PHYSIOLOGICAL THRESHOLDS AND LIMITS: FOUNDATIONS OF CLIMATE RESILIENCE

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Key points for policymakers

Climate change is causing rising temperatures, increased air pollution and disruption to food systems. This impacts the physiology of people around the world, making it more difficult for their body to stay healthy and function normally. Physiological harm can begin well before official warning levels are reached, especially for vulnerable groups. Policies based on how the human body responds to heat, pollution and food insecurity can protect people earlier and more effectively, and show why climate action to reduce emissions is essential.

In this sense, physiological resilience is a core component of climate resilience: it determines whether people can live, work and function as environmental conditions change.

What needs to happen:

Trigger protection earlier: Set warning systems and safety standards so action starts before people become unwell, not only once extreme conditions are reached.

Design for vulnerable groups: Use population-level physiological thresholds, derived from evidence across groups and exposure contexts, as triggers for system-level protection. These thresholds must be differentiated to protect vulnerable groups such as older adults, pregnant people, young children, babies and those with long-term illness (mental and/or physical).

Account for combined risks: Plan for heat, air pollution and poor nutrition together, since they often occur at the same time and make each other more dangerous.

Shift responsibility to systems: Build protection into workplaces, housing, public services and emergency planning, rather than expecting individuals to judge when conditions are unsafe.

Test whether adaptation is enough: Check whether proposed adaptation measures can realistically protect people as risks increase, rather than assuming people can always adjust.

Cut emissions to tackle climate change: Treat cutting emissions and air pollution as essential for keeping conditions within what people can safely tolerate.

Physiological resilience and climate resilience

Climate resilience is often framed in terms of emergency response or infrastructure such as energy systems and transport networks. Alongside these, the resilience of the people themselves who rely on those services or operate the infrastructure is essential.

That is physiological resilience: the capacity of people to maintain health, function and make decisions under environmental stress – as well as recover afterwards. Rising heat, deteriorating air quality and disruption to food systems place strain on physiological resilience, often before failures in the wider system are visible.

Physiological thresholds provide warning signals of where resilience is under stress i.e. where action is required to prevent conditions overwhelming the body. Physiological limits mark conditions where resilience fails.

1. Why this matters

Climate change is already placing a growing strain on human health. Rising temperatures, deteriorating air quality and increasing food insecurity are not abstract environmental problems. They translate directly into physiological stress on the human body and are already contributing to ill health, loss of function and, in some settings, premature mortality, particularly among populations with lower physiological resilience (i.e. the ability to cope with stress and recover without lasting harm).

Evidence from physiology research shows that health harm as a result of climate change occurs earlier, more unevenly and for more people than many current policy frameworks assume. Physiological thresholds and limits provide a way to understand where and how climate impacts become dangerous for people. Together, they define the boundaries of human tolerance and show where adaptation policy must act early to prevent harm, and why mitigation is essential because adaptation cannot always succeed.

Without explicitly accounting for these physiological boundaries, climate and health policies risk being too generic – i.e. too slow, too weak and poorly targeted, particularly for those most at risk.

In this briefing we consider resilience at two interconnected levels. Physiological resilience refers to the capacity of people to maintain their health, function and cognitive ability under environmental stress (such as rising heat) and to recover after. System resilience refers to the ability of infrastructure, services and institutions to continue operating under stress. These concepts are deeply interrelated: resilience of the system as a whole depends on the physiological resilience of the population they serve and the people who operate them.

2. What physiological thresholds and limits tell us

This section sets out (i) the physiological basis of thresholds and limits at the level of the human body, and (ii) how defining population-level thresholds for different physiologically vulnerable groups can guide effective policy action.

Physiology helps explain how the human body responds to environmental stressors such as heat, air pollution, dehydration and poor nutrition, and why climate change poses increasing risks to health.

Physiological thresholds

Physiological thresholds mark the point at which environmental stress begins to overwhelm the body's capacity to maintain function and the risk of harm increases. At this stage, bodily systems are still functioning, but with growing strain. Health, comfort, cognition and productivity may begin to decline, and the ability to cope with additional stress (physiological resilience) is reduced. Thresholds should not be viewed as benign or acceptable margins - they are warning points for when protective action is required to prevent escalation to more severe outcomes.

Thresholds vary both between individuals and within the same person depending on their personal circumstances and the situation, influenced by factors such as age, health status, hydration, activity level, acclimatisation, pregnancy and exposure duration. For people with lower physiological resilience, including older adults, young children (including babies), pregnant people, those with underlying health conditions and those suffering from malnutrition, thresholds may be reached earlier and over shorter periods of exposure. Both underlying health conditions and the levels of environmental stressors often correlate with socio-economic status in populations, with people of lower socio-economic status generally having a greater risk of physiological vulnerability. For many groups, physiological evidence enables population-based thresholds to be defined. These can provide actionable levels for when institutions must intervene to protect health and maintain productivity.

Physiological limits

Physiological limits describe conditions in which continued exposure leads to progressive physiological failure and survival becomes increasingly unlikely. These limits are not fixed, universal or precisely definable. They vary across individuals and contexts and reflect unavoidable constraints of human biology rather than a single point at which survival abruptly ends.

Thresholds and limits therefore sit along a continuum of physiology-based risk. People move along this continuum at different speeds depending on vulnerability, exposure intensity and duration, and the presence of multiple stressors. Together, thresholds and limits show where early action can prevent harm, and where harm becomes unavoidable if exposures continue to increase.

Practical policy implementation of physiological thresholds

Physiological thresholds, as defined in this briefing, describe points at which strain begins to overwhelm the body at the individual level and the risk of harm increases. Because individual thresholds vary widely, policy cannot operate at the level of the individual. To make action possible, this briefing argues for the use of population-level physiological thresholds, derived from evidence across groups and exposure contexts, as triggers for system-level protection. These thresholds must themselves be differentiated, reflecting known differences in physiological resilience across groups such as older adults, pregnant people, children and those with chronic illness. These population-level thresholds are designed to act well before physiological limits are approached, recognising that limits vary across individuals and cannot be reliably predicted or engineered around. Thresholds are not intended to define universal safety, but to guide differentiated action that prioritises those with lower physiological resilience.

From a resilience perspective, physiological thresholds should be used as indicators of system stress. They signal when the conditions in the environment are beginning to exceed the capacity of people – and therefore the systems that depend on them – to function safely.

3. Heat, air pollution and nutrition mechanisms

Heat

Human thermoregulation relies on maintaining core body temperature through sweating and circulatory adjustments that dissipate heat to the environment. As internal (exercise) and environmental thermal load (e.g. heat, humidity) increase these mechanisms become progressively less effective, increasing physiological strain even before extreme temperatures are reached. A physiological threshold is reached when heat production and gain begin to exceed heat loss. At this point, dehydration, cardiovascular strain and rising core temperature lead to increased fatigue, impaired cognition and reduced capacity to work safely.

With continued exposure, particularly under high humidity, heavy protective clothing and physical exertion, thermoregulatory mechanisms can no longer compensate and severe physiological consequences occur. While healthy adults may tolerate higher heat loads for short periods, vulnerable groups, notably the elderly, are likely to reach both thresholds and limits at lower temperatures and with shorter exposure durations. The transition from manageable strain to severe heat illness may occur rapidly and varies substantially between individuals and settings, increasing the risk of heat exhaustion, heatstroke and organ failure.

Air pollution

People may be exposed to air pollution, including particulate matter, in the natural environment, the urban environment and inside buildings. Air pollution makes the air we breathe harmful and damages our health by causing inflammation and oxidative stress, with systemic effects on the cardiovascular, respiratory, endocrine and nervous systems.

Climate change increases the likelihood and duration of harmful exposure e.g. through higher ozone concentrations at ground level and wildfire smoke. This makes establishing thresholds for triggering protection important, particularly for vulnerable populations.

It is important to note that, unlike an environmental stressor such as heat, there is not a level of air pollution below which long-term exposure is harmless. Health risks such as lung disease, heart attacks, dementia and stroke, rise with increased exposure.

In this context, a physiological threshold should not be considered a safe or acceptable level of exposure. In the absence of a 'safe' exposure level, we should think of a physiological threshold for air pollution as a trigger for action i.e. when a short-term exposure to a pollutant in the air produces a measurable impairment in the body, such as airway inflammation, reduced lung function or increased cardiovascular strain. In this way, the threshold marks the point at which the probability and severity of long-term harm increase to require system-level action to protect health.

Nutrition

Nutrition underpins the body's ability to cope with all stressors. Malnutrition reduces physiological resilience by impairing processes such as thermoregulation and limiting the capacity to respond to additional stress. Climate change has many wide ranging impacts on nutritional availability. For example, extreme weather events can reduce overall yields while the changing atmospheric composition reduces nutrient density. This results in many millions of people around the world being pushed closer to nutritional thresholds. A nutritional threshold is crossed when energy or micronutrient intake falls below levels needed to maintain normal bodily function. At this stage, susceptibility to infection rises, physical and cognitive capacity decline, and tolerance to other stressors such as heat is reduced.

Physiological limits are reached when malnutrition becomes severe enough to cause organ dysfunction, immune collapse or failure of vital systems. Climate change increases the risk of populations crossing nutritional thresholds through food insecurity and declining food quality, while also increasing exposure to heat and disease. These conditions lower the body's capacity to cope and can result in vicious cycles whereby, e.g. climate change increases communicable diseases such as diarrhoeal diseases which can reduce nutrient absorption, worsening undernutrition and making communities even more vulnerable to further illness.

Conversely, it is worth also noting that excessive calorific intake can lead to obesity which impacts on resilience, e.g. people with obesity are more predisposed to heat illness.

4. Combined stressors: why thresholds are crossed earlier and limits reached faster

In real-world settings, people are rarely exposed to a single environmental stressor in isolation. Heat, air pollution and poor nutrition frequently coincide, often alongside social and economic disadvantage. Climate change increases the likelihood, intensity and duration of these overlapping exposures.

From a physiological perspective, combined stressors interact by reducing the body's ability to compensate (physiological resilience). When heat places demand on thermoregulatory and cardiovascular systems, air pollution increases systemic inflammation, and malnutrition limits physiological resilience, thresholds are crossed at lower levels of exposure and over shorter timeframes than would be expected for any single stressor alone.

This interaction lowers thresholds and shortens the distance between threshold and physiological failure (limits), particularly for vulnerable groups. It also makes physiological thresholds and limits more difficult to predict and manage. Because combined effects vary across individuals and contexts, relying on behavioural adaptation or individual coping becomes increasingly unreliable.

In resilience terms, when thresholds are crossed earlier and limits reach faster due to these combined stressors, the likelihood of cascading failures across workplaces, health services, housing and wider social and economic systems increases.

5. Why current approach to policy underestimates real risk

Many climate and health policies, such as air quality standards or heat warning systems, rely on whole population averages and respond to single hazards, rather than considering how different groups - particularly the most vulnerable - respond to combined stressors.

When policy assumes people can self-regulate or adapt indefinitely, it shifts responsibility away from institutions and ignores biological constraints. Across heat, air pollution and combined exposures, physiological evidence consistently shows that measurable strain and health harm begins below commonly used single-hazard thresholds, especially for groups with lower physiological resilience, meaning policies that wait for generic thresholds to be crossed act too late to prevent harm. For example, this is evident in heat exposure, where older adults, pregnant people and those with chronic illness experience cardiovascular and thermal strain at lower temperatures than healthy adults; in air pollution, where people with existing heart or lung disease show adverse responses at concentrations below population guideline values; and when heat and air pollution occur together, where physiological strain and health impacts increase more rapidly than would be expected from either exposure alone.

For policy, this means that many existing approaches systematically underestimate risk especially for the most vulnerable, which can result in standards and warning systems - such as heatwave alerts, workplace heat guidance and building overheating criteria - that activate too late to prevent harm.

6. From thresholds to limits: what physiology means for adaptation and mitigation

Climate adaptation: Using physiologically informed differentiated population-level thresholds to trigger protective action

Adaptation strategies must prioritise those most at risk, which will in turn strengthen protection for everyone.

Individual physiological responses vary, but policy cannot operate at the level of the individual and therefore requires differentiated population-level thresholds to guide action. When used to determine policy action, physiological thresholds do not have to predict the exact point at which any one person will experience harm. Rather, physiologically informed population thresholds can focus on specific vulnerable groups and/or exposure contexts and use evidence derived from population-level data showing where risk begins to rise. Used in this way, thresholds provide a practical and precautionary basis for adaptation, triggering protective action before vulnerable individuals are pushed towards physiological limits. Recognising individual variability strengthens the case for earlier and differentiated thresholds and reinforces why adaptation has boundaries and cannot fully eliminate risk as exposures increase.

In this way, physiologically informed population thresholds identify points at which system-level protections must be activated to prevent escalating harm, rather than relying on individuals to recognise and respond to physiological danger. Viewed through a resilience lens, such thresholds are a practical way to test whether adaptation measures are sufficient to keep people safe in real world conditions. This helps shift responsibility towards employers, service providers and public authorities with responsibility for safe environments. Such action could include triggering heat health alerts, adjusting work practices, improving housing design or strengthening food and social protection systems.

Climate mitigation: Physiological limits and the boundaries of adaptation

Physiological evidence demonstrates that climate adaptation has inherent constraints. While people can adjust behaviour, environments and technologies to reduce risk, there are conditions under which continued exposure to rising heat, increased air pollution and disrupted food systems will progressively overwhelm physiological systems for some individuals and populations.

Therefore, physiological limits provide a strong biological justification for climate mitigation. The only long-term strategy to prevent more people experiencing conditions that exceed human tolerance is to tackle climate change by reducing emissions. Physiological limits define the outer boundary of climate resilience. If limits are exceeded, no amount of improvements to infrastructure or behavioural adaptation can prevent harm. Mitigation is therefore a cornerstone of maintaining a resilient society.

7. Policy-ready actions to enhance climate resilience

Evidence on physiological thresholds and limits points to several immediate actions to enhance climate resilience:

- **Use physiologically informed differentiated population-level thresholds to trigger protection based on targeted risk, not fixed averages:** Warning systems and safety standards should be linked to evidence of when different groups begin to experience harm, rather than relying on single, whole population-average thresholds or uniform trigger points.

- **Set standards that reflect real exposure:** When setting or applying temperature and heat stress limits, regulators and employers should account for humidity, radiant heat, airflow, workload, clothing and hydration, and apply lower, precautionary thresholds for groups with lower physiological resilience.

- **Plan for combined risks, not single hazards:** Climate and health strategies should assess and manage heat, air pollution and food insecurity together, e.g. through joint risk assessments, coordinated warning systems and integrated local resilience planning. It is important to consider future climate conditions when assessing combined risks.

- **Embed protection into systems, not individual behaviour:** Thresholds should trigger action in workplaces, housing, schools and public services, rather than relying on individuals to recognise danger and modify their own behaviour.

- **Climate mitigation is central to health protection:** There are physiological limits to adaptation. Policies to reduce greenhouse gas emissions and air pollution should be treated as essential for keeping environmental conditions within what people can safely tolerate. This cannot be separate from health adaptation policy.

8. Conclusion

Climate change is increasingly pushing people towards the limits of what the human body can tolerate. Evidence on how bodies respond to heat, air pollution and food insecurity shows that harm often begins earlier, and affects some groups more severely, than current policies such as heatwave warning systems assume.

A climate resilient society is about more than just whether infrastructure can withstand stress. It is fundamentally about whether people retain the physiological capacity to live, work and function within it.

Physiology research should be treated as core evidence alongside climate science and public health evidence for climate and health decision-making. Physiological resilience cannot be a secondary health impact to be considered after policies are designed. Physiological thresholds provide a basis for setting standards, triggering early warning systems, designing workplaces and housing, and assessing whether adaptation plans are sufficient to protect people in practice.

Physiological limits also make clear that there are conditions under which no amount of behavioural change or local adaptation can prevent harm. Keeping environmental exposures within what people can safely tolerate requires urgent action to tackle climate change by cutting emissions and air pollution as well as protecting food systems.

As climate risks intensify, integrating physiological thresholds and limits into climate policy is essential to climate resilience and delivering action to keep all of us, and especially the most vulnerable, safe and healthy.

Maintaining climate resilience: How physiological thresholds vary across populations

Physiological thresholds are not the same for everyone. Age, health status, pregnancy, nutritional status, workload and acclimatisation all affect how much environmental stress the body can tolerate before harm occurs. The examples below illustrate how thresholds commonly shift for different groups, and why a single whole population threshold fails to protect those most at risk.

Heat

Example: heat stress thresholds in the workplace (WBGT)

Wet Bulb Globe Temperature (WBGT) is widely used in occupational health because it integrates temperature, humidity, radiant heat and air movement into a single index of heat stress. For healthy, acclimatised adults doing moderate physical work, guideline and experimental evidence indicate that cardiovascular and thermal strain increase around WBGT 26–28 °C, which is why work–rest cycles, cooling and hydration are recommended from this range upwards.

Older workers, or workers who are unacclimatised, can reach similar levels of strain at around WBGT 24–26 °C. This is because of their lower thermoregulatory reserve, that is, the ability of their body to keep their core temperature safe is reduced.

For heavy physical labour, safe work times shorten rapidly once WBGT moves into the mid-20s °C, so thresholds for action need to be set lower than for moderate workloads, especially where opportunities for rest and fluid replacement are limited

Policy relevance: Relying on ambient temperature alone is not sufficient to keep people safe and healthy because it ignores humidity, radiant heat, air movement and workload, all of which can substantially increase physiological strain at the same air temperature. Indices such as WBGT better reflect this combined stress and should be used to set tiered thresholds and work–rest guidance. However, occupational standards that utilise a single WBGT threshold for all workers risk not protecting those with lower physiological resilience, particularly older adults and people with chronic disease.

Air pollution

Example: $PM_{2.5}$ exposure and cardiorespiratory disease

Fine particulate matter ($PM_{2.5}$) increases cardiovascular and respiratory strain at relatively low concentrations and risk increases in an almost linear way, with no clear safe threshold. The World Health Organization (WHO) sets 15 µg/m³ as the 24-hour guideline value for $PM_{2.5}$, and short-term exposures above this level are associated with measurable increases in hospital admissions and deaths from heart disease, heart failure and stroke.

For vulnerable groups, such as people with pre-existing asthma, chronic obstructive pulmonary disease, cardiovascular disease, or for older adults and children, adverse physiological responses may occur at lower concentrations, sometimes below 10 µg/m³.

During wildfires, $PM_{2.5}$ levels from smoke may exceed 100 µg/m³, rapidly overwhelming physiological coping mechanisms for all groups, but especially those with pre-existing conditions.

Policy relevance: Thresholds based only on population averages underestimate risks for vulnerable groups, who experience harm at or below commonly used guideline levels. More conservative $PM_{2.5}$ triggers for schools, care settings and outdoor workers are justified by evidence that susceptible populations show larger and earlier cardiorespiratory responses at a given concentration.

Nutrition and hydration

Example: hydration thresholds affecting heat tolerance

Hydration levels strongly shape thermoregulation and cardiovascular function. As people become dehydrated, core temperature rises more quickly, heart rate increases and sweating becomes less effective, so a given level of heat causes greater physiological strain.

In healthy adults, losing about 1–2% of body mass through dehydration can be enough to shift the point at which heat starts to impair health, safety or performance.

For older adults, children and people with chronic illness, similar physiological impairment can occur with smaller fluid losses because thirst and kidney function are often reduced.

Climate change increases the frequency and intensity of heatwaves and droughts, which both increase the amount of fluid lost through sweating and reduce reliable access to safe water. This results in dehydration developing more quickly and more often, especially for people working or living in hot, exposed environments.

Long term poor nutrition, often caused or made worse by climate-related crop failures, droughts and floods that reduce food availability and affordability, slows growth and reduces muscle mass and circulatory reserve, meaning that heat and air pollution start to cause harm at lower levels of exposure than in people who are well-nourished.

Policy relevance: Heat protection policies that assume people are starting from good hydration and adequate nutrition may fail in populations that do not have secure access to food or are otherwise high risk, where even modest heat and dehydration can lead to disproportionate health impacts.

Pregnancy

Example: heat exposure and maternal–foetal risk

Pregnancy increases blood volume, cardiac output and metabolic heat production, while altering thermoregulation and vascular responses, which increases vulnerability to heat exposure.

Core temperature increases that may be tolerated by non-pregnant adults can pose greater risk during pregnancy, especially during prolonged heat exposure.

Heat stress during pregnancy has been associated with increased risk of adverse birth outcomes, even at temperatures below extreme heat thresholds used in general population guidance. Occupational guidance shows that pregnant workers performing physical tasks in hot environments accumulate greater cardiovascular and thermal strain than non-pregnant workers at similar conditions.

Policy relevance: Pregnant people require earlier and more protective thresholds in heat warning systems and workplace guidance. This includes lower trigger temperatures, more generous rest breaks and proactive access to cooling and hydration in occupational and community settings.

Combined stressors

Example: overlapping vulnerabilities

Simultaneous exposure to heat, air pollution and social or nutritional deprivation produces larger health impacts than would be predicted from any single stressor alone.

Mortality and hospitalisations are increased when high temperatures and high air pollution occur together, with the largest effects among older adults, people with chronic disease and socio-economically disadvantaged groups.

In such contexts, heat levels that are tolerable for a healthy, well-nourished adult in clean air can become dangerous for a malnourished worker breathing polluted air. This is because systemic inflammation, reduced cardiorespiratory reserve and impaired thermoregulation shorten the distance between mild impairment and severe illness.

Overlapping vulnerabilities make it more difficult to adapt safely and increases the likelihood that thresholds will be crossed earlier and limits reached faster

Policy relevance: Where multiple vulnerabilities or stressors coexist, relying on single-hazard, population-average thresholds risks embedding harm among those with the least physiological resilience. It is important that the broader context around stressors such as heat, air pollution and nutrition are considered, as combined stressors shift physiological thresholds and limits to lower levels of exposure.

Key takeaway for decision-makers

Physiological thresholds are population-specific and context-dependent. Using a single threshold for all groups risks normalising harm for people with lower physiological resilience, including older adults, pregnant people, those with chronic illness and people living with food insecurity. Differentiated thresholds, informed by physiology, enable earlier and more effective protection, while physiological limits underline that adaptation alone cannot eliminate risk as heat, air pollution and food insecurity intensify.

Key terms used in this briefing

Acclimatisation: Short-term changes that help the body cope better with environmental stress, such as sweating earlier and more efficiently after repeated heat exposure. This improves tolerance but does not remove risk.

Cardiovascular strain: Extra workload on the heart and blood vessels, for example when the heart has to pump faster and harder when dehydrated.

Climate adaptation: Actions that reduce the harm caused by climate impacts, such as cooling buildings, changing work practices, improving healthcare access or strengthening social protection.

Climate mitigation: Actions that reduce the causes of climate change and environmental pollution, including cutting greenhouse gas emissions and reducing sources of air pollution.

Compound or combined risk: Exposure to more than one environmental stressor at the same time, for example heat plus air pollution, or heat plus undernutrition. Combined exposures increase harm more than would be expected from each factor alone.

Core body temperature: The temperature of the body's vital organs, such as the brain, heart and lungs. Keeping this within a narrow range is vital for survival.

Early warning systems: Public health or occupational systems that trigger protective actions, such as alerts, work restrictions or service adjustments, when environmental conditions reach defined risk levels.

Heat exhaustion: A serious heat illness caused by dehydration and overheating, leading to weakness, dizziness, nausea and impaired thinking.

Heatstroke: A medical emergency where the body can no longer control its temperature, leading to organ damage and potentially death.

Inflammation: The body's immune response to harm or irritation. While useful in short bursts, if the inflammation is ongoing, this can damage blood vessels and organs and increase the risk of heart and lung disease.

Micronutrients: Vitamins and minerals needed in small amounts for normal body function, such as iron, iodine and vitamin A. Deficiency weakens immunity, growth and physical capacity.

Oxidative stress: Cell damage caused by harmful molecules produced during pollution exposure, infection or other stress. This contributes to long-term disease in the lungs, heart and brain.

Physiology: The study of how the human body works and how its organs and systems, such as the heart, lungs, brain and temperature control, respond to everyday demands and to environmental challenges like heat, air pollution and illness. Physiology helps explain not just whether people are exposed to risk, but how that exposure affects the body and when it becomes harmful.

Physiological failure: Progressive breakdown of vital body systems, such as temperature control, circulation or organ function, when stress exceeds the ability of the human body to cope.

Physiological limit: Conditions under which continued exposure leads to worsening failure of vital body systems and survival becomes increasingly unlikely. Limits reflect unavoidable biological constraints, vary widely across individuals and contexts, and cannot be reliably predicted or engineered around. They therefore indicate the boundaries of adaptation and underscore the need to reduce exposure at source.

Physiological resilience: The body's ability to cope with stress and recover without lasting harm. People with lower resilience reach harmful levels of strain more quickly and at lower levels of exposure. Resilience is influenced by age, health, pregnancy, nutrition and fitness.

Physiological threshold: The point at which environmental conditions, such as heat, air pollution or lack of nutrition, begin to overwhelm the body's ability to maintain normal function, and the risk of harm starts to increase. For policy, thresholds are identified from population-level physiological evidence for defined population groups and contexts, and are used in practice as precautionary triggers for protective action. They do not represent a precise boundary of safety for every individual, but indicate when systems should intervene to prevent escalating harm, particularly for groups with lower physiological resilience.

$PM_{2.5}$ (fine particulate matter): Very small air pollution particles that can enter deep into the lungs and bloodstream, increasing the risk of heart disease, stroke, lung disease and other health problems.

Standards and thresholds: Regulatory or guidance values used to decide when conditions are considered unsafe and when protective measures must be taken, for example in workplaces, housing, schools or public spaces.

Thermoregulation: The body's process for keeping its internal temperature within a safe range, mainly through sweating, shivering and changes in blood flow.

Thermal strain: The overall stress placed on the body by heat, combining rising body temperature, dehydration and cardiovascular load.

Vulnerable groups: People who reach harmful levels of strain earlier or more quickly, including older adults, pregnant people, children, people with chronic illness, and those affected by food insecurity, poor housing or demanding physical work.

Wet Bulb Globe Temperature (WBGT): A heat stress index that combines air temperature, humidity, radiant heat and airflow to better reflect how hot conditions feel to the body.