-sheet processes. The multi-century lag means that even if temperatures stabilised, the seas would keep rising for generations. The scale of exposure matters: Kulp and Strauss show that today's coastal elevation data triple earlier estimates of the population living on land vulnerable to sea level rise, with 110 million people on land below high-tide lines now and up to 630 million on land below annual flood levels by 2100 under high emissions.

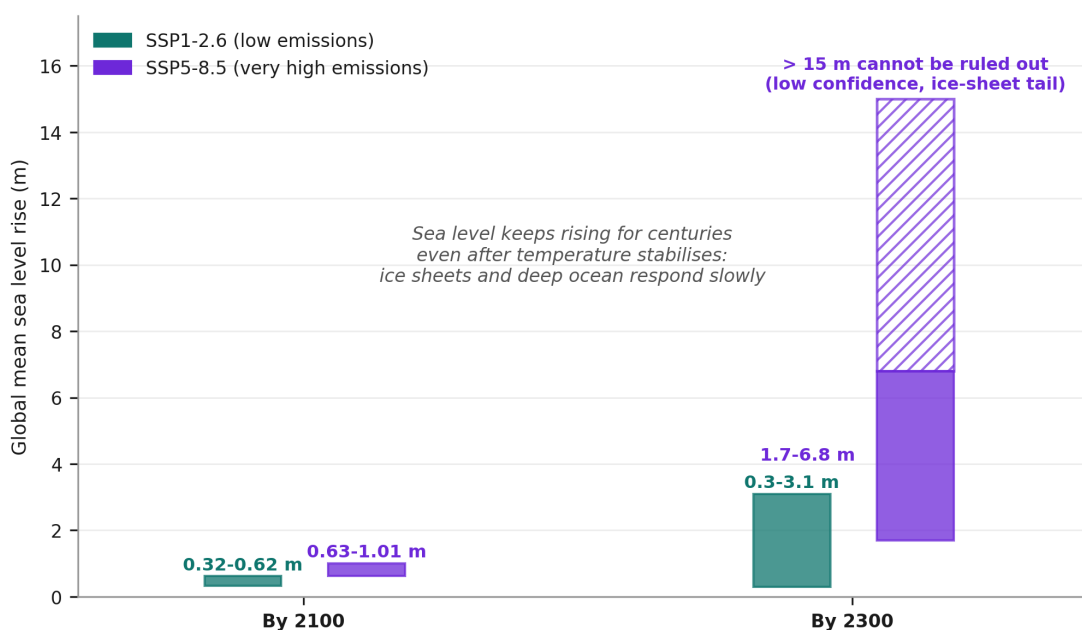


Figure 15. Global mean sea level rise by 2100 and by 2300 under low and very high emissions.

Source: [IPCC AR6 WGI SPM, Figure SPM.8](#): 17th-83rd percentile ranges relative to 1900 (2300) and likely ranges (2100). The hatched bar shows the low-confidence tail that cannot be ruled out.

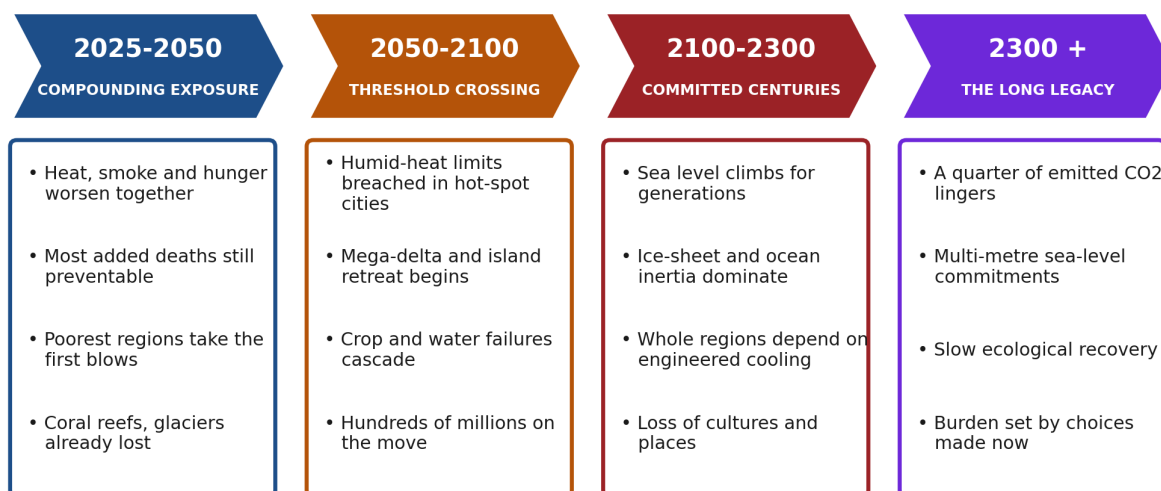
9.4 Slow tipping elements

Some elements of the Earth system respond so slowly to warming that their consequences are inherited by generations unborn. Permafrost carbon release, as noted, is expected to occur largely after 2100. The Greenland and West Antarctic ice sheets, according to the [Global Tipping Points Report](#), are among the systems near their thresholds at about 1.5 °C, and once their loss becomes self-sustaining it continues for centuries. The Atlantic Meridional Overturning Circulation is a different case: [a physics-based early-warning study found the circulation to be on a tipping course, with a collapse bringing severe winter cooling in north-west Europe, shifts in tropical rainfall belts and disruption of the Amazon](#) (van Westen et al. 2024),

though the IPCC has medium confidence that it will not collapse before 2100 and the timing is highly uncertain. These are low-probability, high-consequence events, and they cannot be dealt with after the fact.

9.5 Four phases of a prolonged crisis

Taken together, the evidence suggests a four-phase structure for how suffering unfolds over centuries (Figure 16). *Compounding exposure* (to about 2050) is the period in which the present-day pathways intensify together but most of the added suffering remains preventable. *Threshold crossing* (about 2050 to 2100) is the period in which, under medium and high emissions, local limits are breached: humid-heat limits in hot-spot cities, water and salinity limits in deltas, food and water failures in vulnerable regions. *Committed centuries* (2100 to 2300) is the period in which the slow components of the Earth system dominate: sea level continues to rise, and ice-sheet and ocean inertia determine the burden, which in the high-emissions case includes the progressive abandonment of whole regions. And the *long legacy* (beyond 2300) is the period in which the persistent fraction of carbon dioxide leaves a multi-millennial imprint.



Cumulative commitment to suffering rises with each phase - and is set largely by emissions in the first

Figure 16. Four phases of a prolonged polycrisis, from compounding exposure to a multi-century legacy.

Source: H Heuristics, conceptual schematic informed by [IPCC AR6](#), the [Global Tipping Points Report 2025](#) and Archer's carbon-persistence work. Phase boundaries are indicative.

The ethical significance of this structure is easy to miss. In the first phase the people who suffer are mostly alive today. In the third and fourth phases, they are mostly not yet born. The harms do not fall on those who made the decisions, and they cannot be undone by them. That asymmetry is what makes the polycrisis a problem of intergenerational justice as well as of public health.

10. Survivability Risk Areas

As warming proceeds, the risk to life does not rise evenly across the planet. It concentrates in particular places where hazards overlap, where adaptive capacity is thin, and where the margin between current conditions and the limits of human physiology or of agricultural and water systems is narrow. This section identifies ten such survivability risk areas, explains how they were assessed, and stresses what the term does and does not mean.

10.1 What survivability risk means

Survivability risk is the likelihood that conditions in a place will exceed what its people can withstand with the adaptation they can realistically mobilise. It has two halves, exposure and capacity, and neither alone is sufficient. A very hot place with abundant cheap energy, strong health systems and good housing can protect its residents, as the oil-rich states of the Gulf largely do, though at the cost of dependence on continuous cooling and on imported labour who work outdoors. A moderately hot place with fragile institutions, subsistence agriculture and no cooling can be lethal. The practical question is therefore not whether a region will be too hot for humans in the abstract, but for whom, with what protection, and at what cost.

The concept also needs a caution. Survivability risk is not the same as uninhabitability. No region of the planet is projected to become instantly unsurvivable at a given date; risk rises gradually, with episodic extremes first, and populations respond by changing behaviour, technology and, ultimately, location. What the framework identifies is where the combination of hazards and constraints makes the human cost of staying highest, and where migration, if it occurs, is likely to be compelled rather than chosen.

10.2 How the areas were assessed

Ten regions were chosen because the literature repeatedly identifies them as hot spots for at least one lethal hazard. For each, H Heuristics scored six dimensions on a scale from 1 (low) to 5 (extreme): humid heat; drought and food-system stress; flooding and sea-level rise; air pollution and wildfire smoke; water scarcity and salinity; and the adaptive-capacity gap (the extent to which the population lacks the resources to protect itself). Scores were made for two time points, 2050 (about 2 °C) and 2100 (about 2.7 °C, current policies), and a third case adds one point to each hazard score for the high-emissions world of about 4.4 °C. The scoring is a structured judgement informed by the sources cited, not a statistical model, and is described in Appendix A. It is offered as a transparent way of comparing regions, to be challenged and refined, and not as a prediction.

	2050 (about 2 °C)						2100 (about 2.7 °C, current policies)					
	Humid heat	Drought and food	Flood and sea level	Air and smoke	Water and salinity	Adaptive-capacity gap	Humid heat	Drought and food	Flood and sea level	Air and smoke	Water and salinity	Adaptive-capacity gap
Persian Gulf and Arabian Peninsula	4	3	2	4	5	2	5	4	3	4	5	2
Indo-Gangetic Plain (N. India, Pakistan, Bangladesh)	4	3	4	5	4	4	5	4	4	5	5	4
Sahel and Horn of Africa	3	5	3	3	4	5	4	5	3	3	5	5
Central America and Caribbean	3	4	4	2	3	4	4	5	4	3	4	4
Amazon basin and northern S. America	3	3	3	4	2	3	4	5	3	4	3	3
Mega-deltas (Ganges, Mekong, Irrawaddy, Nile)	3	2	5	3	5	4	4	2	5	3	5	4
Small-island states and atolls	2	3	5	1	5	4	3	3	5	1	5	4
Mediterranean and Levant	3	4	3	3	5	3	4	5	3	3	5	3
North China Plain and East Asia	3	3	4	4	4	2	4	3	4	3	4	2
Arctic and permafrost communities	1	1	3	2	3	4	1	1	4	3	3	4

Figure 17. Survivability-risk matrix: ten regions scored on six dimensions in 2050 and 2100.

Source: H Heuristics assessment on a 1-5 scale (1 = low, 5 = extreme), informed by the sources cited in Section 10.3 and described in Appendix A. A structured judgement, not a model output.

10.3 The ten areas

Persian Gulf and Arabian Peninsula

The Gulf is where the physiological limit is closest to being reached. [Pal and Eltahir](#) projected that, under high emissions, a wet-bulb temperature of 35 °C would be breached for a six-hour period at least once every ten to twenty years along the Persian Gulf by the end of the century, and [Raymond and colleagues](#) found that extreme humid heat has already approached the limit on the Gulf coast. The risk is mitigated by wealth, since the Gulf states can afford air-conditioned cities and desalinated water, but the protection is conditional on continuous energy and does not extend to the migrant workers who build and service the cities: the ILO reports that [83.6 per cent of workers in the Arab States are exposed to excessive heat](#). The 2024 Hajj deaths showed how rapidly an outdoor population can be overwhelmed.

Indo-Gangetic Plain

The densely populated plain of northern India, Pakistan and Bangladesh combines nearly every hazard. It suffers intense pre-monsoon heat: [the April 2026 heatwave was made about three times more likely by climate change](#). It has some of the worst air in the world (Pakistan, Bangladesh and India all in the top six in [IQAir's 2025 ranking](#)), recurrent catastrophic floods, of which the [2022 Pakistan floods](#) were the largest recent example, and a large, poor and often rural population with limited access to cooling. It holds the largest concentration of people at risk in the world, and it is the region in which the wet-bulb thresholds of Section 4 are most likely to be approached first by people in large numbers.

Sahel and Horn of Africa

Here the dominant hazard is drought and the resulting food insecurity, set against weak institutions, conflict and extreme poverty. [Africa has the highest prevalence of hunger, about 20 per cent of the population and some 309 million people undernourished](#), and the ILO estimates that 92.9 per cent of African workers are exposed to excessive heat. The World Bank's *Groundswell Africa* report estimates that [up to 32 million people in West Africa could be compelled to move within their countries by 2050 without climate and development action](#), and that concrete action could cut that number by about 60 per cent. The risk is less a single physiological threshold than a slow failure of the systems that keep people fed and watered.

Central America and the Caribbean

The region faces drought in its dry corridor, hurricanes on its coasts and heat in its agricultural lowlands. The kidney disease of sugarcane workers described in Section 4.3 is a regional signature of heat as an occupational hazard. [Groundswell](#) projects 17 million internal climate migrants in Latin America by 2050. Heavy dependence on rain-fed subsistence agriculture, together with exposure to storms, makes household resilience low and the cycle of poverty and disaster (R4) especially visible.

Amazon basin and northern South America

The Amazon is at once a victim and an amplifier. Deforestation stands at about 17 per cent, and [clearing just over a fifth of the forest is enough to lower the dieback tipping point to 1.5 °C of global warming](#). A dieback would remove one of the planet's great carbon sinks and rainfall engines and expose millions of forest-dependent and indigenous people to heat, smoke and food loss. Fire-season smoke is already a major health hazard in the region, as part of the record 154,000 deaths from wildfire smoke worldwide in 2024.

Mega-deltas: Ganges-Brahmaputra, Mekong, Irrawaddy and Nile

River deltas combine high population density, low elevation and dependence on freshwater and fertile soil. Sea-level rise and storm surge do not simply flood them: they push salt into rivers, groundwater and fields. In Bangladesh, a [World Bank study projects significant increases in river salinity in the south-west coast by 2050](#), with drinking-water shortages and lost dry-season irrigation; and in the Mekong Delta, home to more than 20 million people, modelling indicates that sea-level rise will become the dominant driver of salinisation by around 2050. [Kulp and Strauss](#) estimate that 190 million people worldwide live on land below projected 2100 high-tide lines under low emissions, and many of them live in these deltas.

Small-island states and atolls

For low-lying atoll nations, sea-level rise is existential. Even under the low-emissions scenario, the IPCC's projections reach 0.3 to 3.1 m by 2300, and under very high emissions several metres more ([IPCC AR6 SPM](#)). Well before land is lost, saline intrusion degrades freshwater lenses and the soils on which food crops depend, storm waves overtop settlements, and coral reefs, which protect shorelines and sustain fisheries, have [already passed their tipping point](#). The risk includes loss of territory, of livelihood and of cultural continuity, and the question of what happens to a state whose land disappears.

Mediterranean and Levant

The Mediterranean basin is a climate hot spot where drought, heat and wildfire reinforce one another, and where water is already scarce. Heat exposure, particularly among older populations in ageing societies,

together with falling water availability and severe fire seasons, raises the risk to health and to agriculture, and combines with fragile states on the southern and eastern shores. Unlike the first areas above, a large share of the risk here comes from compounded, recurrent extremes rather than from any one limit. This area is scored on the basis of the general hazard assessments in Sections 4 and 5 rather than a dedicated study, and its scores are correspondingly less certain.

North China Plain and East Asia

Modelling by [Kang and Eltahir](#) identified the North China Plain as a second hot spot of potentially lethal humid heat, because intensive irrigation raises humidity on top of rising temperatures. The region's adaptive capacity is considerably higher than in South Asia, and its air quality has improved substantially, so its score reflects exposure more than vulnerability. It is included because of the sheer size of the exposed population and because it demonstrates that the risk is not confined to the poorest regions.

Arctic and permafrost communities

The Arctic is warming nearly four times faster than the global average ([Rantanen et al. 2022](#)). Its human population is small but its communities, many of them Indigenous, face thawing permafrost that damages roads, buildings and water systems, coastal erosion, changes in sea ice that cut hunting and travel, and wildfire. Heat is not a lethal threat in the physiological sense, but the loss of the ground itself is. The Arctic matters to the rest of the world also because its permafrost carbon is among the largest stores that could feed the carbon-cycle loop (R5).

Table 5. The ten survivability risk areas: dominant hazards and why survival is at risk.

Area	Dominant hazards	Why survival is at risk	Composite 2050 / 2100
Persian Gulf and Arabian Peninsula	Humid heat, water	Wet-bulb limits approached; outdoor workers and pilgrims exposed	3.3 / 3.8
Indo-Gangetic Plain	Heat, air, floods, water	Huge exposed population; poor housing; extreme smog; monsoon floods	4.0 / 4.5
Sahel and Horn of Africa	Drought, food, water	Hunger above 20%; fragile states; conflict; limited adaptive capacity	3.8 / 4.2
Central America and Caribbean	Drought, storms, heat	Dry corridor; occupational kidney disease; subsistence farming	3.3 / 4.0
Amazon basin and northern S. America	Dieback, fire, smoke	Tipping threshold near; fire smoke; forest-dependent peoples	3.0 / 3.7
Mega-deltas	Flooding, salinity	Low elevation; saltwater intrusion; dense population	3.7 / 3.8
Small-island states and atolls	Sea level, salinity	Loss of land, freshwater and reefs; loss of statehood	3.3 / 3.5
Mediterranean and Levant	Drought, heat, fire	Water scarcity; compounding extremes; fragile states	3.5 / 3.8
North China Plain and East Asia	Humid heat, floods	Irrigation-amplified humid heat; very large population	3.3 / 3.3
Arctic and permafrost communities	Thaw, erosion, fire	Loss of ground, ice and infrastructure; remote and Indigenous communities	2.3 / 2.7

Scores refer to the composite in Figure 18 (mean of six dimensions, 1-5). H Heuristics assessment; sources as linked in Section 10.3.

10.4 What the ranking shows

Three conclusions emerge from the comparison. First, the ranking is dominated by regions where several hazards coincide with low adaptive capacity, rather than by those where a single hazard is most extreme. The Indo-Gangetic Plain, the Sahel and Horn and Central America lead in 2100 not because they are the hottest, but because heat, water stress, floods and poverty overlap. Second, the high-emissions case (about 4.4 °C) pushes almost every region above the *severe* line, which is itself an indication that the world's habitable and productive space shrinks sharply in a high-emissions world; by contrast, at about 2 °C in 2050, no region other than the Indo-Gangetic Plain reaches the severe line. Third, adaptive capacity, the one dimension that societies can still change, differs most between regions and has the most leverage.

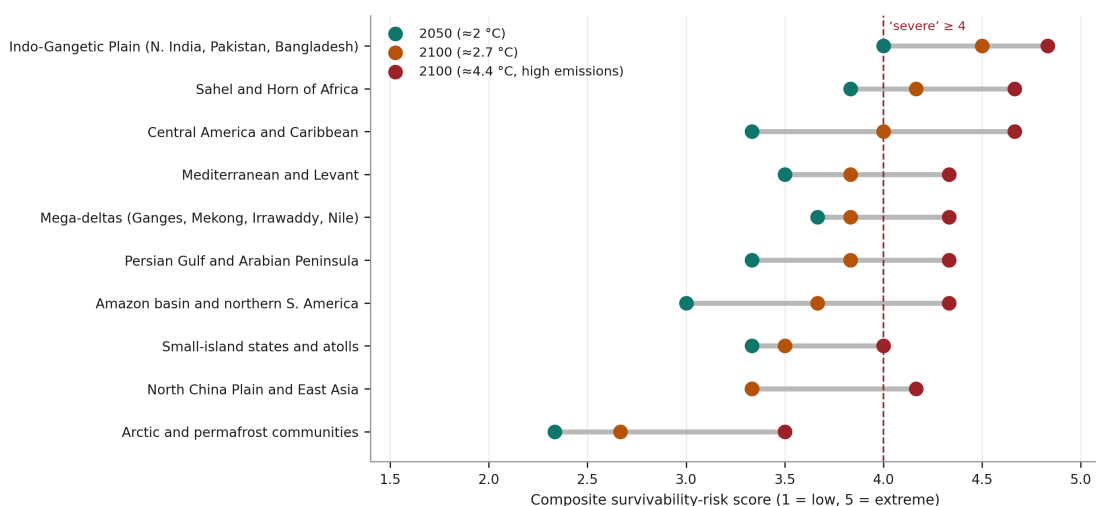


Figure 18. Composite survivability-risk score by region, 2050 and 2100 under three warming levels.

Source: H Heuristics assessment; composite is the unweighted mean of six dimensions scored 1-5. The high-emissions case adds one point (capped at 5) to the five hazard scores for 2100. See Appendix A.

10.5 What the framework does not say

The framework should not be read as a map of places to abandon. Many of the areas above are among the most productive and culturally rich regions on Earth, and the people who live there have enormous experience in adapting to extreme conditions. Nor does it forecast mass migration, which depends on policy, wealth and the willingness of destination countries to receive people. And the scores do not capture surprises: tipping points, sudden policy changes, technological advances and rapid declines in the cost of cooling and clean energy could shift any of them. The purpose of the exercise is to show where preventive investment in adaptation, early warning, cooling, water and social protection will do most to protect life, before the thresholds are reached rather than after.

11. Who Bears the Weight

Suffering is not distributed by chance. It follows lines of income, age, occupation, gender and geography, and the people who bear the heaviest burden are, in nearly every case, those who have done least to cause the problem and have the fewest resources with which to meet it.

11.1 Geography and income

The geography of harm is the clearest evidence. About 92 per cent of pollution-related deaths occur in low- and middle-income countries ([Lancet Commission](#)). The countries with the worst air are Pakistan, Bangladesh, Tajikistan, Chad and the Democratic Republic of the Congo. Hunger is concentrated in Africa and Western Asia. The highest shares of workers exposed to excessive heat are in Africa (92.9 per cent), the Arab States (83.6 per cent) and Asia and the Pacific (74.7 per cent) ([ILO](#)). The result is a stark inversion: the regions with the lowest per-capita emissions and the least capacity to adapt face the highest exposure.

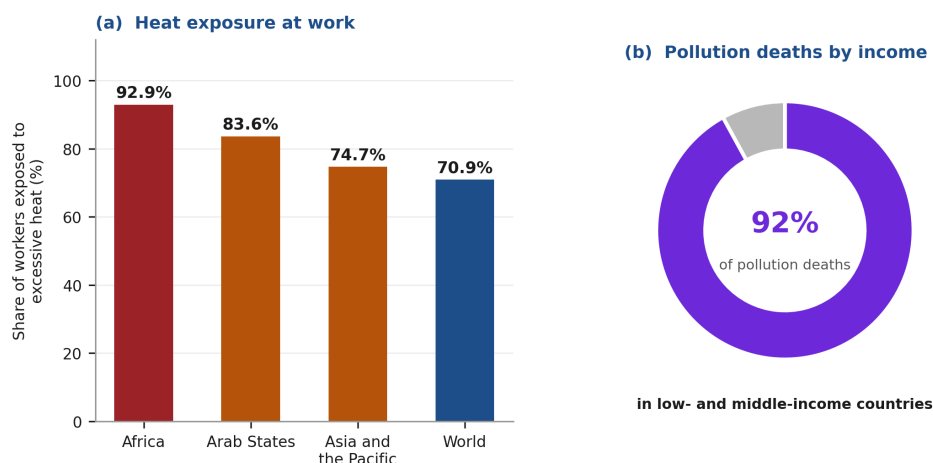


Figure 19. Unequal exposure: (a) share of workers exposed to excessive heat by region; (b) pollution deaths by income group.

Sources: [ILO 2024](#); [Lancet Commission on Pollution and Health](#).

11.2 Age, pregnancy, work and gender

Within countries, the pattern repeats. Infants and older adults experience far more dangerous heat days than the average ([Lancet Countdown](#)). Children bear the heaviest burden of air pollution: [air pollution is the second-leading risk factor for death among children under five](#), and the lifetime effects of early deprivation compound. Pregnant women face higher risks of preterm birth and stillbirth in heat ([BMJ](#)). Outdoor and manual workers shoulder the occupational toll. And in the sleep data, [women, the elderly and residents of lower-income countries lost substantially more sleep to warm nights than average](#). The burdens on women extend beyond physiology, since women are usually the household fuel collectors, water carriers and caregivers who absorb the work created by each hazard.

11.3 The ethics of unequal suffering

The Lancet Countdown calculation that the toll of heat alone amounts to roughly a death every minute ([UCL summary](#)) puts the human stakes plainly. Three ethical features stand out. The harms are *distributionally regressive*, falling hardest on the poorest. They are *intergenerational*, since Section 9 shows

that the children of today and the unborn of the coming centuries will inherit most of the committed damage. And they are *largely preventable*: nearly all the pathways described here have known, cost-effective interventions. When a harm is both unequal and preventable, its persistence is a matter of justice as well as of policy.

11.4 Who is counted

A final inequality is statistical. The people who suffer most are often the least visible in the data on which policy is built. Heat deaths in informal settlements and among migrant workers are rarely attributed to heat; more than half of those who died at the 2024 Hajj were unregistered ([CBS News](#)). Incomplete data can distort even the ranking of the most polluted countries: Chad's fall from first place in 2024 to fourth in 2025 is attributed to data gaps rather than cleaner air ([IQAir 2025, via Anadolu](#)). Mortality attributions in low-income countries rest heavily on modelling because vital registration is incomplete. The consequence is that official figures probably understate the burden precisely where it is greatest, and that investments in measurement, monitoring and registration are themselves a form of protection: what is not counted is seldom prevented.

12. Bending the Curve: What Reduces Suffering

If the polycrisis is a system of reinforcing loops, the way to reduce suffering is to weaken the loops where they are most sensitive and to build the capacity of people to withstand what cannot be prevented. The evidence suggests that the most effective measures are those that work on the pollution, climate and poverty agendas at once.

12.1 What a stylised model says about the next three centuries

To illustrate the stakes, H Heuristics constructed a transparent stylised model (Appendix A) in which a composite *suffering index*, set to 100 in 2025, depends on population, on the vulnerability of people to a given level of heat and related hazard, and on a convex damage function of global temperature. It includes an optional feedback increment to represent the carbon-cycle and tipping loops of Section 7. It is not a forecast: it is an argument about structure, showing how much hinges on the emissions path, on the strength of adaptation, and on whether feedbacks are triggered.

The results are stark. In a rapid-decarbonisation world, the index peaks at about 120 around mid-century and then falls, to roughly 99 by 2100 and 35 by 2300, as warming stabilises and adaptation continues. Under current policies it roughly doubles by 2050 (to about 210), peaks at about 370 around 2110, and remains near 280 in 2300. Under high emissions it reaches about 350 in 2050, about 1,500 in 2100 and about 4,400 in 2300, a figure that should be read not as a prediction of suffering but as a signal that the model has left the range in which adaptation can be assumed to work. Summed over 2025 to 2300, the current-policies path produces about 4.4 times as much suffering as rapid decarbonisation, and the high-emissions path about 36 times as much. Feedbacks add about 2 per cent to the total in the low case, 17 per cent in the current-policies case and 45 per cent in the high case: loops matter most exactly where warming is largest.

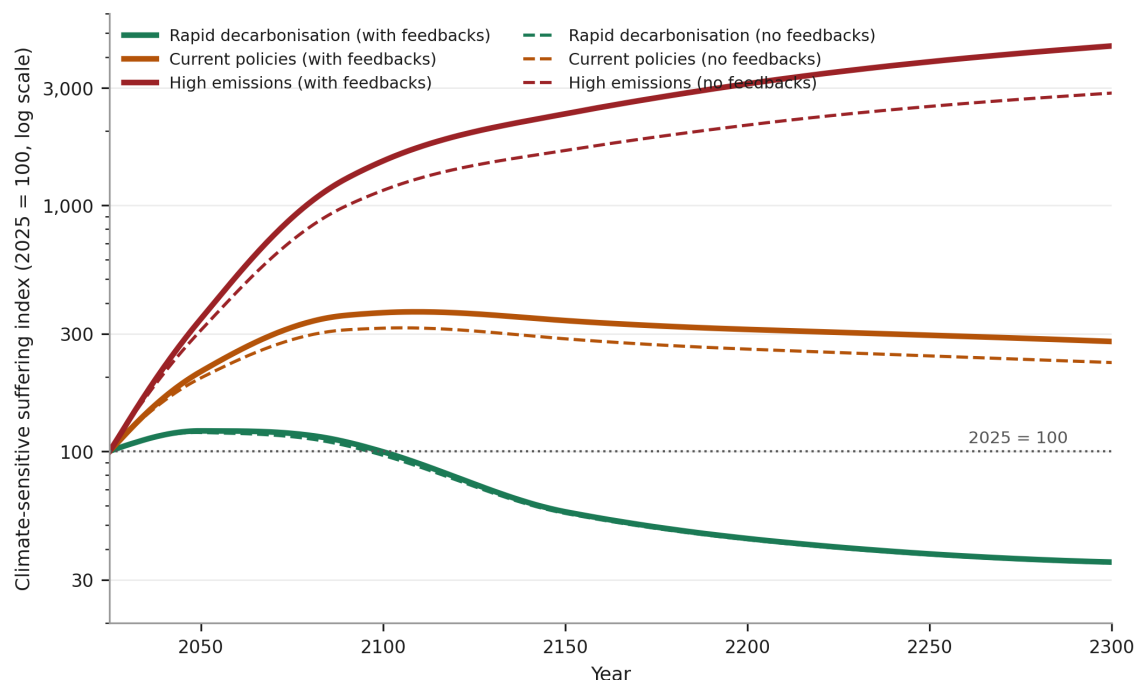


Figure 20. An illustrative suffering index, 2025-2300, under three emissions paths with and without feedbacks (log scale).

Source: H Heuristics illustrative model (Appendix A). Temperature anchors from [IPCC AR6](#); population hump and vulnerability decline are stated assumptions. An argument about structure, not a forecast.

12.2 The levers, and what each can do

Table 6 summarises the principal levers. Several of them deliver immediate, measurable reductions in suffering, within the lifetime of today's children, while also reducing the long-run commitment. That is important because the most common objection to decisive action is that its benefits come late. For pollution and heat, that is not true.

Table 6. Levers for reducing suffering: evidence of benefit and time to effect.

Lever	Evidence of benefit	Time to effect
Cut methane and short-lived pollutants	45% cut in methane this decade: avoids nearly 0.3 °C by 2045 and about 260,000 premature deaths a year (Global Methane Assessment)	Years
Universal clean cooking	2.09 billion people still cook with polluting fuels; household air pollution killed about 2.8 million in 2023 (Tracking SDG7 ; SoGA 2025)	Immediate to years
Clean air policy and clean power	99% of people breathe air above WHO guideline levels; 7.9 million deaths (WHO)	Years to decades
Rapid decarbonisation	Fast cuts avoid about 74 million of 83 million excess heat deaths this century (Bressler 2021); 1.5 °C rather than 2.7 °C means about five times fewer people in dangerous heat (Lenton et al.)	Decades, commitments for centuries
Heat action and workplace protection	Improved prevention could save up to US\$361 billion in lost income and medical costs (ILO); sleep and pregnancy protections	Immediate
Early warning and anticipatory action	Early Warnings for All aims to protect everyone with multi-hazard warnings by 2027	Years

Lever	Evidence of benefit	Time to effect
Adaptation finance and social protection	Adaptation finance of about US\$26 billion a year against a need of US\$310-365 billion (UNEP Adaptation Gap Report 2025)	Years
Development that cuts vulnerability	Decisive action could cut internal climate migration by up to 80% (Groundswell)	Decades

Sources as linked. Benefits are those reported by the cited sources and are not additive. H Heuristics classification of time to effect.

12.3 Sequencing: relief now, commitment later

The implication of the evidence is a two-track strategy. The first track is *suffering relief now*: clean cooking, cleaner air, heat action plans, early warning, safe water and nutrition, which deliver rapid reductions in death and illness among the most exposed and which also strengthen their capacity to withstand the shocks to come. The second is *commitment management*: cutting emissions fast enough to keep the world on the lower-warming paths, where the multi-century tail is far smaller. The first track buys time and relieves immediate pain; the second shapes whether the pain eventually ends. Neither can substitute for the other, and the pollution-and-climate overlap means that many of the same measures serve both.

12.4 Honest limits

Three limits should be stated. First, adaptation is not unlimited: the humid-heat thresholds of Section 4 and the sea-level commitments of Section 9 are physical limits, and the cost and energy needed to adapt rise steeply as they are approached. Second, adaptation resources are unequally distributed, and the people with the greatest exposure often have the least access to them, which is why finance and institutions matter as much as technology. Third, the long tail cannot be eliminated by any action taken now; it can only be shortened. The aim of policy should be to move the world toward the futures in which suffering diminishes rather than the futures in which it compounds.

13. Conclusion

The polycrisis is usually described in the language of systems, risks and tipping points. Behind that language is a plain fact: it hurts people, in specific ways, in specific places, and it is set to hurt more of them for longer unless the loops that sustain it are broken.

This report has traced the suffering through the body and the mind. Polluted air, now killing about 7.9 million people a year, damages the heart, brain and lungs from the womb to old age. Heat, at about 546,000 deaths a year and rising, overloads the cardiovascular system, injures the kidneys, steals sleep and endangers pregnancy. Floods, droughts and a changing nutrient and disease landscape add hunger, thirst and infection. Fear, grief, displacement and conflict add a social and psychological layer. These pathways are not separate: they are joined by reinforcing loops running through energy poverty, heat and power demand, wildfire, disaster and poverty, the carbon cycle and conflict, held in check only by a perverse balancing loop in which cleaning the air unmasks warming.

Looking forward, the suffering grows non-linearly with warming. By the end of the century, depending on the path, the number of people exposed to dangerous heat could differ by a factor of five, excess heat deaths by roughly 74 million, and internal climate migration by 170 million. Looking further, it is prolonged for centuries by the persistence of carbon dioxide, the inertia of the sea and ice, and the slow tipping elements. Ten regions, from the Gulf and the Indo-Gangetic Plain to the Sahel, the great deltas, the islands and the Arctic, face the greatest risk to survival, and in each the risk is the product of hazard and of a gap in the capacity to adapt.

Three messages follow. *First, the agendas are one.* Pollution, climate and poverty share causes, victims and loops, and policies that treat them separately risk making each worse, as in the case of aerosol masking. *Second, much suffering is preventable now.* Clean cooking, cleaner air, heat protection, early warning, safe water and nutrition relieve pain within years and strengthen resilience for what follows. *Third, the long tail is a choice.* The difference between a world in which suffering peaks and recedes and one in which it compounds for centuries is set in large part by the emissions of the next two decades. The people who will live with that choice are mostly not yet born. The decisions are being made by those who are.

Appendix A. Method Notes and Assumptions

A.1 The illustrative suffering-index model

The index in Section 12 is computed as $100 \times [\text{Pop}(t)/\text{Pop}(2025)] \times [\text{Vul}(t)/\text{Vul}(2025)] \times [\text{D}(\text{Tf}(t))/\text{D}(\text{T}2025)]$, where Pop is global population (a hump rising from 8.2 billion in 2025 to about 10.3 billion in the 2080s and declining thereafter), Vul is vulnerability per exposed person, D is a convex damage function and Tf is global temperature including the feedback increment. The damage function is $\text{D}(T) = (T/1.43)^2$, so that the index equals 100 in 2025 when warming is 1.43 °C ([WMO](#)). Vulnerability falls exponentially with scenario-specific adaptation, toward a floor. The feedback increment is $\text{Tf} = T + 0.15 \times \max(0, T - 1.5)^{1.3}$, a stylised representation of tipping and carbon-cycle feedbacks, set to be modest relative to the published ranges.

Table A1. Model assumptions by scenario.

Assumption	Rapid decarbonisation	Current policies	High emissions
Scenario analogue	SSP1-2.6	SSP2-4.5	SSP5-8.5
Warming 2050 / 2090 / 2300 (°C)	1.65 / 1.80 / 1.60	2.00 / 2.70 / 3.45	2.40 / 4.40 / 10.35
Adaptation rate (per year)	1.2%	0.65%	0.3%
Vulnerability floor (share of 2025)	30%	40%	50%
Feedback increment coefficient	0.15 (on / off)	0.15 (on / off)	0.15 (on / off)

Temperature anchors are best estimates from [IPCC AR6](#); 2300 values are mid-points of the AR6 likely ranges (1.0-2.2 °C; 2.3-4.6 °C, medium confidence; 6.6-14.1 °C). All other values are H Heuristics assumptions chosen for transparency.

A.2 The survivability-risk matrix

Each region was scored on six dimensions from 1 to 5, using the sources cited in Section 10.3 and the hazard indicators in earlier sections, with the following anchors. For humid heat, 1 indicates no projected approach to the physiological limits, and 5 recurrent exceedance of the 31 to 35 °C wet-bulb range. For drought and food, 5 indicates recurring failure of staple production at the scale of the region. For flooding and sea level, 5 indicates inundation or chronic flooding of a large part of the inhabited area. For air and smoke, 5 indicates annual mean PM2.5 more than ten times the WHO guideline or recurring smoke emergencies. For water and salinity, 5 indicates severe, rising scarcity or saline degradation of the main water supply. For the adaptive-capacity gap, 5 indicates the weakest combination of income, institutions and health services. The composite is the unweighted mean. The high-emissions case adds one point to each of the five hazard dimensions (capped at 5) and leaves the capacity gap unchanged. The scores are a structured judgement with substantial uncertainty.

A.3 Limits of the evidence

Mortality attributions are modelled rather than counted and carry wide uncertainty. Burden figures overlap and use different years. Projections of mortality and exposure depend on assumptions about adaptation, which are poorly constrained. Several secondary sources are used for primary findings where the primary source was not directly retrieved; readers needing exact values should consult the primary publications. The temperature path beyond 2100 relies on only two scenarios with limited multi-model support.

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