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The Polycrisis Apocalypse

*How a global polycrisis could spiral into
civilisational collapse lasting centuries — and what
keeps repair ahead of stress*

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Navigating a Changing World

Abstract

This report defines and examines the **Polycrisis Apocalypse**, a term coined by H Heuristics for a scenario in which multiple interconnected global crises intensify and reinforce one another beyond humanity’s capacity to manage them, triggering cascading systemic failures that end in the collapse of industrial civilisation and a prolonged period of societal regression lasting centuries or millennia. Unlike a conventional apocalypse, it has no single cause or moment. It is a process, and the report argues that its decisive variable is the balance between two rates: the rate at which interacting crises add stress, and the rate at which a civilisation’s institutions, infrastructure and finance repair it.

The historical record shows that such regressions are common and slow. In the Mycenaean world, writing disappeared with the palaces around 1200 BCE and did not return for roughly four and a half centuries; Roman-era lead pollution recorded in Greenland ice fell with the Antonine Plague of 165 CE and did not regain its level for more than 500 years; Egypt’s First Intermediate Period lasted about 125 years. Survival analysis of premodern states finds that their risk of termination rises over the first two centuries of their existence, and one survey of past civilisations puts their average lifespan at about 336 years. Collapse, in this record, is a loss of complexity rather than of people, and recovery is measured in generations.

A stress–repair model makes the mechanism explicit. Crises arrive at random and add stress; capacity repairs stress but saturates when stress is high; stress erodes capacity; and amplification between crises depends on how interconnected the system is. The model has a sharp threshold. At its default settings, 91 per cent of 300 simulated runs collapse within 1,000 years and the median dark age lasts 471 years, but raising repair capacity by a sixth cuts that share to 27 per cent, loosening coupling cuts it to 10 per cent, and a combination of levers removes it entirely. Faster rebuilding, through preserved knowledge and institutions, does not prevent collapse but reduces the share of time spent collapsed from 51 to 19 per cent. The model is illustrative, not a forecast.

Today’s ledger shows stress rising on most of the ten crisis domains in the definition — seven of nine planetary boundaries breached in 2025 against three in 2009, 65 state-based armed conflicts in 2025, 673 million people hungry in 2024 — while several measures of repair capacity weaken: official development assistance fell 23.1 per cent in real terms in 2025, the largest drop on record, and global human development gained 2.75 thousandths a year in 2019–2023 against 5.6 in the 2000s. Modern societies still recover fast, as the return of life expectancy after the pandemic shows. The report concludes that the Polycrisis Apocalypse is avoidable precisely because it is a race: the levers that keep repair ahead of stress — reducing shocks at source, loosening the couplings between systems, sustaining the capacity to repair, and preserving the means to rebuild — are known, and the model shows they compound.

This Word edition adds two things. It sets the concept beside **human extinction** — the adjacent and final category of risk — and argues that a long regression is not safely separated from it (Section 2.7). And it assesses the present trajectory (Section 12): with stress rising on six of ten fronts and measured repair capacity slowing, **on current trajectories the world may be heading toward a Polycrisis Apocalypse**. The evidence establishes the direction of travel, not a date or a probability.

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Key Findings

Eight findings from the historical record, a stress–repair model, a ledger of ten crisis domains and an assessment of current trajectories. The model and ledger give direction, not dates or probabilities.

1. **The Polycrisis Apocalypse is a race, not an event.** Crises add stress; a civilisation’s capacity — institutions, infrastructure, finance, cooperation — repairs it; and unrepaired stress erodes the capacity doing the repairing. The decisive variable is the balance between the two rates, not the size of any single crisis.
2. **Past regressions were common and slow.** Writing vanished from Greece for about 450 years after the Mycenaean palaces fell; Roman-era lead pollution in [Greenland ice](#) did not regain its second-century level for more than 500 years; Egypt’s First Intermediate Period lasted about 125 years. Descent took decades, recovery took centuries.
3. **Collapse is a loss of complexity, not of people — but it is not safely separated from extinction.** What disappears first is writing, coinage, cities and long-distance trade. A Polycrisis Apocalypse is defined by regression, not extinction; yet a civilisation held for centuries at low capacity has lost much of what guards humanity against extinction-scale hazards (Section 2.7).
4. **The model has a sharp threshold.** At its default settings, 91% of 300 simulated runs collapse within 1,000 years and the median dark age lasts 471 years. A one-sixth rise in repair capacity cuts the collapse share to 27%; loosening coupling cuts it to 10%; modest changes to all three levers remove collapse entirely in the 300 runs.
5. **Preventing collapse and shortening it are different jobs.** Rebuild speed barely changes the odds of falling, but cuts the share of simulated years spent collapsed from 51% to 19%. A serious strategy needs both.
6. **Stress is rising on most fronts while repair capacity weakens.** Seven of nine planetary boundaries were breached in 2025 (three in 2009); state-based armed conflicts reached 65, the most since records began in 1946; official development assistance fell 23.1% in real terms in 2025, the largest drop on record; and global human development gained 2.75 thousandths a year in 2019–23 against 5.6 in the 2000s.
7. **On current trajectories, the world may be heading toward a Polycrisis Apocalypse.** The directions of travel in the ledger and the early-warning data are the ones the model identifies as dangerous — more stress and less repair at once — and the distance between a stable world and a collapsing one is, in the model, a matter of tens of percent on three settings (Section 12). This is a judgement about direction, not a forecast of timing or probability.
8. **The outcome is avoidable.** Modern societies still recover fast — global life expectancy was back above its pre-pandemic level within three years — and the four levers that keep repair ahead of stress (shrink the shocks, loosen the links, fund the repair, preserve the means to rebuild) are known and compound. The cheapest moment to act is before the threshold.

1. Overview

A name for the worst way the polycrisis could end — and a framework for keeping it hypothetical.

POLYCRISIS APOCALYPSE (NOUN)

A scenario in which multiple interconnected global crises intensify and reinforce one another beyond humanity's capacity to manage them, triggering cascading systemic failures that ultimately result in the collapse of industrial civilization and a prolonged period of societal regression lasting centuries or millennia.

Term coined by Hunter Hughes, H Heuristics, 2026

The word *apocalypse* usually summons a single event: an impact, a war, a plague that arrives on a known day. The Polycrisis Apocalypse is different in kind. It has no single cause and no single date. It unfolds through the interaction of many crises — climate and ecological degradation, resource depletion, water scarcity, food insecurity, economic instability, geopolitical conflict, demographic change, infrastructure decay, technological disruption and pandemics — each of which amplifies the others until the institutions, governments and supply chains that hold a complex civilisation together are overwhelmed. Its signature is not the moment of failure but the length of what follows: a regression measured in centuries.

This report treats the concept as a hypothesis to be examined rather than a prophecy to be believed. It asks three questions. *Has anything like it happened before, and how long did the regression last? What mechanism would turn a polycrisis into a collapse rather than a bad decade? And where does the world stand today on the quantities that mechanism depends on?* The answers come from the historical record, from a stress–repair model whose code and settings are published in full, and from a ledger of current indicators for each of the ten crisis domains in the definition.

It is the long-form edition of the interactive dashboard published as [H Heuristics Digital Report № 2026-24](#), expanded with additional historical context, a fuller treatment of how crises entangle, new sensitivity analysis and scenario runs of the model, a monitoring framework and a discussion of objections. This Word edition adds two further elements requested for publication: a treatment of where **human extinction** sits relative to the concept (Section 2.7), and an assessment of what **current trajectories** imply (Section 12). A complementary line of argument — on energy, complexity overhead and demography — from the author's [Substack essay](#) is set out in Appendix A. Where this edition adds analysis beyond the web report, the text says so.

1.1 The argument in brief

A Polycrisis Apocalypse is *a race that is lost*. Crises add stress to a civilisation; its capacity — institutions, infrastructure, finance, cooperation — repairs that stress; and stress, left unrepaired, erodes the very capacity that does the repairing. Below a threshold, a society absorbs shocks and recovers within years. Beyond it, the loop runs the other way, and the past suggests that what is lost then takes centuries to rebuild. Today stress is rising on most fronts while several measures of repair are weakening. That is a warning, not a verdict: the race can be won, and the levers that win it are known.

The distinction between a bad century and an apocalypse matters for what should be done. A bad century calls for crisis management: absorb each shock, recover, move on. A Polycrisis Apocalypse calls for something harder — protecting the *capacity to recover itself*, because that capacity is what the spiral consumes. Much of the policy agenda of recent years, from adaptation finance to debt relief to pandemic

preparedness, can be read as an attempt to do exactly that, and the evidence in this report is that the attempt is now being underfunded at the moment it matters most.

1.2 The evidence at a glance

7 of 9 planetary boundaries breached in 2025, against 3 in the first assessment in 2009 Planetary Health Check 2025	65 state-based armed conflicts in 2025 — the most in any year since 1946 UCDP/PRIO v26.1	85 sec the Doomsday Clock in January 2026, the closest to midnight it has ever been set Bulletin of the Atomic Scientists	–23.1% official development assistance in 2025 in real terms, the largest annual fall on record OECD, preliminary, April 2026
2.75 thousandths a year gained on the global HDI in 2019–23, against 5.6 in the 2000s UNDP HDR 2025 · author's calculation	500+ yrs before Roman-era lead pollution in Greenland ice regained its 2nd-century level McConnell et al. 2018, PNAS	~450 yrs without writing in Greece between the fall of the Mycenaean palaces and the alphabet c. 1200 – c. 750 BCE	471 yrs median dark age in the spiral model at its default settings, among runs that collapse and recover Illustrative model · 300 runs

1.3 How to read this report

Section 2 defines the concept precisely, distinguishes it from its neighbours and sets it beside human extinction. Section 3 places it in the intellectual lineage of collapse studies and systemic-risk research. Section 4 reviews what past collapses lost and how long recovery took. Section 5 describes how crises entangle — the channels through which a shock in one domain reaches another. Sections 6 and 7 present and analyse the spiral model and its threshold. Section 8 sets out today's ledger of stress across the ten domains, Section 9 looks for early warnings that repair is slowing, and Section 10 translates the model's levers into off-ramps. Section 11 runs four illustrative worlds through the model, Section 12 assesses where current trajectories point, Section 13 proposes what to monitor, Section 14 addresses objections and Section 15 concludes. Section 16 states every assumption the model makes. None of the model's numbers should be read as a forecast.

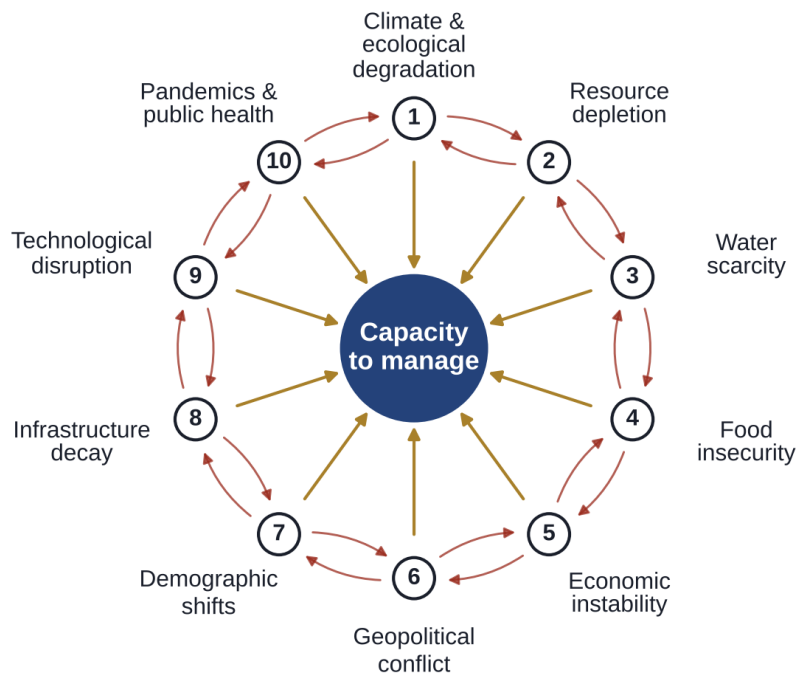
Readers who want only the argument should read Sections 1, 2, 4, 10 and 12. Readers who want to test it should read Sections 6, 7 and 16 and Appendix B. Every quantitative claim carries a hyperlink to its source; the full bibliography follows Section 16.

2. Definition

Three conditions separate a Polycrisis Apocalypse from a run of bad years, from a single-event catastrophe and from human extinction.

The definition rests on three conditions, each necessary and none sufficient alone: **interaction**, **overwhelm** and **duration**. Together they locate the concept precisely among its neighbours.

Figure 1. The spiral: ten crisis domains around a shared capacity to manage them. Schematic; arrows show reinforcement between neighbouring domains and load on the centre. When the load arriving at the centre exceeds what it can repair, capacity shrinks, repair falls further and reinforcement around the ring strengthens.



Red arrows: reinforcement between neighbouring domains Gold arrows: load on the shared capacity

Source: H Heuristics. Domains from the definition (Section 2). Conceptual.

2.1 Condition one: interaction

The crises involved must reinforce one another rather than simply coincide: drought raising food prices, food prices fuelling unrest, unrest disrupting trade and energy, energy shocks deepening debt, debt cutting the budgets that would have paid for adaptation. This is the [Cascade Institute's](#) sense of a global polycrisis — crises that become causally entangled so that their combined harm exceeds the sum of their parts — and it is what distinguishes the concept from a run of independent misfortunes.

The test of interaction is counterfactual: remove one crisis and ask whether the others would have been milder. If so, the crises were entangled. If not, they merely coincided. The practical importance of this test is that entangled crises cannot be managed one at a time. A response that fixes one domain while leaving the couplings intact will see the stress re-enter through another.

2.2 Condition two: overwhelm

Interacting crises are a feature of every century; what makes this scenario apocalyptic is that their combined load exceeds the capacity of institutions to manage them, so that failures cascade instead of being contained. The definition locates the tipping point not in any single crisis but in the relation between load and capacity. A world with far more stress than today could remain stable if its capacity grew faster; a world with less could collapse if its capacity eroded.

This is the most important analytical move in the concept, and the one most often missed in popular discussion of “collapse”. Headline numbers about emissions, debt or conflict describe the *load*. They say nothing about whether the machinery of repair can bear it. The relevant question for any year is not simply whether things are getting worse, but whether stress is rising faster than the capacity to absorb it.

2.3 Condition three: duration

The outcome is not a recession, a war or a pandemic from which the world rebounds within a decade, but the collapse of industrial civilisation followed by regression lasting centuries or millennia. That is what distinguishes it from the bad decades of the twentieth century, and also from human extinction, which is a different and more final category of risk: in a Polycrisis Apocalypse people survive, but the complexity they had built — its knowledge, networks and institutions — does not, and must be rebuilt slowly. Section 2.7 returns to how closely the two categories are connected.

2.4 What it is, and what it is not

What it is

- **A process** driven by interacting crises, not a single event.
- **A loss of complexity** — institutions, networks, specialised knowledge, long-distance trade — rather than of humanity.
- **Defined by a race** between the stress crises add and the capacity to repair it.
- **Long**: its regression is measured in centuries, as past collapses were.

What it is not

- **Not a forecast.** The concept describes a possible trajectory; this report assigns it no real-world probability and asks only which way current trends point.
- **Not extinction — but not safely separated from it.** People survive; the civilisation they had built does not. A long regression would leave humanity more exposed to extinction-scale hazards (Section 2.7).
- **Not a bad decade.** Recessions, wars and pandemics from which the world rebounds are polycrisis, not apocalypse.
- **Not inevitable.** Every term in the race can be changed by choices made now.

2.5 Neighbouring concepts

Several established terms cover adjacent ground. The table below sets out how the Polycrisis Apocalypse differs from each. The contrasts are not criticisms of the neighbouring concepts, which are designed for different purposes; they are the reason a separate name is useful.

Table 1. The Polycrisis Apocalypse and its neighbours

Concept	Core idea	Typical time scale	How the Polycrisis Apocalypse differs
Polycrisis	Crises in several global systems become causally entangled; harm exceeds the sum of parts (Cascade Institute).	Years to decades	A polycrisis can be survived and managed. The Polycrisis Apocalypse is the specific case in which it is not — load outruns repair and the system regresses.
Permacerisis	A long period of instability and insecurity, a descriptive label for the current mood.	Years	Permacerisis describes an experience; the Polycrisis Apocalypse describes a mechanism with a threshold and an end-state.

Concept	Core idea	Typical time scale	How the Polycrisis Apocalypse differs
Global catastrophic risk	Events that could inflict serious damage on human well-being on a global scale (pandemics, nuclear war, severe climate change).	Event-based	Catastrophic-risk analysis usually starts from discrete events. The Polycrisis Apocalypse starts from interaction and ends in duration.
Existential risk	Events that would permanently destroy humanity's long-term potential, including extinction and unrecoverable collapse (Ord, 2020).	Permanent	The regression here is by definition recoverable — it lasts centuries or millennia, not forever. People and some knowledge persist.
Societal collapse	Rapid, significant loss of an established level of sociopolitical complexity (Tainter, 1988).	Decades	Same core idea, applied here to a global, industrial system and to a multi-causal path.
Doomsday scenario	A single decisive catastrophe — nuclear exchange, asteroid, engineered pandemic.	Days to years	No single trigger or date; the failure is distributed across domains and through time.

2.6 Why a new term

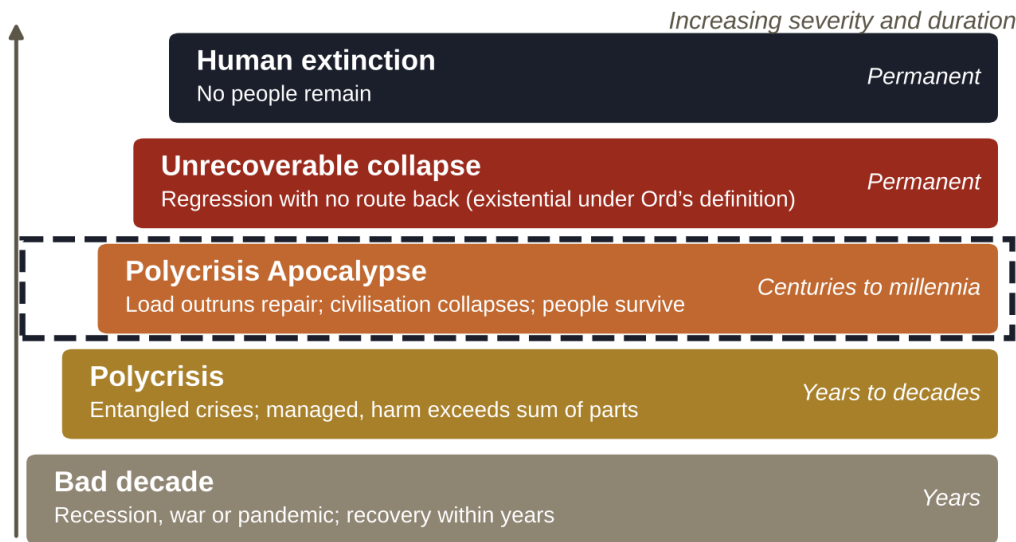
Existing vocabulary tends to fail in one of two ways. It either names the *entanglement* without an end-state (polycrisis, permacrisis) or it names the *end-state* without the mechanism (collapse, existential catastrophe). The Polycrisis Apocalypse joins the two: it is the end-state reached through entanglement when load outruns repair. That joining has practical value. It ties the abstract language of systemic risk to a concrete question — *how long would the dark last?* — and it identifies the variable (capacity to repair) that policy can actually change.

It also implies what to measure. If the outcome depends on the balance between load and repair, then the question for any year is whether that capacity is being maintained, spent down or built up. Sections 8 and 9 attempt that accounting with public data; the model in Sections 6 and 7 shows why the balance, rather than either quantity alone, is what matters.

2.7 Where human extinction fits

The definition deliberately stops short of extinction. In a Polycrisis Apocalypse people survive; what does not survive is the complexity they had built. Human extinction is a different and final category of risk. In the framework of Toby Ord's [The Precipice](#), an existential catastrophe is one that destroys humanity's long-term potential, either through extinction or through an *unrecoverable* collapse of civilisation. The Polycrisis Apocalypse sits one rung below on the ladder of outcomes in Figure 2: severe, lasting centuries, and recoverable by definition.

Figure 2. A ladder of outcomes. The Polycrisis Apocalypse (dashed outline) is the point at which collapse becomes long-lasting but remains recoverable; unrecoverable collapse and extinction lie above it. Schematic.



Source: H Heuristics, adapting the existential-risk categories of [Ord \(2020\)](#). Conceptual.

The separation is analytical, not physical. Three arguments suggest that the two categories are connected rather than cleanly divided. They are offered as reasoned hypotheses, not findings; nothing in the model or the ledger can assign them a probability.

Exposure. A civilisation held in regression for centuries has lost much of what protects humanity against extinction-scale hazards: the health systems and surveillance that catch pandemics, the agricultural productivity that feeds a population of more than eight billion, the scientific and logistical capacity to detect and respond to hazards. In the model's collapsed state (capacity below 0.25) the next large shock meets a fraction of the response that the last one did, and background hazards — natural and human — keep arriving throughout a dark age that lasts a median of 471 years in the default world.

Residual hazards. The most dangerous human-made capabilities — nuclear arsenals, engineered pathogens, increasingly capable artificial intelligence — are products of the same civilisation whose decline the concept describes. Two of the ten domains in the ledger, geopolitical conflict and technological disruption, are among those moving the wrong way: 65 state-based conflicts in 2025 and a [Doomsday Clock](#) at 85 seconds to midnight. In a polycrisis, conflict and technological hazard are entangled with food, energy and finance, so the paths to a more final outcome run through the same system.

The irreversibility trap. The author's [Substack essay](#) argues that survivors of a collapse would face an “energetic moat”: the easily accessible fossil energy that bootstrapped industrialisation has largely been spent, so that rebuilding an industrial base would require an industrial base that no longer exists. If that is right, a regression that is recoverable in principle could become unrecoverable in practice — which, on Ord's definition, is itself an existential outcome. The essay gives no supporting calculations (Appendix A); it is treated here as a hypothesis, not a result.

What follows is a matter of emphasis. Defining the concept as *regression*, not *extinction* keeps it precise and empirically anchored: history offers many regressions of centuries and no extinctions. But a Polycrisis Apocalypse should not be treated as a bounded or tolerable fallback; it is the stage at which the margin for error has gone and the tail risk of the worst category rises. In that light the fourth lever in Section 10 — preserve the means to rebuild — is also a hedge against the tail.

3. Intellectual Lineage

The concept sits where two literatures that rarely meet overlap: the study of why complex societies fail, and the study of how shocks travel between systems.

The Polycrisis Apocalypse is a new name, but it is not a new set of ideas. It draws on at least five bodies of work, each of which contributes a piece of the mechanism. This section sets them out so that readers can judge what is borrowed, what is adapted and what is the author's own.

WHAT IS ORIGINAL HERE

The component ideas are established. The author's contributions are (i) the definition and three-condition test; (ii) the stress–repair model in Section 6; (iii) the ledger linking ten domains to the model's terms; and (iv) the translation of its four levers into off-ramps. The model is illustrative and was not calibrated to data.

3.1 The study of collapse

Joseph Tainter's [*The Collapse of Complex Societies*](#) (1988) argued that societies solve problems by becoming more complex — adding administration, specialisation, trade and infrastructure — and that the returns on that investment eventually diminish. When marginal returns fall far enough, complexity becomes a burden rather than an asset, and a society may find it cheaper to simplify than to continue. Tainter defined collapse narrowly, as a rapid, significant loss of an established level of sociopolitical complexity; not every failed empire qualifies.

Jared Diamond's [*Collapse*](#) (2005) emphasised a different set of causes: environmental damage, climate change, hostile neighbours, loss of friendly trading partners and, above all, a society's response to its problems. Diamond's cases are contested in detail — the Easter Island account in particular has been challenged — but the framework of interacting stresses plus a response capacity is close to the one used here.

Peter Turchin and colleagues approach the question quantitatively. Their [*structural-demographic theory*](#), tested against long historical series in the [Seshat Global History Databank](#), identifies popular immiseration, elite overproduction and weakening state capacity as recurrent drivers of political disintegration. Where Tainter locates collapse in the economics of complexity, Turchin locates it in the politics of extraction and competition; the Polycrisis Apocalypse is agnostic between them and treats both as ways in which capacity to repair is eroded.

Eric Cline's [*1177 B.C.*](#) makes the case for the end of the Late Bronze Age as a multi-causal systems collapse: earthquakes, drought, famine, invasion, internal revolt and the severing of trade routes combining across an interdependent eastern Mediterranean. Cline argues that the interdependence of the palace economies may itself have hastened their fall. This is, in miniature, the thesis of the present report.

3.2 Systemic risk and networked fragility

The second body of work explains how shocks propagate. Charles Perrow's [*Normal Accidents*](#) (1984) showed that systems that are both interactively complex and tightly coupled will, over time, experience failures that no designer anticipated. [Haldane and May \(2011\)](#) applied network ecology to banking and found that connectivity which stabilises a system against small shocks can destabilise it against large ones. [Helbing \(2013\)](#) extended the argument to globally networked risks — finance, supply chains, communications — and warned of cascade effects that are invisible from within any single domain.

[Centeno and colleagues \(2015\)](#) traced the emergence of global systemic risk as a sociological phenomenon.

These studies supply the **coupling** term in the spiral model: the extent to which stress in one place feeds stress elsewhere.

3.3 The polycrisis literature

The word *polycrisis* was used by Edgar Morin and Anne Brigitte Kern in the early 1990s, revived in European politics in the mid-2010s and popularised in 2022 by the economic historian [Adam Tooze](#). It entered the mainstream risk vocabulary through the World Economic Forum's [Global Risks Report](#) and through the [Cascade Institute](#), whose researchers gave it its most careful definition: [Lawrence, Homer-Dixon, Janzwood, Rockström, Renn and Donges \(2024\)](#) set out the causal mechanisms of crisis entanglement and tied the concept to testable propositions.

Thomas Homer-Dixon's earlier work on *synchronous failure* anticipated much of this. His argument — that the danger lies in several systems failing at once, so that the usual remedy of drawing on the others is unavailable — is the intuition behind the spiral's saturating repair term.

Two related H Heuristics reports pursue the empirical side: [The Polycrisis Century](#) measures how often systems are stressed at once, and [Resilience in an Age of Polycrisis](#) traces how a single shock cascades. This report asks what happens if the cascade is not contained.

3.4 Planetary limits and tipping points

The fourth body of work supplies the stress side. [Rockström and colleagues \(2009\)](#) proposed nine planetary boundaries within which humanity could operate safely; the first assessment judged three transgressed. [Richardson and colleagues \(2023\)](#) found six of nine beyond their boundaries, and the [Planetary Health Check 2025](#) seven. [Lenton and colleagues \(2008\)](#) identified the Earth-system components that could pass tipping points, and [Armstrong McKay and colleagues \(2022\)](#) concluded from more than 200 studies that several — including the Greenland and West Antarctic ice sheets, abrupt permafrost thaw, Labrador Sea convection and tropical coral reefs — may already be at risk at present warming, with more becoming possible between 1.5 °C and 2 °C.

Earlier modelling in the *Limits to Growth* tradition ([Meadows et al., 1972](#); [Herrington, 2021](#)) reached an analogous structural conclusion — overshoot on a finite planet, then decline — and remains contested. It is cited here as an ancestor of the stress–repair framing, not as evidence for any date.

3.5 Early-warning signals

The fifth contribution is the idea that systems approaching a threshold give warning. [Scheffer and colleagues \(2009\)](#) described *critical slowing down*: as resilience erodes, a system takes longer to recover from each disturbance, and fluctuations grow more correlated. [Scheffer et al. \(2021\)](#) found this signature in the construction record of pre-Hispanic Pueblo societies before their transformations, and [Scheffer et al. \(2023\)](#) analysed the survival of premodern states, finding that their risk of ending rises over their first two centuries. Section 9 applies the logic to the present.

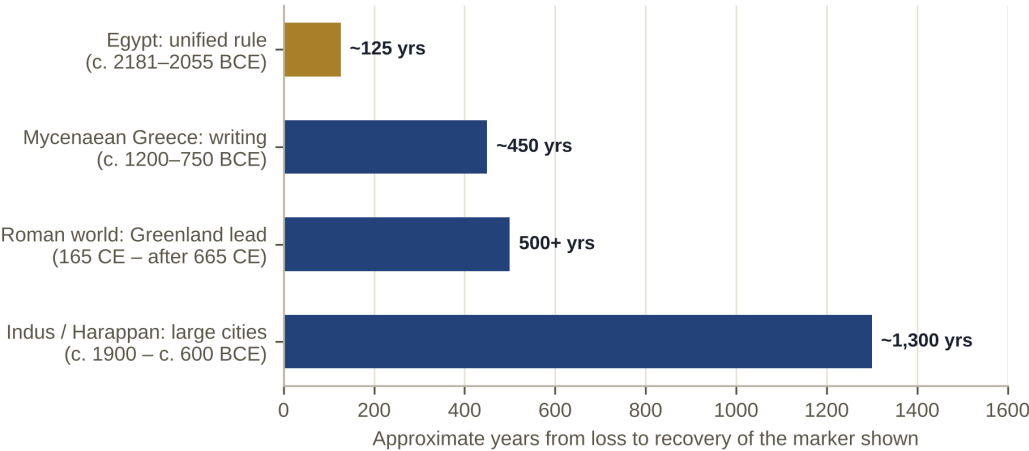
4. The Historical Record

Collapse is common in history, and recovery is slow. What disappears first is complexity: writing, coinage, cities and long-distance trade.

The historical record offers no example of an industrial civilisation collapsing, but it offers many examples of complex societies losing their complexity, and it is unusually consistent about how long the loss lasted. When the Mycenaean palaces fell around 1200 BCE, the Linear B script fell with them; Greece was without writing until the alphabet was adopted around 750 BCE. When the Antonine Plague struck the Roman Empire in 165 CE, the lead pollution that Roman mining and smelting had deposited in [Greenland ice](#) fell sharply, and it did not regain its earlier level for more than 500 years. Egypt’s Old Kingdom gave way to the [First Intermediate Period](#), about 125 years of fragmented rule, before the Middle Kingdom reunited the country.

These are not exact equivalents of each other, and none is an exact precedent for a global industrial collapse. The durations are approximate and some measure different things: the end of writing in one case, a pollution proxy for economic activity in another, the return of cities to a different region in a third. What they share is a pattern. Complexity was lost quickly, within a generation or two, and regained slowly, over centuries — a pattern the model in Section 6 reproduces from its own logic.

Figure 3. How long the regression lasted. Approximate years from loss to recovery of the marker shown. The Indus figure measures the return of large cities to South Asia, in the Ganges plain rather than the Indus valley. The Classic Maya southern lowlands, which declined c. 760–910 CE, are omitted because only limited parts of them ever fully recovered.



Sources: [World History Encyclopedia](#); [McConnell et al. 2018](#); [Giosan et al. 2012](#); [Kemp 2019](#).

Table 2. Episodes and markers: what was lost, and what marks its return

Episode	Marker	Span
Egypt	Unified rule: Old Kingdom to Middle Kingdom (source)	c. 2181–2055 BCE
Mycenaean Greece	Writing: Linear B to the Greek alphabet (source)	c. 1200–750 BCE
Roman world	Lead pollution in Greenland ice regains its Pax Romana level (McConnell et al.)	165 CE – after 665 CE
Harappan cities	Large cities return to South Asia, in the Ganges plain (Giosan et al.)	c. 1900 – c. 600 BCE
Classic Maya	Royal cities of the southern lowlands (source)	c. 760–910 CE, partial recovery

~336 yrs

average lifespan of the past civilisations in Luke Kemp's survey for BBC Future (2019)
[BBC Future](#)

200 yrs

period over which premodern states' risk of termination rises before levelling off
[Scheffer et al., PNAS 2023](#)

0

industrial, globally integrated civilisations that have collapsed — there is no direct precedent
 Historical record

4.1 Four cases in more detail

The Late Bronze Age: an interdependent world unravels

Around 1200 BCE the eastern Mediterranean and Near East supported a network of palace-centred states — Mycenaean Greece, Hittite Anatolia, Egypt, Ugarit, Babylonia and Assyria — linked by trade in tin, copper, grain, textiles and luxury goods. Within roughly a century most of the palace systems had been destroyed or abandoned. [Cline](#) stresses that the collapse took not a year but something closer to a century, and that no single cause suffices: earthquakes, drought and famine, invasion and migration, internal revolt and the breakdown of trade all appear in the record and plausibly reinforced one another. The Polycrisis Apocalypse is a global-scale analogue of that argument.

In Greece the consequence was a loss of administrative literacy. Linear B, a script used by palace scribes to track goods and labour, vanished with the palaces that used it; no writing is securely attested until the Greek alphabet appears around 750 BCE. Population fell, settlements shrank and long-distance exchange contracted. The Greek “Dark Age” is contested as a label, and archaeology shows pockets of continuity, but the loss of specialised institutions and the long time to regain them are not in dispute.

The Roman world: a pollution proxy for economic life

The Greenland ice record gives an unusually continuous measure of Roman economic activity: lead smelted for silver and for plumbing was carried north in the atmosphere and deposited in snow. [McConnell and colleagues \(2018\)](#) showed that emissions rose with Roman expansion, fell during the Antonine Plague that began in 165 CE and during later crises, and did not return to Pax Romana levels for more than five centuries. The proxy does not show that Roman life ended; it shows that the scale of organised, large-scale extraction and trade did not return for a very long time.

Whether the end of the western empire was a “fall” or a “transformation” is a long-running historical debate. Bryan Ward-Perkins's [The Fall of Rome and the End of Civilization](#) argues from material evidence — the disappearance of mass-produced pottery and coinage from post-Roman Britain, for example — that the contraction in living standards and complexity was severe. Kyle Harper's [The Fate of Rome](#) emphasises climate change and disease as stressors interacting with political fragility. Both are consistent with the interaction logic used here.

The Classic Maya: a drought-sensitive complexity

The Classic Maya of the southern lowlands built densely populated city-states whose political order began to fragment from about 760 CE. [Kennett and colleagues \(2012\)](#) reconstructed rainfall from a stalagmite and linked the period of peak political expansion to unusually wet centuries, and the period of political breakdown to prolonged drought, with inscriptions allowing climate phases to be matched against political events. Drought was not the only factor — warfare, land use and political competition all contributed — but the study illustrates the signature of the concept: a climate stress interacting with political and demographic stresses in a society whose complexity depended on predictable rainfall. Only limited parts of the southern lowlands ever fully recovered.

The Black Death: a contrast case

The mid-fourteenth-century plague is an instructive contrast. It killed an estimated third to a half of Europe's population, yet the continent did not regress to a dark age. Institutions, law, literacy, towns and trade survived; labour shortages shifted bargaining power and, over generations, altered social relations.

Population recovery, by contrast, was slow — around [six generations](#) in some accounts, with recurrent outbreaks suppressing the rebound. The Black Death shows that enormous mortality alone does not produce a Polycrisis Apocalypse. What matters is whether the capacity to repair survives the shock — whether the machinery of coordination remains intact.

4.2 Three lessons

The first lesson is that **collapse is ordinary rather than exceptional**. Survey after survey finds that complex polities tend to last centuries rather than millennia. [Kemp's survey](#) puts the average lifespan of the civilisations he examined at about 336 years, and the [survival analysis by Scheffer and colleagues](#) found that premodern states' risk of ending rises over their first two centuries before levelling off, a pattern the authors interpret as a gradual loss of resilience. Longevity is the exception that requires explanation, not collapse.

The second lesson is that **collapse is mostly a loss of complexity, not of people**. Populations fell in many of these episodes, sometimes steeply, but humans persisted; what disappeared were the institutions that coordinated large numbers of people — scribal bureaucracies, monetary systems, long-distance trade, urban provisioning. That is why the Polycrisis Apocalypse is defined by regression rather than extinction, and why the speed of recovery depends on how much knowledge and how many institutions survive the fall.

The third lesson is **the asymmetry of time**. In every case above, the descent took decades and the recovery took centuries. Modern societies are far richer, more knowledgeable and more connected than any of these, which should make them harder to topple and faster to rebuild. But global integration also means there is no outside world from which a collapsed region can re-import complexity, as Western Europe eventually did from Byzantium and the Islamic world. A global collapse would have to be rebuilt from within.

4.3 What the record cannot tell us

Three cautions apply. First, the sample is of premodern, mostly agrarian societies whose complexity rested on a narrow energy base; modern societies' dependence on fossil energy, global supply chains and just-in-time logistics gives them different failure modes. Second, the markers differ — a script, a pollution proxy, a form of rule — so the durations in Figure 3 are comparable in shape but not in kind. Third, collapse is documented partly because it left evidence; recoveries and continuities are harder to see. The record supports the claim that regressions of centuries are possible and historically ordinary. It cannot tell us how probable one is for the present world.

5. How Crises Entangle

A polycrisis is not ten problems in a list. It is a network, and the interesting questions are about the links.

The definition rests on interaction, so it is worth being specific about how crises reach one another. This section describes five transmission channels, ten illustrative couplings between the domains in the definition, and the three mechanisms that can turn entanglement into overwhelm. The couplings are the author's qualitative synthesis of the literature reviewed in Section 3; they are illustrations of mechanism, not measurements of strength.

5.1 Five transmission channels

Energy

Energy is both an input to every other system and a target of several. The 2022 energy shock that followed Russia's invasion of Ukraine raised electricity and gas prices across Europe and Asia, increased fertiliser and food costs, strained public budgets through subsidies and pushed inflation higher — one geopolitical event transmitting into the food, finance and cost-of-living domains in a single quarter. Energy also couples to climate (through emissions) and to infrastructure (through grid reliability and the heat and cold that stress it).

Food and water

Food prices are a classic transmission belt between climate, markets and politics. The [New England Complex Systems Institute's 2011 analysis](#) of the food-price spikes of 2007–08 and 2010–11 linked weather shocks and biofuel and trade policy to political instability, finding that unrest broke out when food prices rose above a threshold. The FAO's [Food Price Index](#) is now one of the most closely watched cross-domain indicators. The [Global Report on Food Crises 2025](#) counted about 295 million people in acute food insecurity across 53 countries and territories in 2024, the sixth consecutive annual rise, with conflict and climate extremes the main drivers.

Finance and debt

Debt turns shocks into constraints. Governments that borrowed heavily to respond to the pandemic faced higher interest rates just as energy and food shocks arrived; [the IMF's list](#) shows 32 of 68 low-income countries in or at high risk of debt distress in March 2026. Debt service competes directly with the spending that builds resilience — adaptation, health systems, social protection — which is how a financial stress becomes a reduction in repair capacity. The same logic links the [Institute of International Finance's](#) global debt monitoring to everything downstream of public budgets.

Conflict and displacement

Conflict destroys infrastructure, displaces people, disrupts trade and diverts budgets toward security. The UCDP counted 65 state-based conflicts in 2025, spread across 35 countries, including a record eight between states ([Uppsala University, 2026](#)). Each is a locus where climate, food and finance stresses can combine with violence; each also reduces the ability of the affected state to respond to anything else.

Information and trust

Information is a transmission channel in its own right. Misinformation and disinformation ranks second among the near-term risks in the World Economic Forum's [Global Risks Report 2026](#), behind only geoeconomic confrontation. Eroded trust in institutions slows the adoption of difficult but necessary measures — vaccination campaigns, emergency restrictions, fiscal consolidation — and so reduces repair

capacity indirectly. It is also the channel through which confidence can collapse faster than any physical stock.

5.2 Ten illustrative couplings

Table 3. Ten illustrative couplings between the domains

From	To	Mechanism	Example
Climate & ecology	Food insecurity	Heat, drought and floods cut yields and disrupt supply	Weather shocks behind the 2010–11 price spike (NECSI)
Climate & ecology	Infrastructure decay	Hazards destroy and degrade assets faster than they are replaced	\$732–845 bn a year in hazard losses (CDRI)
Food insecurity	Geopolitical conflict	Price spikes and hunger raise grievance and mobilisation	NECSI analysis of 2011 unrest
Geopolitical conflict	Resource depletion	Sanctions, blockades and war disrupt energy and mineral flows	2022 gas and fertiliser shocks
Resource depletion	Economic instability	Input price volatility feeds inflation and squeezes margins	Energy-driven inflation, 2022–23
Economic instability	Infrastructure decay	Debt service displaces maintenance and resilience spending	32 of 68 low-income countries in or at high risk of debt distress (IMF)
Infrastructure decay	Pandemics	Weak water, sanitation and health systems raise outbreak risk and mortality	Health-system strain in 2020–21
Pandemics	Economic instability	Lockdowns and stimulus raise debt and disrupt supply chains	14.9 m excess deaths and the 2020–23 compound shock (WHO)
Technological disruption	Geopolitical conflict	Cyber, information and autonomous-weapons risks lower the threshold for escalation	AI governance among the Doomsday Clock 2026 calls for action
Demographic shifts	Economic instability	Ageing and shrinking workforces raise fiscal burdens; youth bulges strain labour markets	Divergent demographic pressures across regions

5.3 From entanglement to overwhelm

Entanglement alone does not produce collapse; societies have always faced several problems at once. Three mechanisms convert it into overwhelm, and each maps onto a term in the model of Section 6.

- **Synchronisation and coupling.** A common driver — a warming climate, a financial regime, a technology — can push several systems toward failure simultaneously, and links between them let stress propagate. In the model this is the *coupling* parameter: the strength with which unresolved stress generates further stress in proportion to existing capacity and stress.
- **Buffer depletion and saturation.** Each shock is met with a thinner reserve than the last, and repair capacity is finite: when many systems demand attention at once, institutions triage, and the marginal unit of repair resolves less. In the model, repair *saturates* as stress rises.
- **Erosion of the repairer.** Unrepaired stress reduces the capacity that does the repairing: budgets shrink, trust declines, experts leave, infrastructure degrades. This is the step that turns a persistent problem into a spiral, and it is the central loop in the model.

The 2020–23 compound shock illustrates all three in miniature. A pandemic produced a synchronised demand and supply shock; stimulus and supply-chain disruption fed inflation; monetary tightening raised the cost of debt just as an energy and food shock arrived; and a series of emerging-economy debt stresses followed. [Pakistan’s 2022 floods](#), with damages of more than \$30 billion hitting an economy already under debt and inflation stress, are a single-country example of climate stress meeting a depleted fiscal buffer. The world recovered from that episode — which is why it is a polycrisis, not an apocalypse — but the pattern is the one the spiral model amplifies.

5.4 Why institutions struggle with interactions

Institutions are organised by domain: ministries of health, finance and defence; agencies for climate, trade and energy; multilateral bodies with distinct mandates. Entangled crises cross these boundaries. Three features make the mismatch worse. **Time horizons differ:** electoral cycles, budget cycles and the decades over which climate or demographic stresses unfold rarely align. **Accountability is siloed:** no body is responsible for the interaction terms, so no one measures them. And **response bandwidth is finite:** when leaders and agencies face several simultaneous emergencies, attention itself is a scarce resource that is rationed, often badly.

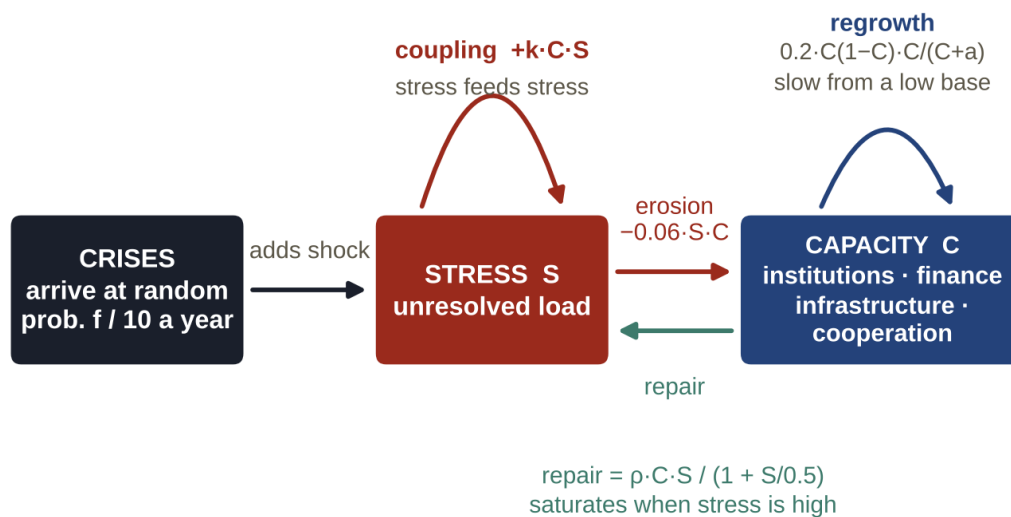
The implication, developed in Section 10, is that some of the highest-value interventions are not domain-specific at all. They are the shared capacities — fiscal space, emergency finance, information systems, trust — on which every domain depends.

6. The Spiral Model

A deliberately simple model of the race between stress and repair. It is built to make the mechanism visible, not to predict.

The spiral model has two state variables. **Capacity**, from 0 to 1, stands for a civilisation's complexity and its ability to manage problems: institutions, infrastructure, finance and cooperation. **Stress** stands for the unresolved load of crises. Each year a crisis may arrive at random and add stress. Capacity repairs stress, but repair saturates when stress is high — the “beyond humanity's capacity to manage” of the definition. Crises reinforce one another in proportion to how interconnected the system is. And unrepaired stress erodes capacity, while capacity regrows slowly, especially from a low base, because rebuilding complexity needs complexity.

Figure 4. The structure of the spiral model. Crises add stress; coupling lets stress feed stress in proportion to capacity; repair removes stress but saturates when stress is high; stress erodes capacity; capacity regrows slowly from a low base.



Collapse: $C < 0.25$ Recovery: $C > 0.75$ Start: $C = 1, S = 0.05$

Source: H Heuristics. Structure of the stress–repair model specified in Section 16.

Those few assumptions are enough to produce the behaviour the definition describes: long stretches of stability, a threshold beyond which stress runs away and capacity collapses within a few decades, and a dark age of centuries before capacity recovers.

6.1 The five settings

The model is controlled by five settings. The defaults were chosen to place the model near its threshold, where its behaviour is most informative; they are not estimated from data.

Table 4. The model's five settings and their default values

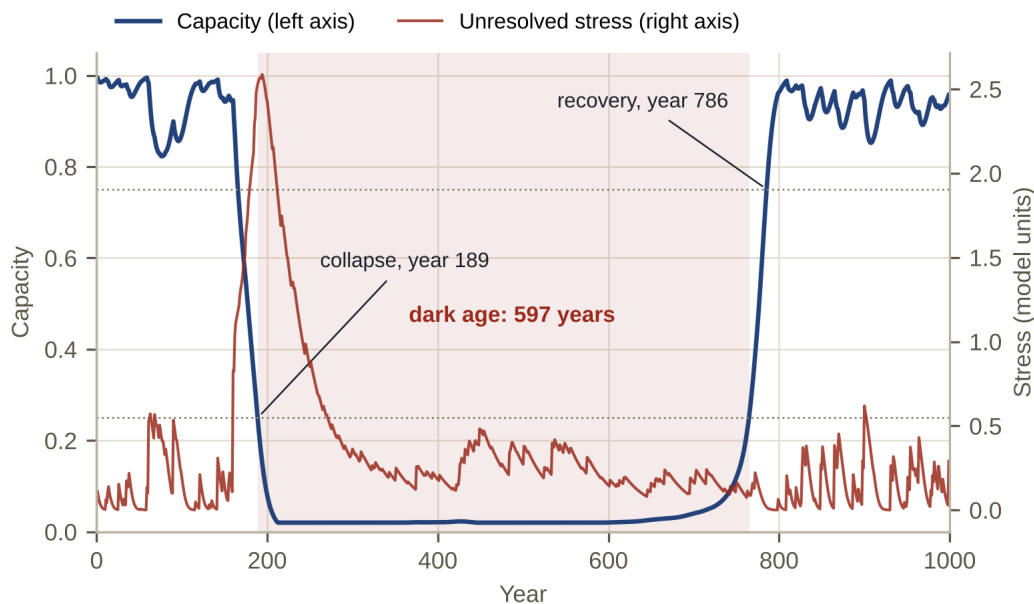
Setting	What it represents	Default	Range used
Crisis frequency	Average number of major crises per decade	2 per decade	1–3
Crisis size	Average stress a crisis adds when it arrives (scaled by capacity)	0.12	0.08 – 0.16

Setting	What it represents	Default	Range used
Coupling	How strongly crises reinforce one another through an interconnected system	0.25	0.14 – 0.36
Repair capacity	How much stress institutions can resolve each year at full capacity	0.60	0.45 – 0.75
Rebuild speed	How quickly capacity regrows from a low base — preserved knowledge and institutions	Moderate ($a = 0.3$)	Very slow – very fast ($a = 1$ to 0.05)

6.2 One simulated millennium

The model runs in annual steps, with a seeded random-number generator so that results can be reproduced exactly. Figure 5 shows one run of 1,000 years at the default settings. For nearly two centuries, capacity stays close to its maximum, absorbing a series of crises. Then a cluster of shocks arrives; stress spikes above 2.5 model units, repair saturates, capacity falls through the 0.25 collapse threshold in year 189 and stays near its floor for almost six centuries before regrowing past 0.75 in year 786. In this run the dark age lasts 597 years.

Figure 5. One simulated millennium (run 1, default settings). Capacity (blue, left axis) and unresolved stress (red, right axis). Shaded: collapsed, defined as capacity below 0.25. The run recovers when capacity next exceeds 0.75.



Source: H Heuristics spiral model; seed 1. Illustrative. Reproduced independently for this edition (Appendix B).

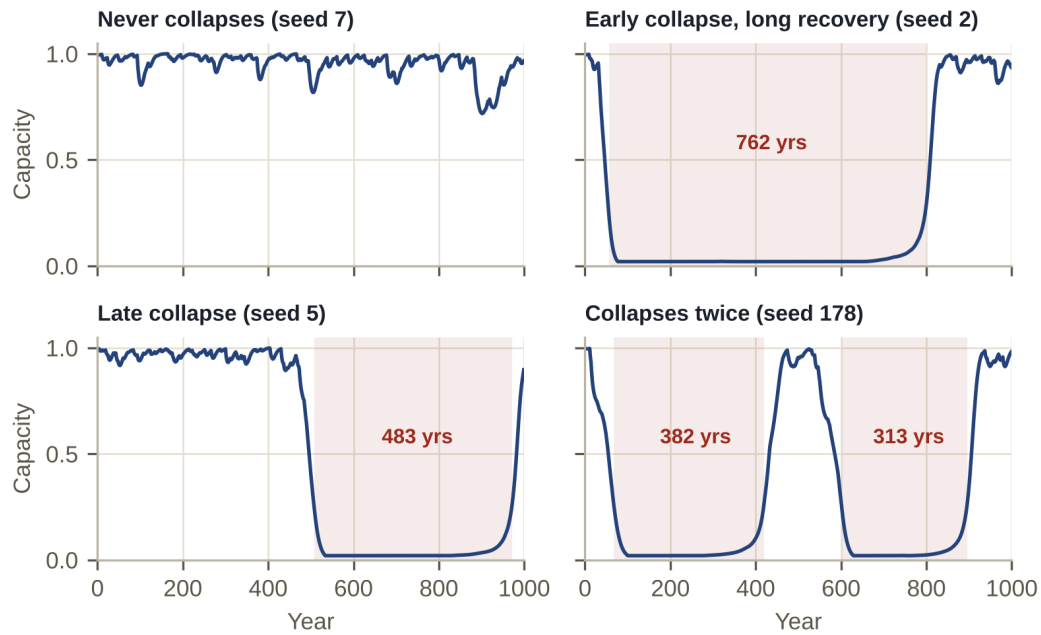
Two features are worth noticing. First, the collapse is abrupt compared with the stability that precedes it: capacity falls from near its ceiling to near its floor in a few decades. Second, the recovery is slow to start but, once it begins, also fairly sharp. The long middle is the dark age: capacity is so low that it cannot regrow quickly, because — in the model as in history — rebuilding complexity requires complexity.

6.3 The variety of outcomes

A single run is only one draw. Because crises arrive at random, runs with identical settings can differ enormously. Figure 6 shows four runs at the default settings: one that never collapses, one that collapses early (year 56) and takes more than 700 years to recover, one that collapses late (year 508) and has only just recovered by the end of the millennium, and one that collapses twice. This variability is part of the message. A world on the wrong side of the threshold is not certain to collapse in any given century; it is

likely to do so over a long enough horizon, and the timing is dominated by the luck of when large crises cluster.

Figure 6. Four runs at identical default settings. Shaded regions mark collapse; labels give the length of each dark age.

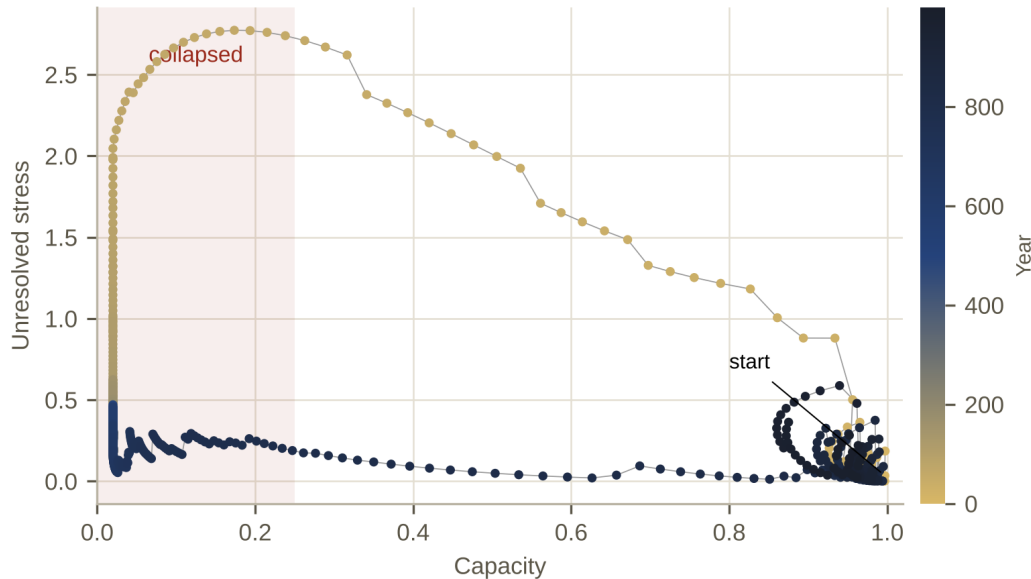


Source: H Heuristics spiral model; seeds 7, 2, 5 and 178. Illustrative.

6.4 The phase portrait

The relationship between the two variables can be seen directly by plotting stress against capacity over time (Figure 7). The trajectory begins at high capacity and low stress, wanders in a small loop as small crises are absorbed, then sweeps out to high stress as a large shock lands. Capacity falls while stress is high; stress then decays slowly because there is little capacity left to resolve it, and the system settles in the collapsed corner — low capacity, low stress — from which it later climbs back. The loop is *hysteretic*: the path out is not the path back.

Figure 7. Phase portrait of a collapsing run (seed 2): unresolved stress against capacity, coloured by year. The excursion to high stress drives capacity into the collapsed region (shaded), where it remains for centuries before returning along a different path.



Source: H Heuristics spiral model. Illustrative.

6.5 What the model leaves out

The model is deliberately minimal. It has one stress variable and one capacity variable, so it cannot say which crises matter or where capacity is lost. It has no spatial structure, no technology, no population, no distinction between regions that collapse and regions that do not. It does not model recovery of the kind that comes from outside, as Western Europe's did from Byzantium and the Islamic world. Its parameters are not estimated from data. All of this is by design: a richer model would have more parameters than evidence. What the minimal model offers instead is a transparent demonstration that a small number of plausible assumptions — interaction, saturation, erosion — produce a threshold, a collapse and a long dark age. Section 14 returns to what follows from its limits.

7. Where the Threshold Lies

The model’s most useful property is that it has a sharp edge. Small changes near it have large effects.

This section reports results from the model: 300 runs of 1,000 years at the default settings, 100-run grids across repair and coupling, and one-at-a-time sensitivity tests. All runs use fixed seeds (1000 onward), so every figure can be reproduced from the published specification.

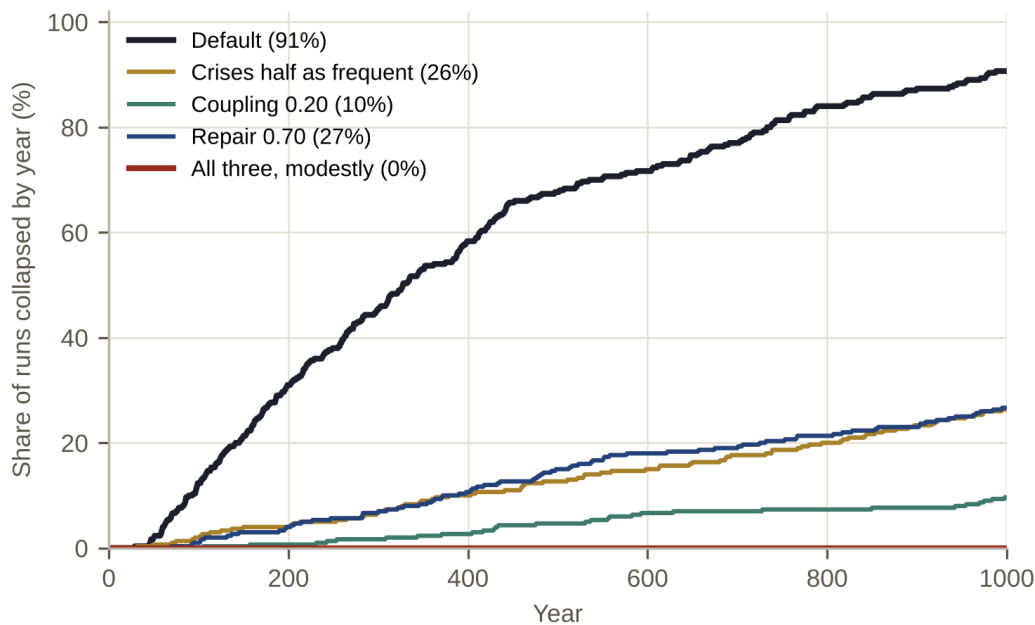
7.1 The default world

At its default settings — two major crises a decade, moderate coupling and a repair capacity of 0.6 — the model sits close to its threshold. About one run in eight collapses within a century, 45% within 300 years and 91% within 1,000 (Figure 8). Among runs that collapse and recover within the millennium, the median dark age lasts 471 years. Across all runs, 44% of simulated years are spent collapsed. These settings are not calibrated to the real world; they were chosen to place the model near its edge.

Table 5. Default-settings results, 300 runs of 1,000 years

Measure	Result
Runs collapsing within 100 years	12%
Runs collapsing within 300 years	45%
Runs collapsing within 1,000 years	91% (272 of 300)
Year by which half of runs have collapsed	≈ 330
Median dark age, runs that collapse and recover within the millennium	471 years (168 runs)
Middle half of dark ages (25th–75th percentile)	383 – 565 years
Share of all simulated years spent collapsed	44%
Average number of collapse episodes per 1,000-year run	1.09

Figure 8. The cumulative share of runs that have collapsed by each year, under default settings and four alternatives. At default settings the curve climbs steadily toward 91% by year 1,000. Halving crisis frequency, raising repair capacity from 0.6 to 0.7 and loosening coupling from 0.25 to 0.20 each flatten it dramatically; modest changes to all three (frequency 1.7, coupling 0.21, repair 0.70) remove collapse in all 300 runs.

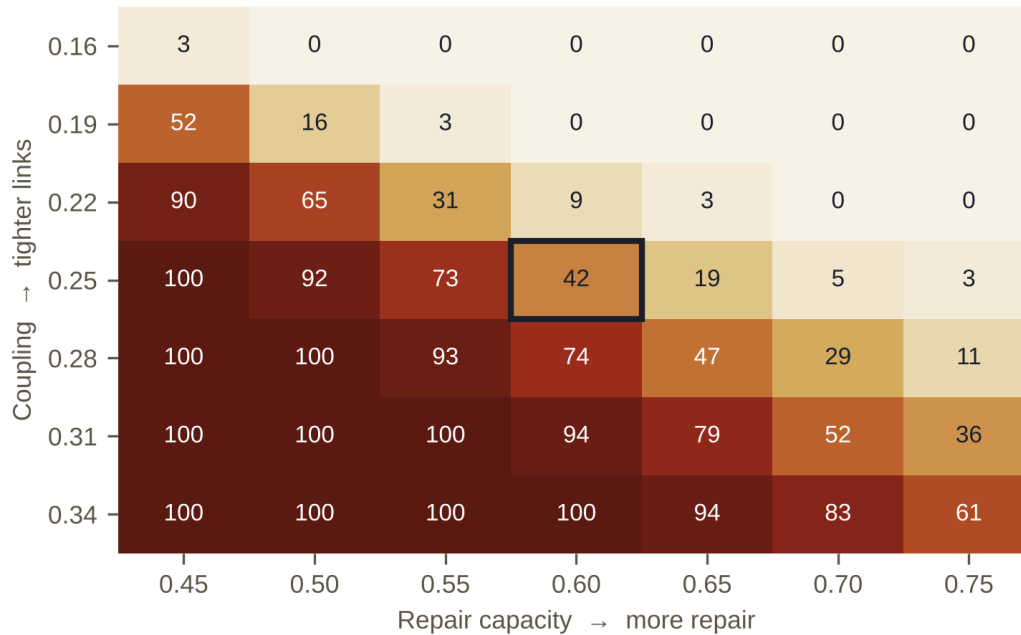


Source: H Heuristics spiral model; 300 runs per scenario, seeds 1000–1299. Illustrative.

7.2 The tipping ridge

The heatmap in Figure 9 shows why the balance matters more than either term alone. The boundary between safety and collapse runs diagonally: stronger coupling can be offset by more repair, and weaker repair by looser coupling. Near the ridge, small changes have large effects. With repair at 0.6, moving coupling from 0.22 to 0.28 raises the share of runs collapsing within 300 years from 9% to 74%. This is the signature of a threshold system, and it is why a world that has coped with every shock so far can still be closer to the edge than its record suggests.

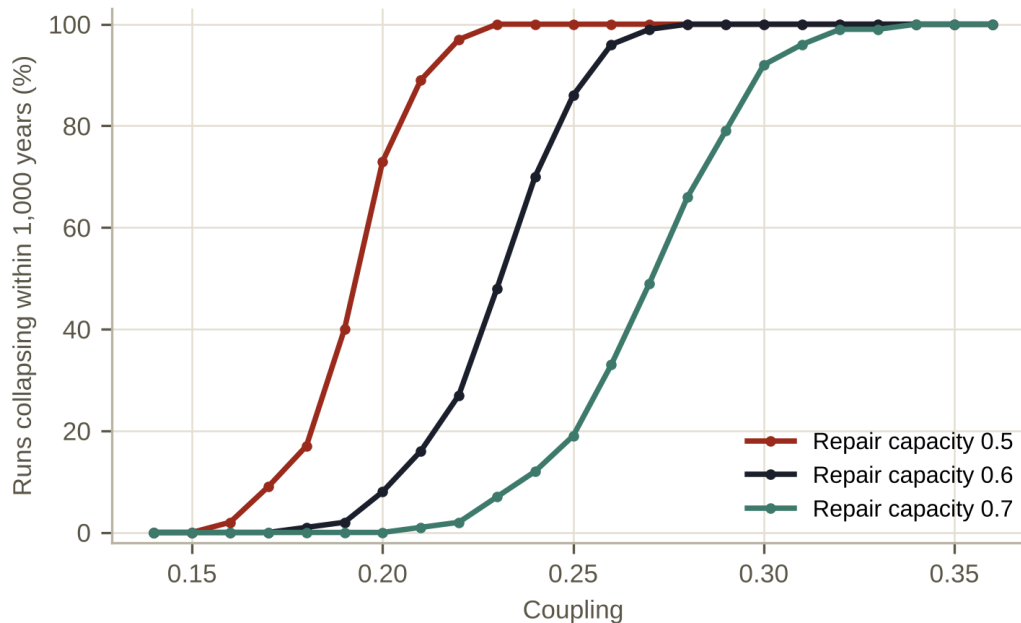
Figure 9. The tipping ridge. Each cell shows the share of 100 runs whose capacity falls below 0.25 within 300 years, as repair capacity (across) and coupling (down) vary; other settings at default. Darker is worse; the outlined cell is the default (42% in this 100-run grid, 45% in the 300-run tile).



Source: H Heuristics spiral model; 100 runs per cell, seeds 1000–1099, 300 years. Illustrative.

Figure 10 shows the same relationship as three curves. Each rises from near zero to near 100% over a narrow band of coupling, and the band shifts to the right as repair capacity improves. At repair 0.7 the 1,000-year collapse share does not reach one in three until coupling is about 0.26, against 0.20 at repair 0.5 where it is already above 70%. Higher repair capacity buys room, but the transition remains abrupt wherever it sits. Systems of this kind do not fail gradually; they hold, hold, and then do not.

Figure 10. Share of runs collapsing within 1,000 years as coupling rises, for three levels of repair capacity. Higher repair shifts the transition to higher coupling but does not soften it.

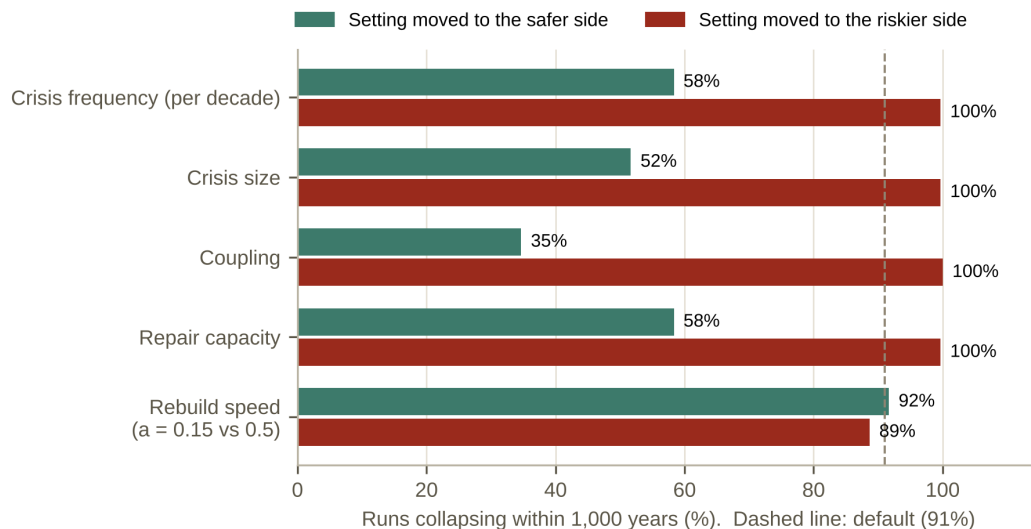


Source: H Heuristics spiral model; 100 runs per point, 1,000 years. Illustrative.

7.3 Which setting matters most?

To test sensitivity, each of the four risk-side settings was moved one step either side of its default while the others were held constant (Figure 11). Every one of them moves the 1,000-year collapse share from near-certain to well below 100% within a very small change: coupling from 0.28 to 0.22 reduces it from 100% to 35%; repair capacity from 0.55 to 0.65 from 100% to 58%; crisis frequency from 2.5 to 1.5 per decade from 100% to 58%; and crisis size from 0.14 to 0.10 from 100% to 52%.

Figure 11. One-at-a-time sensitivity of the 1,000-year collapse share to each setting, moved one step either side of default. Rebuild speed (bottom) has almost no effect on whether collapse happens — it affects how long it lasts.



Source: H Heuristics spiral model; 300 runs per bar, seeds 1000–1299. Illustrative.

Table 6. Sensitivity of the 1,000-year collapse share

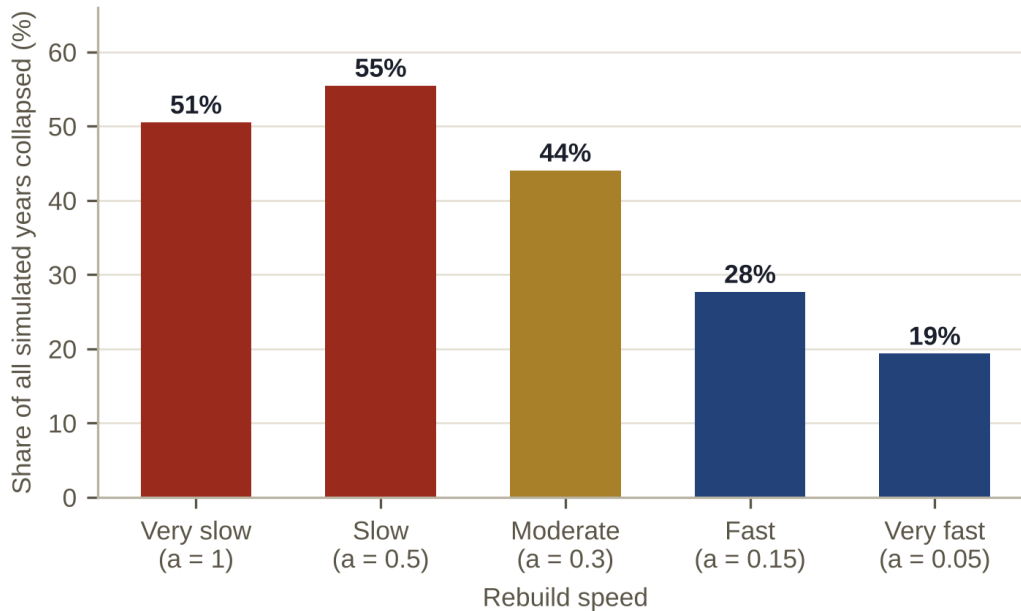
Setting varied	Lower setting	Collapse share	Higher setting	Collapse share
Crisis frequency (per decade)	1.5	58%	2.5	100%
Crisis size	0.10	52%	0.14	100%
Coupling	0.22	35%	0.28	100%
Repair capacity	0.55	100%	0.65	58%
Rebuild speed	Fast (a = 0.15)	92%	Slow (a = 0.5)	89%

No setting is a lone hero. The four risk-side settings are interchangeable in their effects over this range: a modest shift in any one produces a large change in outcome, and combinations compound. That is the practical content of the idea that the race is won on several fronts at once.

7.4 How long the dark lasts

The model separates two kinds of resilience. The settings that change the *probability* of collapse are on the stress side and the repair side: fewer or smaller crises, looser coupling, more repair. The rebuild setting barely changes the odds of falling, but it changes how long the fall lasts: at the slowest setting runs spend about half of all simulated years collapsed, at the fastest about a fifth (Figure 12). Preventing collapse and shortening it are different jobs, and a serious strategy needs both.

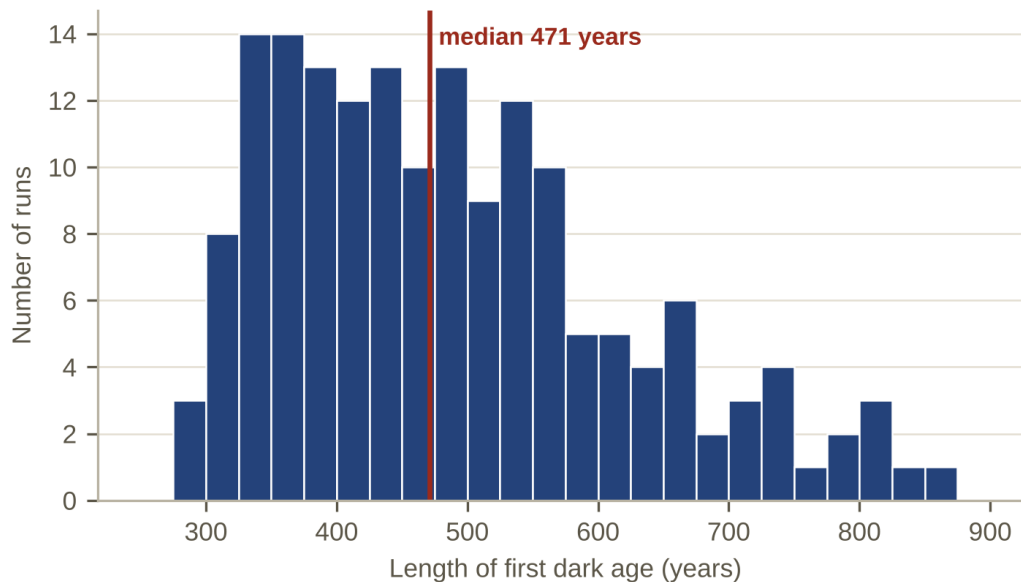
Figure 12. Share of all simulated years spent collapsed, by rebuild setting, at otherwise default settings. Faster rebuilding — standing in for preserved knowledge and institutions — more than halves the time spent in the dark.



Source: H Heuristics spiral model; 300 runs per bar. Illustrative.

Among runs that collapse and recover, the dark age at the default settings runs from 288 to 867 years, with half falling between 383 and 565 (Figure 13). A note on interpretation: the median dark age is computed only among runs that recover within the 1,000-year window, so for slow-rebuild settings it understates the true duration (runs that have not recovered are excluded) and does not move monotonically with rebuild speed. The share of years spent collapsed, which counts every year of every run, is the cleaner measure of the effect of rebuilding.

Figure 13. Distribution of the length of the first dark age in the 168 default-settings runs that collapse and recover within the millennium. The median is 471 years.



Source: H Heuristics spiral model; seeds 1000–1299. Illustrative.

7.5 What the results do and do not mean

The results are a demonstration of mechanism. They show that a model with interaction, saturation and erosion has a threshold; that near the threshold, outcomes are very sensitive to small changes; and that once collapse occurs, the duration depends on a different variable from the one that determines the odds. They do not show that the real world is near its threshold, that real-world coupling is 0.25, or that the dark age would last 471 years. Section 8 asks where the world's measured stress stands, and Section 9 whether its repair capacity is holding.

8. The Present Ledger

One indicator of stress for each of the ten crisis domains in the definition, with its direction of travel.

The model's lesson is that stress must be read against repair, and both against their trends. The ledger below takes the first step for each of the ten domains: a current, published indicator of stress, its latest value and whether it is moving the wrong way. It is not a composite index; the domains are measured in incompatible units and adding them would hide more than it showed. Its purpose is to show breadth — how many fronts are under pressure at once — which is the condition for the reinforcement the definition describes.

Table 7. The ledger: ten domains, ten indicators

Domain	Indicator	Latest	Direction	Source
Climate & ecology	Planetary boundaries breached	7 of 9 (2025)	▲ from 3 in 2009	Planetary Health Check
Resource depletion	Material footprint per person	12.7 t (2023)	▲ from 8.7 t in 1990	UNDP HDR data
Water scarcity	People without safely managed drinking water	2.1 bn (2024)	▼ rural coverage 50% → 60% since 2015	WHO/UNICEF JMP 2025
Food insecurity	People facing hunger	673 m (2024)	▼ slightly, above pre-pandemic	FAO SOFI 2025
Economic instability	Low-income countries in or at high risk of debt distress	32 of 68 (Mar 2026)	▲ high and persistent	IMF LIC DSA list
Geopolitical conflict	State-based armed conflicts	65 (2025)	▲ most since 1946	UCDP/PRIO v26.1
Demographic shifts	Projected peak of world population	~10.3 bn (mid-2080s)	◆ ageing, peak this century	UN WPP 2024
Infrastructure decay	Average annual hazard loss to infrastructure and buildings	\$732–845 bn	▲ rising with climate risk	CDRI 2023
Technological disruption	Doomsday Clock (nuclear, climate, biology, AI)	85 sec (2026)	▲ from 100 sec in 2020–22	Bulletin of the Atomic Scientists
Pandemics	Excess deaths associated with COVID-19, 2020–21	14.9 m	◆ largest in a century	WHO

▲ stress rising · ▼ improving or easing · ◆ mixed or structural. The water coverage trend refers to the rural population, as reported by WHO/UNICEF; 2.1 billion is the global count lacking safely managed drinking water.

Figure 14. The ledger at a glance: six of ten domains are moving the wrong way, three are mixed and one is improving.

WRONG WAY (6)	MIXED (3)	IMPROVING (1)
Climate & ecology 7 of 9 boundaries breached	Food insecurity 673 m hungry, easing slightly	Water scarcity rural safe water up from 50% to 60%
Resource depletion 12.7 t per person	Demographic shifts peak ~10.3 bn this century	
Economic instability 32 of 68 LICs in distress	Pandemics 14.9 m excess deaths 2020–21	
Geopolitical conflict 65 conflicts, most since 1946		
Infrastructure decay \$732–845 bn a year in losses		
Technological disruption Doomsday Clock at 85 sec		

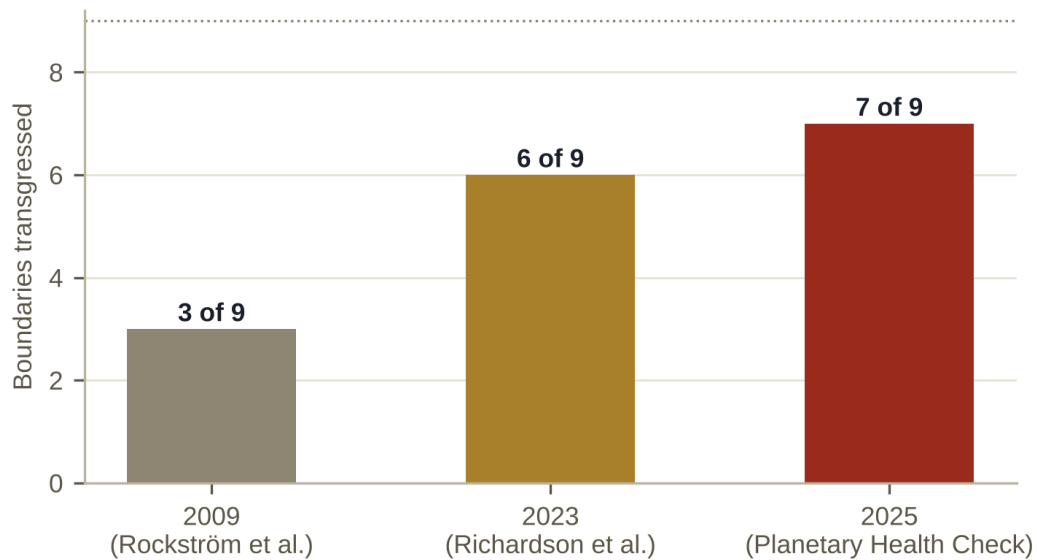
Source: H Heuristics classification of the indicators in the ledger table. Judgemental.

Six of the ten domains are moving the wrong way, three are mixed and one is improving. The improving one is instructive: safely managed drinking water has expanded since 2015 — rural coverage rose from 50% to 60% according to [WHO and UNICEF](#) — a reminder that sustained investment does move indicators. Hunger fell slightly in 2024 to 673 million people but remains above its pre-pandemic level, and the 2.3 billion people facing moderate or severe food insecurity are a measure of how little slack the food system has.

8.1 Four indicators through time

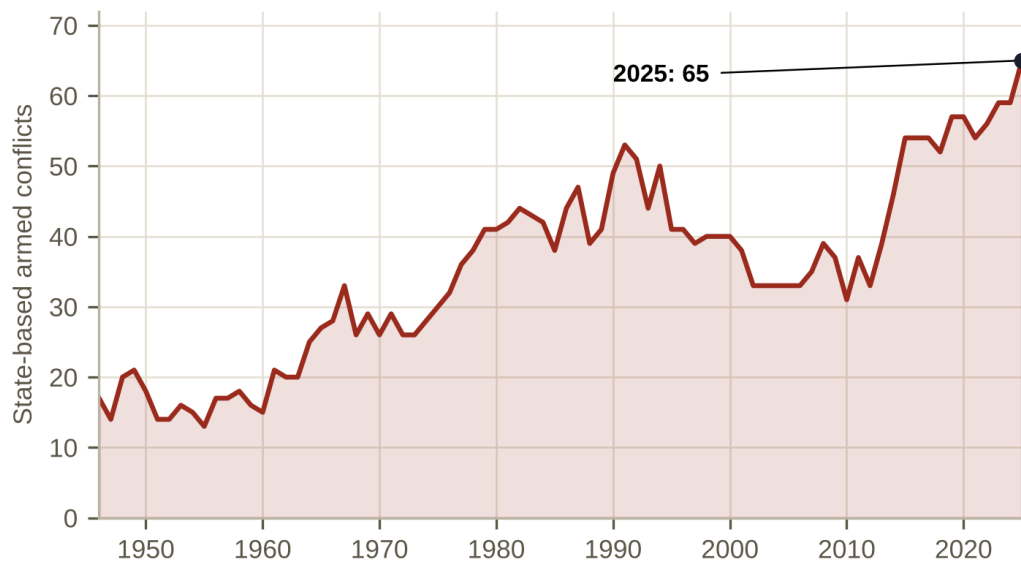
A level means little without a trajectory. The four charts that follow take four of the ledger’s indicators back in time. Planetary boundaries have been crossed one after another since the first assessment in 2009; the number of state-based armed conflicts has reached its highest level since 1946; global temperature has set successive records; and the material footprint of the average person has risen by almost half since 1990.

Figure 15. Planetary boundaries breached, by assessment. Number of the nine boundaries assessed as transgressed.



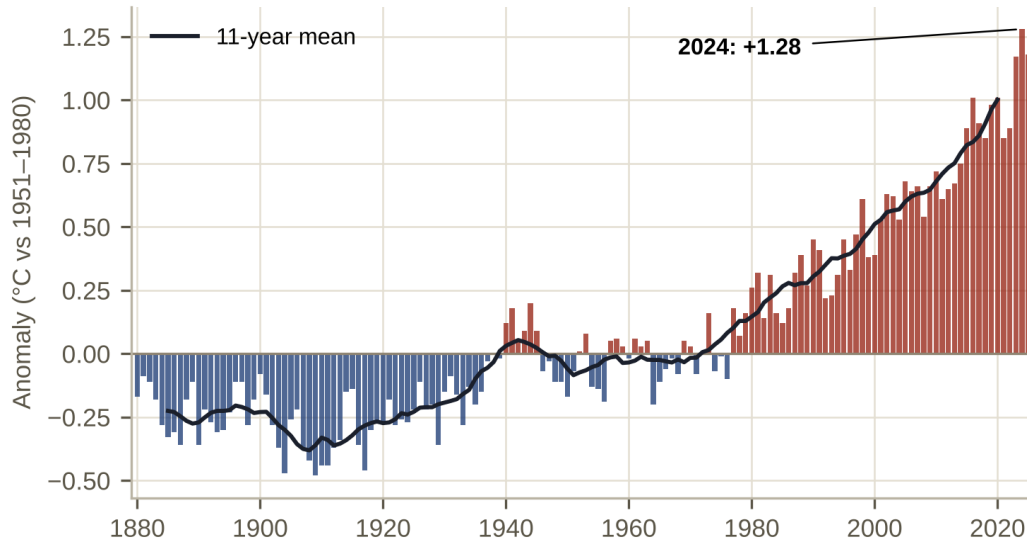
Sources: *Rockström et al. 2009*; *Richardson et al. 2023*; *Planetary Health Check 2025*.

Figure 16. State-based armed conflicts, 1946–2025. Active conflicts per year. The 2025 count of 65 is the highest since records began.



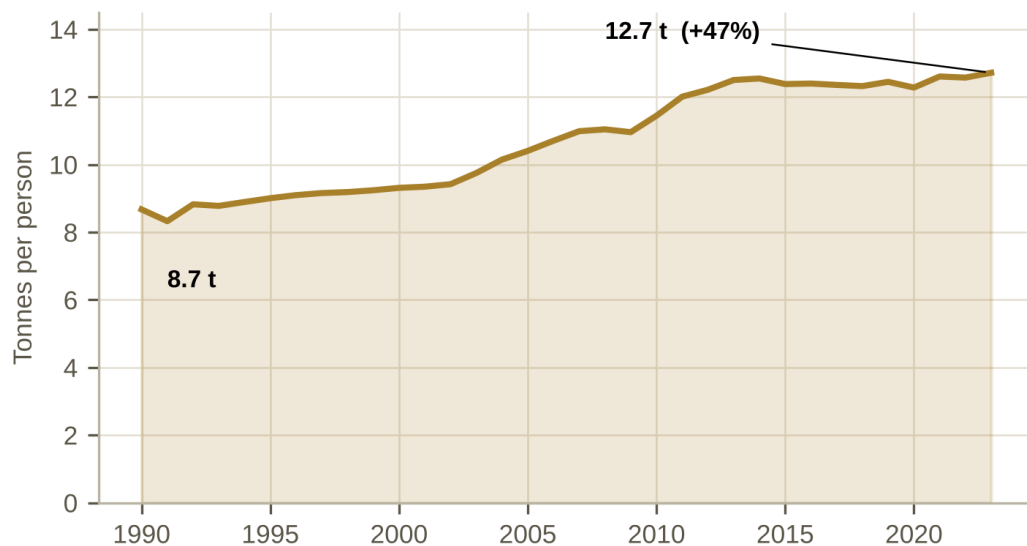
Source: *UCDP/PRIO Armed Conflict Dataset v26.1*; chart redrawn from the dataset for this edition.

Figure 17. Global temperature, 1880–2025. Annual mean anomaly in °C relative to 1951–1980, with an 11-year centred mean. 2024 (+1.28 °C) is the highest annual value in the series; 2025 stands at +1.18 °C.



Source: [NASA GISS, GISTEMP v4](#), annual (J–D) land-ocean means, retrieved October 2026; chart redrawn for this edition.

Figure 18. Material footprint per person, 1990–2023. Tonnes of materials per capita; up 47% since 1990.



Source: [UNDP HDR 2025 data](#); author's calculation.

8.2 Domain by domain

Climate and ecological degradation

The [Planetary Health Check 2025](#) judged seven of nine planetary boundaries transgressed, up from three in 2009 and six in 2023. Global temperature reached +1.28 °C against the 1951–1980 baseline in 2024, the highest annual value in NASA's record, and stood at +1.18 °C in 2025. The [IPCC's Sixth Assessment Synthesis Report](#) estimated that 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change, and that mortality from floods, droughts and storms in 2010–2020 was 15 times higher in highly vulnerable regions than in those with very low vulnerability. [Armstrong McKay and colleagues' 2022 assessment](#) concluded that several tipping elements may already be at risk. In the model's terms,

climate is a driver of crisis frequency and size and, through its effects on food, infrastructure and conflict, of coupling.

Resource depletion

Material footprint per person rose from 8.7 tonnes in 1990 to 12.7 tonnes in 2023. Resource depletion is both a stress and a coupling: scarcity of energy, minerals or fertiliser transmits shocks across domains. The World Economic Forum's [Global Risks Report 2026](#) ranks natural resource shortages sixth over a ten-year horizon.

Water scarcity

The [WHO/UNICEF Joint Monitoring Programme](#) reported in 2025 that 2.1 billion people — one in four — still lacked safely managed drinking water, with rural coverage up from 50% to 60% since 2015 and urban coverage stagnating. Water is the quiet link between climate, food, health and conflict.

Food insecurity

About 673 million people faced hunger in 2024 according to FAO's [State of Food Security and Nutrition 2025](#), slightly down but above the pre-pandemic level; 2.3 billion experienced moderate or severe food insecurity. The [Global Report on Food Crises](#) counts about 295 million in acute food insecurity in 2024, with a rising number in the most extreme phase concentrated in conflict zones. Humanitarian funding has fallen over the same period.

Economic instability

The [IMF's list](#) shows 32 of 68 low-income countries in or at high risk of debt distress as of 31 March 2026. For these countries, debt service competes with health, education and adaptation spending, which is the mechanism by which a financial stress becomes a loss of repair capacity.

Geopolitical conflict

UCDP recorded 65 state-based conflicts in 2025 across 35 countries, 13 of them wars with at least 1,000 battle-related deaths in the year, and around 244,600 people killed in organised violence, making it the second deadliest year since the 1994 genocide in Rwanda ([Uppsala University](#)). The record eight interstate conflicts include Russia–Ukraine, Iran–Israel, India–Pakistan and Israel–Syria. Conflict is the domain most directly connected to the others, as both cause and consequence of food, energy and fiscal stress.

Demographic shifts

The UN's [World Population Prospects 2024](#) projects that the world's population will peak at about 10.3 billion in the mid-2080s. Demographic change is mixed rather than uniformly adverse: slowing growth relieves resource pressure, while ageing and uneven working-age populations strain fiscal systems and labour markets differently across regions.

Infrastructure decay

The Coalition for Disaster Resilient Infrastructure estimated average annual losses to infrastructure and buildings from hazards at \$732–845 billion in its 2023 report, [as reported in the press](#). Infrastructure is the physical form of capacity; its decay is a direct measure of erosion.

Technological disruption

The Bulletin of the Atomic Scientists set the [Doomsday Clock](#) to 85 seconds to midnight in January 2026, the closest ever, from 89 seconds a year earlier, citing nuclear, climate, biological and artificial-intelligence risks. The World Economic Forum's 2026 ranking shows adverse outcomes of AI rising from 30th over two years to 5th over ten, the biggest climb of any risk. Technology is double-edged in the framework: it can add stress, and it can raise repair capacity.

Pandemics and public health

The [WHO estimated 14.9 million excess deaths](#) associated with COVID-19 in 2020 and 2021, the largest mortality event in a century, followed by a rapid recovery in life expectancy (Section 9). Pandemics are the domain in which both the stress (a novel pathogen) and the repair (vaccines, health systems) are most visible.

8.3 Reading the ledger against the model

The worsening domains are also the ones most tightly coupled to others. Breaching planetary boundaries raises the frequency and size of climate and ecological shocks; conflict destroys infrastructure, displaces people and diverts budgets; debt distress removes the fiscal room to respond to anything else. In the language of the model, these are increases in crisis frequency, crisis size and coupling at the same time — the combination that the heatmap shows moving a system toward its ridge.

None of this establishes that the world is on the path the definition describes. The ledger measures stress, and the outcome depends on stress relative to the capacity to repair it, which grew enormously over the past century. The question that matters is whether that capacity is still growing as fast as the load — and the next section suggests that, on several measures, it is not.

9. Early Warnings

Systems approaching a threshold recover more slowly from each shock. Some measures of the world's repair capacity are now slowing or shrinking.

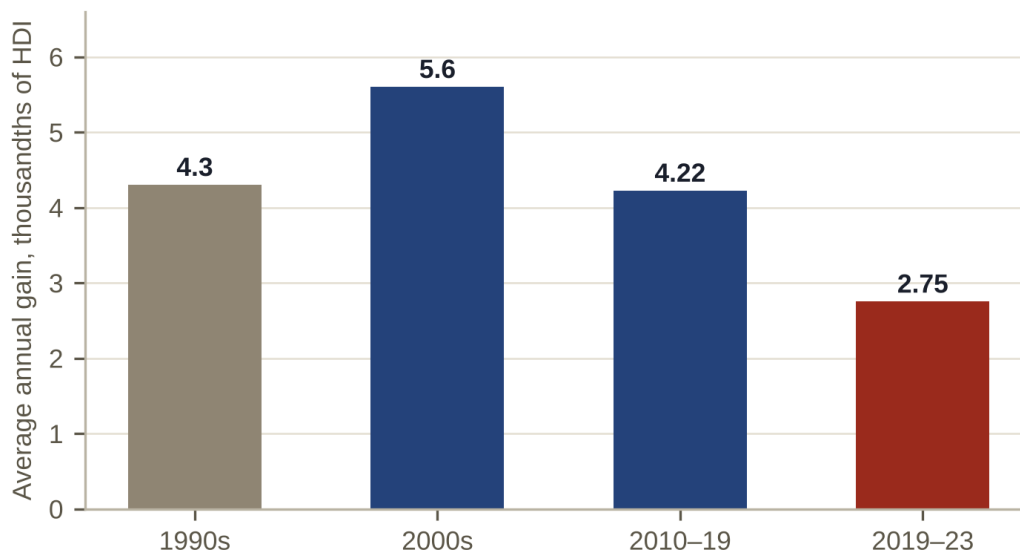
Complex systems often give warning before they tip. As a system loses resilience, it takes longer to return to its normal state after each disturbance, a phenomenon known as *critical slowing down*. The Pueblo societies of the American Southwest showed exactly this before their transformations, according to a [2021 study by Scheffer and colleagues](#): their construction activity recovered more and more slowly from climatic shocks in the decades before each collapse. The equivalent question for today is whether the world's capacity to recover from shocks is holding up as the shocks multiply.

Two kinds of evidence bear on it. The first is the pace of human development, which summarises health, education and income, and which slowed sharply after 2019. The second is the money that funds repair across borders — development aid and humanitarian relief — which fell steeply in 2025. Against both should be set the strongest evidence of modern resilience: global life expectancy, which fell during the pandemic and was back above its pre-pandemic level by 2022.

9.1 The pace of human development is slowing

The global Human Development Index rose by 5.6 thousandths a year in the 2000s and 4.2 in the 2010s. Between 2019 and 2023 it rose by 2.75 a year, after the first recorded fall in 2020; and [UNDP](#) projects that the gain for 2024, leaving aside the crisis years, will be the smallest since its series began in 1990. This is not collapse, but it is the shape of a system that is recovering less and less fully between shocks.

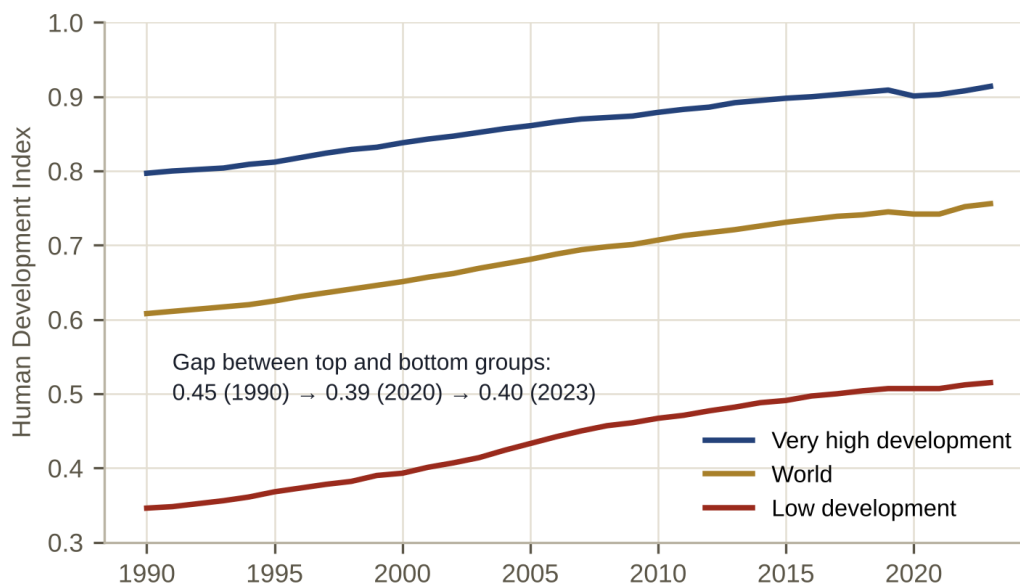
Figure 19. The pace of human development is slowing. Average annual gain in the global HDI, thousandths of a point, by period.



Source: [UNDP HDR 2025 data](#); author's calculation (recomputed from the source series for this edition).

The gap between the lowest and highest development groups, which had been narrowing for three decades — from 0.45 HDI points in 1990 to 0.39 in 2020 — has since edged back up, to 0.40 in 2023 (Figure 20). That is a small movement, but a reversal of direction in a long convergence trend is the kind of change early-warning analysis looks for: the systems least able to absorb shocks are recovering least.

Figure 20. Human Development Index, 1990–2023: very high, world and low development groups. The gap between the top and bottom groups narrowed from 0.45 (1990) to 0.39 (2020), then edged back to 0.40 (2023).

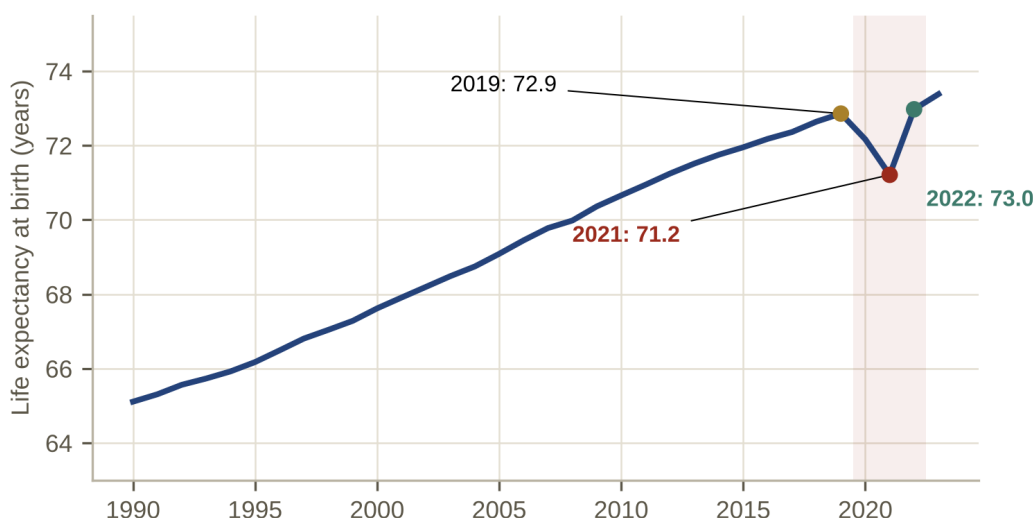


Source: [UNDP HDR 2025 data](#); author's calculation.

9.2 But recovery from a shock is still fast

The counter-evidence is real and should not be understated. Global life expectancy fell from 72.9 years in 2019 to 71.2 in 2021 and was back to 73.0 by 2022 (Figure 21), a recovery that would have taken a generation in most of history. Modern capacity remains vast. Vaccines were developed and deployed in under a year; global food and energy systems adjusted to the 2022 shocks without a global famine; and much of the infrastructure of coordination — central banks, health agencies, statistical systems — functioned under stress. The early warnings are not that this capacity has failed, but that it is being drawn down and under-replenished — which is how resilience is lost, gradually and then suddenly.

Figure 21. But recovery from a shock is still fast. Global life expectancy at birth, 1990–2023, falling to 71.2 years in 2021 and recovering to 73.0 by 2022.



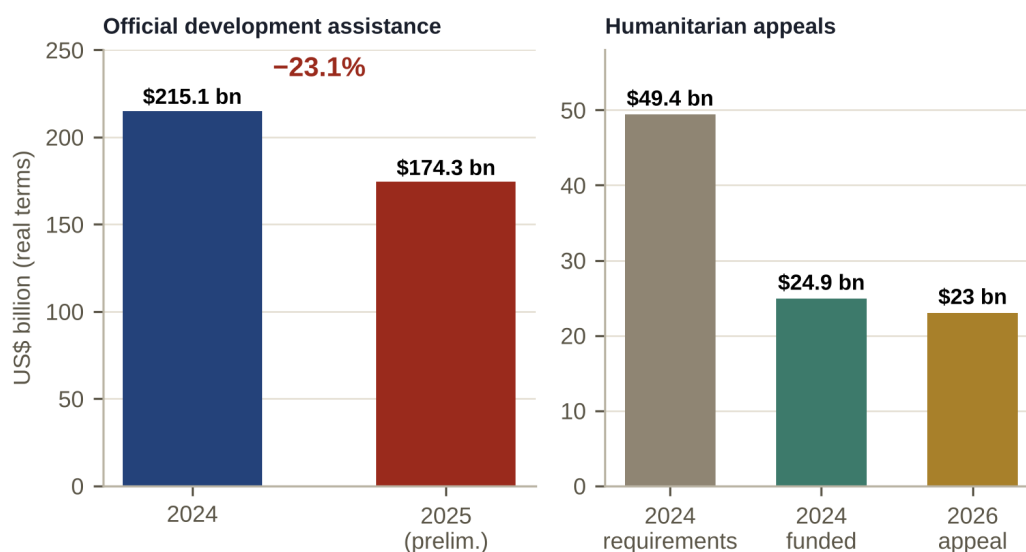
Source: [UNDP HDR 2025 data](#).

9.3 The finance of repair is shrinking faster

Official development assistance fell by 23.1% in real terms in 2025 — from \$215.1 billion in 2024 to \$174.3 billion, or from 0.34% to 0.26% of donors' combined gross national income — the largest annual drop on record, according to [OECD preliminary data](#). Twenty-six of 34 members reduced their aid; the five largest providers accounted for 95.7% of the fall, and the United States alone for about three-quarters of it. Humanitarian aid fell by more than a third (35.8%) and core bilateral development programming by 26.3%. The OECD notes that aid is back at 2015 levels and that final data, due in December 2026, will confirm whether the trend holds.

-23.1% official development assistance in 2025, real terms: \$174.3 bn against \$215.1 bn in 2024 OECD, preliminary	50.4% share of 2024 humanitarian requirements funded (\$24.9 bn of \$49.4 bn) OCHA	\$23 bn the 2026 “hyper-prioritised” humanitarian appeal, aimed at 87 million people OCHA, GHO 2026	2022 year global life expectancy regained its pre-pandemic level (73.0 against 72.9 in 2019) UNDP HDR 2025 data
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Figure 22. The finance of repair. Left: official development assistance, 2024 and 2025 (preliminary). Right: humanitarian requirements and funding in 2024, and the cut-back 2026 appeal.



Sources: [OECD](#); [OCHA GHO 2024](#) and [GHO 2026](#).

Humanitarian appeals were half funded in 2024, and the 2026 appeal was cut back to a “hyper-prioritised” \$23 billion aimed at 87 million people. In the model’s terms, these are reductions in repair capacity at the moment that crisis frequency and coupling are rising — the combination that moves a system toward its ridge from both sides at once.

9.4 What a genuine slowdown signal would look like

The evidence above is suggestive rather than diagnostic. A strict critical-slowng-down test would examine the recovery time of key series after shocks — trade volumes, food prices, employment, health indicators — and the autocorrelation of fluctuations, which rises as resilience falls. Section 13 proposes a watchlist built on that logic. The point for now is that the early-warning question is empirical and answerable, and that the data needed to answer it are mostly public.

10. Off-Ramps

Four levers keep repair ahead of stress. The model shows that each helps on its own and that together they compound.

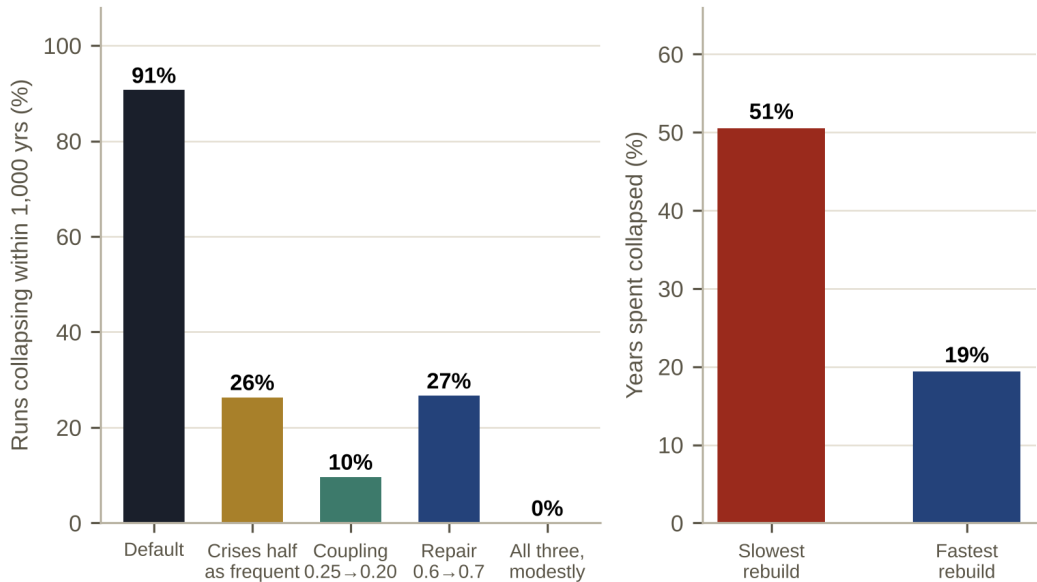
Because the Polycrisis Apocalypse is defined by a race, every off-ramp is a way of changing one of its terms. Fewer and smaller crises reduce the load. Looser coupling stops one crisis from feeding the next. Greater repair capacity resolves stress before it accumulates. And faster rebuilding shortens any regression that does occur. This section translates each lever into the model’s terms and into the kinds of policy that move it in the real world; the figures are the model’s, at default settings, and are illustrative.

The most important result is that the levers compound. Each on its own cuts the share of runs collapsing within 1,000 years from 91% to between 10% and 28%. Together — slightly fewer crises, slightly looser coupling and a little more repair — they remove it entirely in the model’s 300 runs. Near a threshold, modest improvements on several fronts are worth more than a heroic effort on one.

THE CONCLUSION IN ONE LINE

The outcome the definition describes is the product of a race whose terms can be measured and changed, several of which are moving the wrong way at once; the cheapest moment to change them is while the system is still on the safe side of its ridge.

Figure 23. The four levers in the model. Left: the share of 300 runs collapsing within 1,000 years at default settings (91%), and with crises half as frequent, coupling lowered from 0.25 to 0.20, repair raised from 0.6 to 0.7, and modest changes to all three. Right: the share of simulated years spent collapsed at the slowest and fastest rebuild settings.



Source: H Heuristics spiral model; 300 runs per bar. Illustrative.

Table 8. The four off-ramps in the model

Lever	Model term	Illustrative result	Real-world form
1. Shrink the shocks	Crisis frequency and size	91% → 26% (crises half as frequent)	Mitigation; pandemic prevention; conflict prevention

Lever	Model term	Illustrative result	Real-world form
2. Loosen the links	Coupling	91% → 10% (0.25 → 0.20)	Open trade in emergencies; diversified supply; redundancy
3. Fund the repair	Repair capacity	91% → 27% (0.6 → 0.7)	Reverse aid cuts; debt relief; adaptation finance; state capacity
4. Preserve the means to rebuild	Rebuild speed	51% → 19% of years collapsed (slowest vs fastest)	Archives; seed banks; local institutions and skills

10.1 Lever one: shrink the shocks

Reduce how often crises arrive and how large they are, at their source: mitigation that slows warming, prevention that stops outbreaks spreading, diplomacy that prevents wars. In the model, halving crisis frequency cuts the 1,000-year collapse share from 91% to 26%.

The real-world analogues are the least glamorous and the most underfunded. Emissions reductions lower the frequency and severity of climate-linked shocks and the odds of crossing the tipping points described by [Armstrong McKay and colleagues](#). Surveillance and preparedness reduce the chance that a local outbreak becomes a global one; the 2020–21 mortality of 14.9 million ([WHO](#)) is the benchmark of what failure costs. Conflict prevention and arms control address the domain in which the Bulletin of the Atomic Scientists' [Doomsday Clock](#) now stands at 85 seconds.

- Cut emissions and pollution at source
- Pandemic prevention and surveillance
- Conflict prevention and arms control

The strategic problem with this lever is its time profile. Prevention pays off slowly, is hard to attribute and is perennially underfunded relative to response. That is a reason to treat it as infrastructure — a commitment whose returns are measured in avoided crises — rather than as discretionary spending.

10.2 Lever two: loosen the links

Stop one crisis from feeding the next: keep trade open in emergencies, diversify supply, hold buffer stocks and separate critical systems so a failure in one does not cascade. In the model, lowering coupling from 0.25 to 0.20 cuts the 1,000-year collapse share from 91% to 10% — the most powerful single lever in the model over the range tested.

The 2020s made this lever concrete. Export bans on food and fertiliser in 2022 amplified price shocks by shifting scarcity onto importers; the [IFPRI food export restrictions tracker](#) documented the spread of such measures. Diversified energy and supply chains reduce the number of points at which one failure can stop many systems. Redundancy in critical infrastructure — power, water, telecommunications, payments — is the engineering form of loosening.

- No export bans on food and fertiliser
- Diversified energy and supply chains
- Redundancy in critical infrastructure

The trade-off is efficiency: slack costs money in good years. Perrow's insight that tight coupling and interactive complexity produce "normal accidents" implies that some of that efficiency is borrowed from future resilience. Loosening the links is the deliberate repayment of that loan.

10.3 Lever three: fund the repair

Sustain and grow the capacity to resolve stress: state capacity, fiscal space, debt relief, adaptation finance and the international institutions that pool risk across borders. In the model, raising repair capacity from 0.6 to 0.7 cuts the 1,000-year collapse share from 91% to 27%.

This is the lever on which the present ledger is moving backwards. Official development assistance fell 23.1% in 2025 ([OECD](#)); humanitarian appeals were half funded in 2024 ([OCHA](#)); and 32 of 68 low-income countries are in or at high risk of debt distress ([IMF](#)), constraining the budgets from which domestic repair would be paid. The case for restoring this funding is therefore not only humanitarian: in the model's logic it is the cheapest way to move the system back from its ridge.

- Reverse the 2025 cuts in aid and humanitarian funding
- Debt relief that restores fiscal room
- Adaptation and resilience investment

The model also suggests a design principle: spend on general-purpose repair capacity — fiscal space, emergency finance, institutions — rather than only on domain-specific programmes, because the capacity variable is shared across every domain in the ring of Figure 1.

10.4 Lever four: preserve the means to rebuild

Shorten any regression by keeping knowledge, institutions and seed stock intact: archives, distributed expertise, local capacity and the foundations of science and education. In the model, moving from the slowest to the fastest rebuild setting cuts the share of simulated years spent collapsed from 51% to 19%.

The fourth lever is the least discussed and perhaps the most distinctive to this concept. Because a Polycrisis Apocalypse is defined by the length of its regression, anything that preserves the means to rebuild — knowledge, institutions, genetic resources, skills held locally as well as globally — directly reduces its harm, even if it does nothing to prevent the fall. Past recoveries were faster where literacy, law or trade survived somewhere; the libraries and monasteries that carried texts through the European early Middle Ages are the historical form of this lever. Modern forms include seed banks such as the [Svalbard Global Seed Vault](#), durable and distributed knowledge archives, and — most important of all — education and technical skills held in many places rather than few. As Section 2.7 argues, it is also the lever that most directly hedges the tail risk that a long regression becomes an unrecoverable one.

- Durable, distributed archives of knowledge
- Seed banks and genetic resources
- Local institutions and skills, not only global ones

10.5 Why the levers compound

The levers act on different terms of the same loop, so improvements multiply rather than add. Fewer crises give repair capacity time to work; looser coupling stops stress from regenerating itself; stronger repair keeps capacity from eroding; and faster rebuilding limits the damage if the other three fail. The model's result — that modest changes to all three risk-side settings take the collapse share from 91% to 0% — is a quantitative statement of a general principle: near a threshold, breadth beats heroics.

The model's levers map onto debates that are already live. Shrinking the shocks is the domain of mitigation and prevention. Loosening the links is the logic of trade rules, strategic reserves and supply-chain diversification. Funding the repair is the agenda of debt relief, development finance and adaptation, which is moving backwards in 2025 and 2026. Preserving the means to rebuild is almost absent from mainstream policy discussion, which is itself a finding.

11. Four Illustrative Worlds

The model can be used to ask what different combinations of stress, coupling and repair would imply. These are illustrations of mechanism, not forecasts.

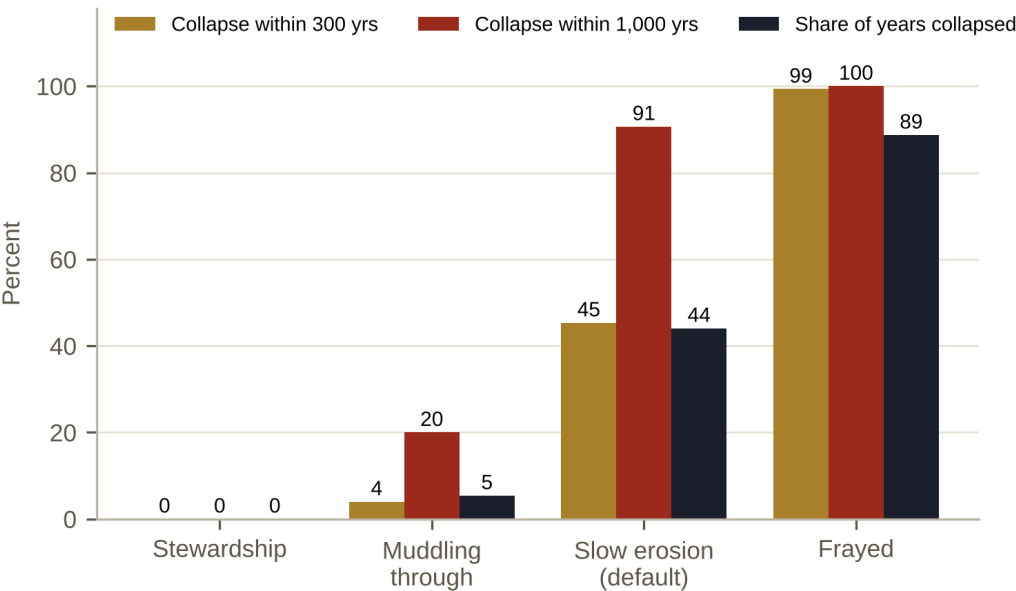
To make the model’s implications concrete, four named worlds were defined by shifting its settings together. Each is a style of future rather than a prediction, and none has been calibrated to real-world data. They are useful for contrast: they show how differently the same mechanism behaves across the range of plausible settings.

Table 9. Four illustrative worlds: settings and results

World	Settings (frequency, coupling, repair)	Collapse ≤ 300 yrs	Collapse ≤ 1,000 yrs	Median dark age	Years collapsed
Stewardship	1.7, 0.21, 0.70	0%	0%	—	0%
Muddling through	1.9, 0.23, 0.65	4%	20%	315 yrs	5%
Slow erosion (default)	2.0, 0.25, 0.60	45%	91%	471 yrs	44%
Frayed	2.4, 0.28, 0.55	99%	100%	604 yrs	89%

300 runs of 1,000 years per world, seeds 1000–1299; crisis size 0.12 and rebuild speed moderate in all. Median dark age is among runs that collapse and recover within the millennium.

Figure 24. The four worlds compared: share of runs collapsing within 300 and 1,000 years, and share of all simulated years spent collapsed.



Source: H Heuristics spiral model. Illustrative.

11.1 Stewardship

In this world, shocks are somewhat less frequent, links are looser and repair capacity is higher than the default. All of the changes are modest — around fifteen percent on each setting — but the result is that none of the 300 runs collapses in 1,000 years. Stress arrives and is absorbed; capacity fluctuates but stays high. Stewardship is not a world without crises; it is a world in which the machinery of repair is maintained faster than it is consumed. In the ledger, it would look like emissions peaking and falling, aid

and adaptation funding recovering, debt restructured, and the HDI's pace of gain returning toward its 2000s rate.

11.2 Muddling through

Here the settings are slightly better than the default, but short of Stewardship. About one run in twenty collapses within 300 years and one in five within a millennium; when collapse occurs the median dark age is just over three centuries. This is a world that mostly holds but whose fate is dominated by luck — whether a cluster of large crises arrives at the wrong moment. Its distinguishing feature is fragility without failure: a long period in which nothing breaks, followed, in a minority of futures, by an abrupt regime shift.

11.3 Slow erosion

This is the model's default: two crises a decade, moderate coupling, repair capacity of 0.6. It is the world in which the system is near its ridge, and the one on which most of this report's numbers are based. Nearly half of runs collapse within 300 years and nine in ten within a millennium. It is called slow erosion because the median run in this world does not collapse for more than three centuries: the failure is in the structure, not the calendar.

11.4 Frayed

In this world, crises are more frequent, coupling is tighter and repair is weaker. Three in four runs collapse within a century and virtually all within 300 years; the median dark age is over 600 years, and on average nine years in ten are spent collapsed. This is what a polycrisis that outruns the capacity to manage it looks like in the model: not a single event but a regime in which the system rarely has time to recover before the next collapse threatens.

Figure 25. Capacity trajectories under the default settings (top, four runs) and under combined modest improvements (bottom, three runs). Under default settings, collapses and long dark ages are common; under modest improvements to all three levers, capacity fluctuates but stays high.



Source: H Heuristics spiral model. Illustrative.

11.5 Where is the real world?

The model cannot say. Its settings are not mapped to measurable quantities, so there is no calibration that places the present on this spectrum. What can be said is directional. On the stress side, the ledger shows more boundaries breached, more conflicts, more hazard losses and rising material throughput. On the repair side, the early-warning evidence shows slowing human development, falling aid and under-funded humanitarian appeals. Those directions are consistent with drift away from Stewardship and toward the right of the table. Whether that drift is large enough to matter is the question Section 12 takes up, and Section 13 proposes to make measurable.

12. On Current Trajectories

The evidence does not support a date or a probability. It does support a direction: stress is rising, repair is slowing, and the combination is the one the model identifies as dangerous.

This section was added for the Word edition. It asks the question the rest of the report deliberately holds at arm's length: *if the directions of travel documented in Sections 8 and 9 simply continue, where does the model say they lead?* The answer is a judgement about direction, built from public data and a deliberately simple model. It is not a forecast, and it assigns no probability to any outcome.

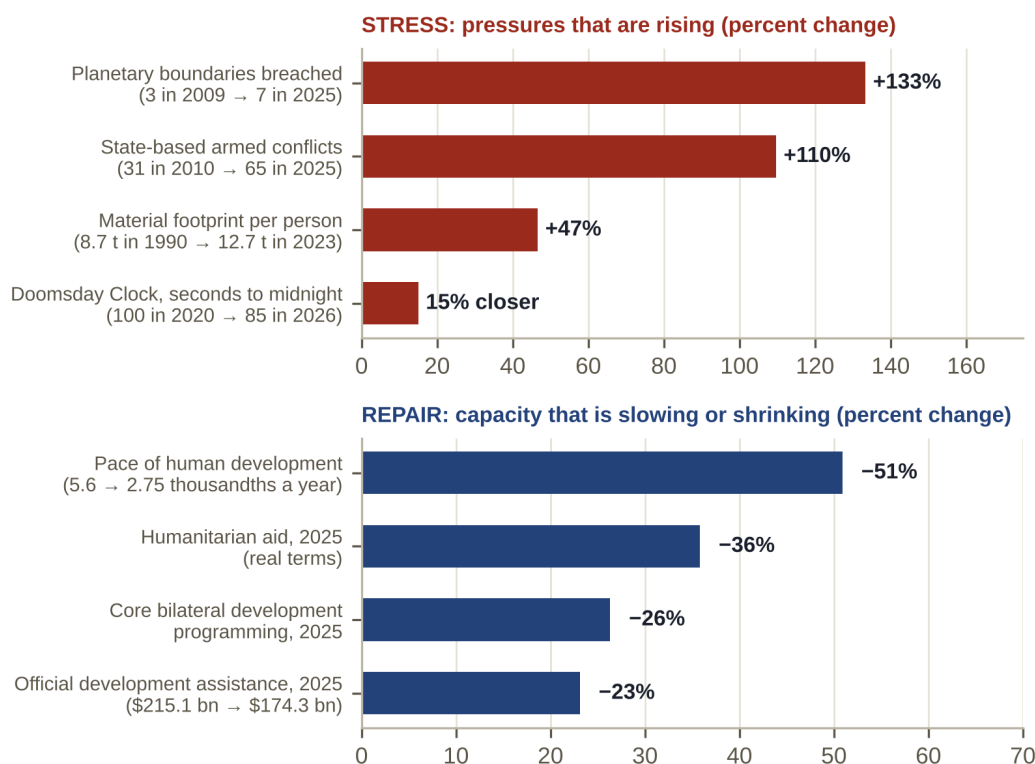
12.1 What “current trajectory” means

By *current trajectory* this report means the continuation of the measured directions of travel — rising stress on most of the ten domains and slowing or shrinking repair on the measures available — without a change in policy, financing or institutions large enough to reverse them. It is a deliberately plain assumption: no new shocks of unprecedented size, no sudden collapse of cooperation, simply the trends of the last several years persisting.

12.2 The direction of travel

Figure 26 puts the principal stress and repair measures side by side. On the stress side, the number of planetary boundaries breached has more than doubled since 2009, armed conflicts have more than doubled since 2010, and the material throughput of the average person is up by almost half since 1990. On the repair side, the pace of human development has roughly halved, development assistance has suffered its largest fall on record, and humanitarian aid has been cut by more than a third. These are different quantities over different periods, so the bars are not comparable with one another; the point is that every one of them is moving in the direction the model identifies as dangerous.

Figure 26. Direction of travel. Top: stress measures that are rising (percentage change over the period shown). Bottom: repair measures that are slowing or shrinking. Periods differ by indicator and are given on each axis label.



Sources: *Planetary Health Check*; *UCDP/PRIQ* (counts recomputed); *UNDP HDR data*; *Bulletin of the Atomic Scientists*; *OECD* (ODA, humanitarian aid, bilateral programming, preliminary 2025).

Table 10. Reading the trajectory against the model's terms

Model term	Evidence	Direction	Reading
Crisis frequency and size	7 of 9 planetary boundaries breached; 65 state-based conflicts; \$732–845 bn a year in hazard losses (PHC ; UCDP ; CDRI)	▲	More and larger shocks
Coupling	Export restrictions amplified 2022 price shocks (IFPRI); 32 of 68 low-income countries in or at high risk of debt distress (IMF); misinformation ranked second among near-term risks (WEF)	▲ (qualitative)	Links tightening; no direct measure exists
Repair: finance	ODA -23.1% in 2025; humanitarian aid -35.8%; 2024 humanitarian requirements 50.4% funded (OECD ; OCHA)	▼	The money for repair is shrinking
Repair: institutions	HDI gain 5.6 → 2.75 thousandths a year; gap between top and bottom groups widening since 2020 (UNDP)	▼	Recovery is less complete between shocks
Buffers and rebuild	Not systematically measured: grain stocks, fiscal reserves, distributed archives, locally held skills (Section 13)	?	The absence of measurement is itself a finding
Counter-evidence	Life expectancy back above pre-pandemic level by 2022; vaccines deployed in under a year; safe-water coverage rising (UNDP ; JMP)	▲ resilience	Capacity remains vast but is being drawn down

12.3 The distance between worlds is short

The most unsettling result in the model is not how bad the bad worlds are but how little separates them from the good ones. Table 11 sets the four worlds of Section 11 against the default. Stewardship, in which

none of 300 runs collapses in a millennium, differs from the default by roughly fifteen percent on each of three settings. Frayed, in which 99% of runs collapse within 300 years, differs from the default by 8% to 20%. A shift of that size on three dials is well within the range of the changes documented in the ledger over the past two decades.

Table 11. How far apart are the four worlds? Settings relative to the default, and outcomes

World	Crisis frequency	Coupling	Repair capacity	Collapse ≤ 300 yrs	Collapse ≤ 1,000 yrs
Stewardship	–15%	–16%	+17%	0%	0%
Muddling through	–5%	–8%	+8%	4%	20%
Slow erosion (default)	—	—	—	45%	91%
Frayed	+20%	+12%	–8%	99%	100%

Percentage differences are computed from the settings in Table 9 relative to the default (frequency 2.0, coupling 0.25, repair 0.60). Illustrative.

The heatmap in Section 7 makes the same point from the other direction: at repair 0.6, moving coupling from 0.22 to 0.28 — a rise of about a quarter — takes the share of runs collapsing within 300 years from 9% to 74%. Where a system sits relative to its ridge matters far more than how large any single change appears.

12.4 If the trajectory persists

If current trajectories continue, the model's verdict is not that collapse is certain, but that the world is drifting out of the region in which it is rare and into the region in which it is typical. In the Frayed world, three in four runs collapse within a century, the median dark age is over 600 years and nine years in ten are spent collapsed. That is what a polycrisis that outruns the capacity to manage it looks like in the model: a regime in which the system rarely has time to recover before the next collapse threatens.

The path from here to there would not look like a single event. The author's [Substack essay](#) gives a worked example of the kind of sequence involved: a multi-year drought cuts hydroelectric output, which curtails industry and fertiliser supply, which raises food insecurity, conflict and migration, which strains municipal finances and ends in sovereign debt default. Each step is individually familiar and individually survivable. The Polycrisis Apocalypse is the case in which the steps arrive together, the repair capacity needed at each is being spent on the others, and the capacity itself erodes (Section 5.3).

If such a regression began, Section 2.7 applies. A civilisation held at low capacity for centuries would be more exposed to the hazards that threaten humanity's survival, would retain the destructive capabilities of its predecessor without the institutions that restrain them, and might — if the energetic and institutional foundations of recovery were gone — find the regression permanent. These are reasoned hypotheses and are flagged as such; but they are the reason the report treats the *length* of the regression, and not only its onset, as the quantity that matters.

12.5 Why the trajectory may be worse than it looks

Four features of the framework suggest that the present position could be closer to the edge than the headline indicators imply.

- **Threshold systems do not warn gradually.** The model's curves rise from near zero to near certainty over a narrow band. A world that has absorbed every shock so far has not shown that it is far from the ridge; at the default settings, the model's median run does not collapse for more than three centuries and yet 91% eventually do.

- **The ledger measures one indicator per domain and lags the underlying state.** Several of its measures — debt distress lists, aid statistics, development indices — are published with delays of months or years, and the preliminary 2025 aid figures await final data in December 2026.
- **Repair and stress are weakening each other.** Debt distress removes the fiscal room to fund adaptation; aid cuts weaken the institutions that prevent crises becoming conflicts; conflict destroys infrastructure. In the model these are the erosion and coupling terms acting together, which is what moves the system toward its ridge from both sides.
- **Some stresses are slow and cannot be quickly reversed.** The author's essay argues, citing the [Stockholm Resilience Centre](#), that Earth systems respond slowly — ocean heat, ice-sheet decay and soil degradation over centuries — so that feedbacks persist regardless of late mitigation. The specific timescales are asserted in the essay without citation and are not relied upon here; the structural point is that load already committed cannot be repaired away on a political timetable (Appendix A).

12.6 What would show the trajectory is changing

A trajectory is not a destiny. The same framework identifies what a change of direction would look like, and each of the following can be observed in public data within a few years:

- Aid and humanitarian funding recovering from the 2025 falls, and the final OECD figures for 2025 (due December 2026) confirming a smaller decline than the preliminary data.
- Debt-distress counts falling as restructuring and relief restore fiscal room.
- The pace of gain in human development returning from 2.75 toward the 4–5 thousandths a year of the 2000s and 2010s, and the gap between the top and bottom groups resuming its narrowing.
- The count of planetary boundaries breached and of state-based conflicts ceasing to rise.
- Recovery times after the next global shock — food prices, trade, health — shortening rather than lengthening (Section 13.2).

THE AUTHOR'S JUDGEMENT

On current trajectories, the world may be heading toward a Polycrisis Apocalypse: stress is rising on most of the ten domains, the capacity to repair it is slowing or shrinking on the measures available, and the model shows that the gap between a stable world and a collapsing one is a matter of tens of percent on three settings.

This is a judgement about the direction of travel, made from public data and a deliberately simple model. It is not a prediction of timing, it assigns no probability, and it is conditional: every term in the race can still be changed, and the levers that change them are known.

13. What to Watch

A monitoring framework: the quantities that would tell us whether stress is outrunning repair, and which way coupling is moving.

If the outcome depends on the balance between load and repair, then the most useful thing an observer can do is to track both, over time, in a consistent way. This section proposes a watchlist organised by the model's terms. It is a framework for annual updating — the next editions of this series can report on it — not a composite index; composites hide the structure the framework is designed to expose.

13.1 The watchlist

Table 12. A watchlist keyed to the model's terms

Model term	What to track	Candidate indicators	Direction of concern
Stress: frequency and size of shocks	Climate, ecological, conflict and health shocks	Planetary boundaries (PHC); temperature (GISTEMP); conflicts (UCDP); hazard losses (EM-DAT); acute food insecurity (GRFC)	Rising
Coupling	How much one domain's stress spreads to others	Co-movement of food, energy and debt indicators (FAO FPI); concentration of critical supply chains; export restrictions (IFPRI); frequency of simultaneous stress (Polycrisis Century)	Rising
Repair: finance	Money available to resolve stress	ODA (OECD); humanitarian funding (OCHA FTS); debt-distress count (IMF); debt service burdens (World Bank IDS)	Falling
Repair: institutions	Capacity of states and multilateral bodies	Government effectiveness (WGI); human development pace (UNDP); life expectancy recovery times	Falling
Buffers	Slack in critical systems	Grain stocks (AMIS); fiscal reserves; energy storage and spare capacity; hospital surge capacity	Falling
Rebuild	Means of reconstitution after failure	Seed bank holdings (Crop Trust); distributed knowledge archives; science and education capacity; skills held locally	Falling

13.2 Critical-slowing-down tests

Beyond levels and trends, the framework suggests a more demanding class of tests. For any key series — global food prices, shipping volumes, employment, equity volatility, life expectancy — two statistics bear on resilience: the recovery time after a shock and the lag-one autocorrelation of fluctuations around the trend. Both tend to rise as a system approaches a threshold ([Scheffer et al., 2009](#)). A rising trend in recovery time across several domains at once would be a stronger warning than any single indicator, because it would show the signature of declining resilience rather than merely of rising stress.

These tests have well-known limits: they require long, clean series; they can give false positives where shocks themselves are changing; and they warn of a loss of resilience, not of its consequences. They are best used as a prompt for closer investigation, not as an alarm.

13.3 A suggested annual rhythm

- **Each January:** update the ledger of ten stress indicators and the repair indicators above, and report direction of travel against the prior year and the 2019 baseline.
- **Each spring:** review preliminary data on aid, humanitarian funding and debt distress, which are published early in the year and are the most responsive measures of repair.

- **Each autumn:** refresh the model's runs with updated qualitative judgement about where on the stress and repair axes the world has moved, and report the implication for the four-world comparison and for the trajectory assessment in Section 12.
- **Every five years:** reassess the model's structure against new evidence — particularly the saturation and erosion terms — and publish a full revision.

14. Objections and Limits

A concept this large invites serious objections. Several have force, and the framework is better for stating them.

“Modern civilisation is different from the past; the historical analogy fails.”

It is different in important ways. Modern societies are richer, more knowledgeable, more connected and better able to store and transmit knowledge than any premodern one, and they have tools — vaccines, satellites, central banks — that no earlier society had. These factors should make them harder to topple and faster to rebuild, and the report says so (Section 4.2). But the same features create new fragilities: dependence on fossil energy, just-in-time supply chains, global interdependence with no outside source of re-import, and the speed at which failures can propagate. The honest position is that the analogy supports the possibility of long regressions and tells us little about the probability.

“The past shows resilience, not collapse. The Black Death did not end civilisation.”

Correct, and the report uses that case (Section 4.1) as a contrast. A great loss of life did not cause regression because the machinery of coordination survived. The concept’s claim is not that large shocks cause collapse, but that collapse occurs when shocks outrun repair capacity and erode it. The Black Death is the case in which the capacity was not eroded.

““Collapse” is a contested concept in history; Rome transformed rather than fell.”

The debate is real. The report’s definition follows Tainter’s: rapid, significant loss of an established level of sociopolitical complexity. On that definition, material evidence — the disappearance of mass-produced pottery and coinage in post-Roman Britain, the end of Linear B, the fall in Greenland lead — supports loss of complexity even where cultural continuity persisted. The concept does not depend on settling whether the end of Rome was a catastrophe or a transition for those who lived it.

“The model is arbitrary; any outcome can be produced by choosing parameters.”

True of the numbers, not of the structure. The model’s defaults were chosen to place it near its threshold; nothing in the report claims they match real-world values. What the model demonstrates is structural: that interaction, saturating repair and erosion produce a threshold, a collapse and a long dark age, and that outcomes are sensitive to small changes near the threshold. Readers who disagree with the structure can change it; the specification is published in full (Section 16 and Appendix B).

“Technology will change the terms; the model ignores innovation.”

Technology appears in the framework on both sides: as a source of stress (the Doomsday Clock’s AI and cyber concerns; the rise of adverse AI outcomes in the World Economic Forum’s ten-year ranking) and as a source of repair (vaccines, clean energy, forecasting, coordination tools). In the model, technology that raises repair capacity or loosens coupling is simply a movement along the lever axes. The framework does not assume it will or will not arrive; it asks what is required for it to move the right terms.

“Naming an apocalypse invites fatalism or sensationalism.”

This is a legitimate concern, and the reason the report states repeatedly that the concept is a hypothesis, not a forecast, assigns it no probability and treats the outcome as avoidable. The purpose of the name is practical: to give a name to the specific failure — a long regression caused by interacting crises that outrun repair — so that its precursors can be measured and its levers pulled. Alarm without a path to action risks paralysis; the framework is designed to supply the path.

““On current trajectories” is a forecast by another name.”

It is not, and the distinction is the point of Section 12. A forecast assigns a probability and a date. The trajectory assessment says only which way the measured quantities are moving and where the model, on its own terms, says that direction leads. It is conditional on the continuation of present trends, it says

nothing about the probability that those trends continue, and it names the observable changes that would show the direction reversing.

“Extinction, not regression, is the real concern; the concept understates the risk.”

The concept is defined narrowly so that it can be examined empirically: history contains many regressions and no extinctions. Section 2.7 argues that the two are connected — a prolonged regression raises exposure to extinction-scale hazards and could become unrecoverable — but offers this as reasoning, not as a finding, because neither the model nor the ledger can quantify it. Readers whose primary concern is extinction should read the Polycrisis Apocalypse as a pathway that makes it more likely, not as a substitute for the category.

“The burden would fall unevenly.”

Yes, and this is a limitation of the model rather than of the concept. A one-variable model cannot represent the fact that stress and repair capacity are distributed unequally within and between societies. The poorest and most fragile regions would be first to lose capacity and last to regain it, and the ledger’s evidence — widening development gaps, debt distress concentrated in low-income countries, aid cuts falling on humanitarian programmes — points in that direction. Any real-world application of the framework should be disaggregated.

14.1 Limits of the evidence

- The historical sample is premodern and agrarian; there is no precedent for an industrial, globally integrated collapse.
- The model is illustrative: one stress variable, one capacity variable, uncalibrated parameters and no spatial structure.
- The ledger uses one indicator per domain; each domain has many, and the choice of indicator affects the picture.
- Several sources are preliminary: OECD ODA data for 2025 are preliminary pending December 2026 figures; the CDRI estimate is cited as reported in the press.
- The causal links in Section 5 are the author’s synthesis, not estimated coefficients.
- The trajectory assessment in Section 12 is a judgement about direction; it is not a probability, and the extinction pathways in Section 2.7 are reasoned hypotheses.

15. Conclusion

The Polycrisis Apocalypse is avoidable precisely because it is a race — but on current trajectories the race is being lost.

This report has defined a concept, set it beside human extinction, tested it against the historical record, built a model that makes its mechanism explicit, measured today's stress and repair, assessed where current trajectories point and translated the model's levers into off-ramps. The argument can be stated in seven sentences.

1. A Polycrisis Apocalypse is the end-state of a race between the stress that interacting crises add and the capacity of a civilisation to repair it.
2. History shows that complex societies lose complexity quickly and regain it slowly, and that regressions of centuries are ordinary rather than exceptional.
3. A simple model of that race has a sharp threshold: near it, small changes in crisis frequency, coupling or repair capacity move the odds of collapse from near-certain to rare.
4. Today stress is rising on most of ten fronts while several measures of repair capacity — development gains, aid, humanitarian funding — are slowing or shrinking.
5. On current trajectories, the world may be heading toward a Polycrisis Apocalypse, and a long regression would leave humanity more exposed to the extinction-scale hazards that the definition itself excludes.
6. The levers that win the race are known: shrink the shocks, loosen the links, fund the repair and preserve the means to rebuild; and they compound.
7. The cheapest moment to pull them is while the system is still on the safe side of its ridge.

The conclusion is not that collapse is imminent, and nothing in this report supports a date or a probability. It is that the outcome the definition describes is the product of a race whose terms can be measured and changed, that several of those terms are moving the wrong way at once, and that the cost of correcting them rises as the threshold nears. The concept is useful precisely because it names what is at stake if that moment is missed.

15.1 Four questions for any policy

The framework implies a simple test for any proposed policy, investment or institutional reform. Does it reduce the frequency or size of shocks? Does it loosen the couplings that carry stress between domains? Does it add to, or at least avoid draining, the capacity to repair? And does it preserve the means to rebuild if the others fail? Policies that score on several should be favoured over policies that score heavily on one, because the levers compound. Policies that draw down repair capacity — even in the name of efficiency or short-run savings — should be recognised as spending the buffer that the whole system depends on.

15.2 Research agenda

- **Calibration.** Estimate the model's settings, or richer analogues, from historical data — for example from the [Seshat Global History Databank](#).
- **Disaggregation.** Extend the model to multiple regions with different stress, coupling and capacity, and to the flows between them.
- **Measurement.** Build the watchlist in Section 13 into a regular public series, and test it against historical episodes for early-warning performance.

- **Rebuild.** Study the fourth lever empirically: what, historically, shortened regressions, and what would do so now.
- **Interaction estimates.** Estimate, from cross-domain time series, which couplings in Section 5 are strongest.
- **Irreversibility and extinction pathways.** Test whether the energetic and institutional foundations of recovery would survive a multi-century regression (Appendix A), and how exposure to extinction-scale hazards would change in a low-capacity world.

16. Method

How the model works, what it assumes and what it cannot tell you.

16.1 The model

The spiral model runs in annual steps. Each year a crisis arrives with probability equal to the chosen frequency per decade divided by ten; its size is drawn from an exponential distribution with the chosen mean and scaled by $0.3 + 0.7 \times \text{capacity}$, so that simpler societies face smaller systemic shocks. Stress then changes by the crisis, plus coupling $\times$ capacity $\times$ stress, minus repair $\times$ capacity $\times$ stress / $(1 + \text{stress} / 0.5)$, minus $0.03 \times \text{stress}$. Capacity changes by $0.2 \times \text{capacity} \times (1 - \text{capacity}) \times \text{capacity} / (\text{capacity} + a)$, minus $0.06 \times \text{stress} \times \text{capacity}$, with a floor of 0.02 . The rebuild setting sets a to 1, 0.5, 0.3, 0.15 or 0.05.

```
Crisis:      with probability f/10, shock ~ Exp(mean s · (0.3 + 0.7 · C)); else 0
Stress:      ΔS = shock + k · C · S - ρ · C · S / (1 + S/0.5) - 0.03 · S
Capacity:    ΔC = 0.2 · C · (1 - C) · C / (C + a) - 0.06 · S · C
Update:      S ← max(0, S + ΔS);    C ← min(1, max(0.02, C + ΔC))
Start:      C = 1, S = 0.05
```

Table 13. Symbols and fixed constants

Symbol	Meaning	Value
f	Crisis frequency (per decade)	2 (default)
s	Mean crisis size	0.12
k	Coupling	0.25
ρ	Repair capacity	0.60
a	Rebuild parameter (smaller = faster rebuild)	0.3 (1, 0.5, 0.3, 0.15, 0.05)
0.5	Saturation scale of repair	fixed
0.03	Natural decay of stress	fixed
0.06	Erosion of capacity by stress	fixed
0.2	Intrinsic regrowth rate of capacity	fixed
0.02	Capacity floor	fixed
0.25 / 0.75	Collapse / recovery thresholds	fixed

16.2 Simulation protocol

A run counts as collapsed when capacity falls below 0.25 and as recovered when it next rises above 0.75. The headline statistics use 300 runs with seeds 1000 to 1299 over 1,000 years; the heatmap uses 100 runs per cell, seeds 1000 to 1099, over 300 years. Shocks are drawn from a seeded 32-bit pseudo-random generator, so every result is deterministic for a given seed. The model was written and calibrated in Node.js, and the [interactive edition](#) of the report runs identical code in the browser, so the figures quoted in the text can be reproduced on the web report. The additional analyses in the long-form edition — the survival curves, sensitivity tests, coupling curves, four-world comparison and example runs — were computed with the same code and seeds. For this Word edition every model chart was regenerated from an independent implementation of the published specification, which reproduces the published results exactly (Appendix B).

Parameters were chosen to place the default near the model's threshold, not estimated from data; the model's outputs are therefore illustrative of mechanism and say nothing about the real probability or

timing of collapse. The “combined” scenario uses crisis frequency 1.7, coupling 0.21 and repair capacity 0.70, each about fifteen per cent from default.

16.3 Historical and present-day data

Historical durations are approximate, drawn from the sources listed, and measure different markers: the Mycenaean palace collapse and the end of Linear B (c. 1200 BCE) and the adoption of the Greek alphabet (c. 750 BCE); Egypt’s First Intermediate Period (c. 2181–2055 BCE); the decline of the Harappan cities (c. 1900–1700 BCE) and the second urbanisation of the Ganges plain (c. 6th century BCE), which is a regional shift rather than a like-for-like recovery; and Roman-era lead emissions in Greenland ice ([McConnell et al., 2018](#)), which did not return to Pax Romana levels for more than 500 years after 165 CE. Present-day indicators are the latest published values at the time of writing (October 2026), from the sources listed. The HDI growth rates, the HDI group gaps and the material-footprint and life-expectancy series are the author’s calculations from the [UNDP Human Development Report 2025 data](#). The 2025 OECD aid figures are preliminary; final data are due in December 2026.

16.4 Notes on specific figures

- **Water.** The ledger’s water coverage trend (50% → 60% since 2015) refers to rural coverage, as reported by WHO/UNICEF; the global count lacking safely managed drinking water is 2.1 billion.
- **HDI gap.** The gap between the very high and low development groups is computed as the difference in group HDI: 0.451 (1990), 0.402 (2019), 0.394 (2020) and 0.399 (2023).
- **Conflict.** The 65 conflicts for 2025 include state-based conflicts of all kinds; eight were between states (Uppsala University). The annual series in Figure 16 was recomputed from the UCDP/PRIO v26.1 dataset and reproduces the count of 65.
- **Temperature.** The annual global-mean anomaly in the current GISTEMP v4 file (land-ocean index, J–D, retrieved October 2026) is +1.28 °C for 2024 and +1.18 °C for 2025. This edition therefore attributes +1.28 °C to 2024, the highest value in the series, rather than to 2025.
- **Infrastructure.** The CDRI estimate of \$732–845 billion in annual hazard losses is cited as reported in the press, not from the primary report.
- **Trajectory chart.** Figure 26 uses percentage changes computed from the figures quoted in the text; the conflict counts for 2010 and 2025 (31 and 65) are computed from the UCDP/PRIO dataset. Periods differ across bars.
- **Model outputs** quoted for scenarios not in the interactive edition (the survival curves, sensitivity tests, worlds) are new to the long-form edition.

16.5 Definition and authorship

The definition of the Polycrisis Apocalypse, the three-condition test, the stress–repair model and the four-lever framework are the author’s. The term was coined by Hunter Hughes of H Heuristics in 2026.

Glossary

Term	Definition
Capacity	In the model, a civilisation's complexity and ability to manage problems — institutions, infrastructure, finance and cooperation — on a scale from 0 to 1.
Collapse (model)	A state in which capacity has fallen below 0.25.
Complexity	The number and variety of a society's institutions, specialised roles, networks and flows of information and goods.
Coupling	The degree to which stress in one system generates stress in others. High coupling lets shocks propagate; low coupling contains them.
Critical slowing down	The tendency of a system near a tipping point to take longer to recover from disturbances, with rising autocorrelation in its fluctuations.
Dark age	In the model, the interval between the fall of capacity below 0.25 and its next rise above 0.75.
Existential risk	A risk that would permanently destroy humanity's long-term potential, through extinction or unrecoverable collapse (Ord, 2020).
Extinction (human)	The end of the human species. In the framework, a separate and final category from the Polycrisis Apocalypse, in which people survive.
Hysteresis	Path-dependence: the route out of a state differs from the route back.
Off-ramp	A policy or investment that changes one of the terms of the race to keep repair ahead of stress.
Planetary boundaries	Nine Earth-system processes within which humanity is argued to be able to operate safely; the first assessment appeared in 2009.
Polycrisis	A cluster of crises in several global systems that are causally entangled so that their combined harm exceeds the sum of the parts.
Polycrisis Apocalypse	A scenario in which interacting global crises outrun humanity's capacity to manage them, ending in the collapse of industrial civilisation and a regression lasting centuries or millennia.
Rebuild speed	How quickly capacity regrows from a low base; a proxy for preserved knowledge and institutions.
Regression	A prolonged period in which a society's complexity is far below its former level.
Repair	The resolution of stress by institutions and infrastructure; in the model it saturates when stress is high.
Saturation	The tendency of a response to resolve less per unit of effort as demand rises.
Stress	In the model, the unresolved load of crises.
Tight coupling	A feature of systems in which components depend closely on one another with little slack, so that failures propagate quickly.
Tipping point	A threshold beyond which a system shifts, often abruptly and sometimes irreversibly, to a different state.
Unrecoverable collapse	A regression with no realistic route back to the prior level of complexity; existential on Ord's definition.

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Appendix A · The Extended Thesis: Complexity, Energy and Demography

A companion argument from the author's Substack essay, which approaches the same concept through thermodynamics, complexity overhead and demography.

A.1 The essay

The essay [*The Polycrisis Apocalypse: Cascading Systemic Failure, Multi-Century Societal Regression, and the Thermodynamics of Civilizational Collapse*](#) (H Heuristics, 20 October 2026) is the shorter, more argumentative companion to the long-form report. It contrasts the sudden catastrophes of popular apocalypse narratives — nuclear war, asteroid impact, engineered pandemic — with the Polycrisis Apocalypse as the more likely route to collapse, and it develops five arguments that the long-form report does not. They are summarised here so that this edition is a complete account of the concept.

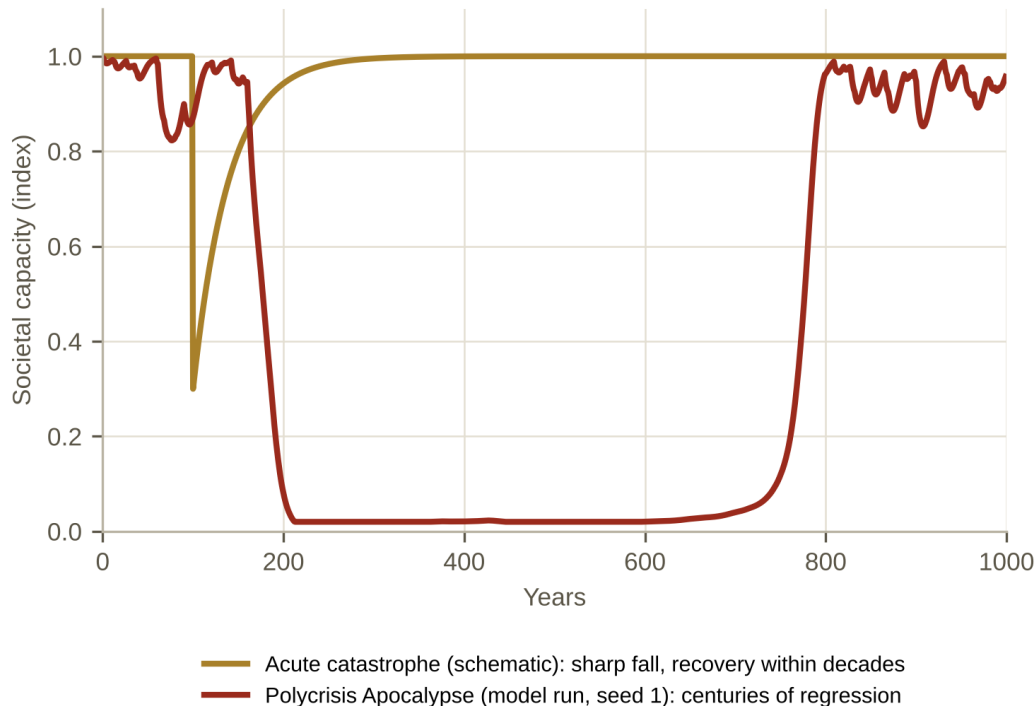
A note on evidence. The essay attaches institutional sources — the [Centre for the Study of Existential Risk](#), the [Stockholm Resilience Centre](#), the [World Economic Forum](#), the [Santa Fe Institute](#), [UNDRR](#), the [Club of Rome](#), the [Oxford Martin School](#), [The Lancet Planetary Health](#), the [World Bank](#) and the [OECD](#) — to its claims as general sourcing, without naming a specific report, year or page. Several of its figures are given without any source. They are reported here as the essay's claims and are **not independently verified**; Table 14 sets out how each is treated.

A.2 Five additional arguments

1. A multi-century temporal architecture

An acute catastrophe is sharp and, if survived, recoverable within decades; a Polycrisis Apocalypse is a cascade whose consequences unfold over centuries. The essay argues that lean supply chains with near-zero inventory buffers remove the slack needed to absorb simultaneous shocks, and that Earth systems respond slowly, so that feedbacks persist regardless of late mitigation. Figure 27 contrasts the two temporal shapes; the Polycrisis Apocalypse curve is the default-settings model run of Section 6, and the acute-catastrophe curve is a schematic.

Figure 27. Temporal architecture of civilisational collapse: acute catastrophe versus Polycrisis Apocalypse over 1,000 years. The acute-catastrophe curve is a schematic; the Polycrisis Apocalypse curve is the default-settings model run of Figure 5.



Source: H Heuristics. Concept after the essay's Figure 1; Polycrisis Apocalypse curve from the spiral model (seed 1). Illustrative.

2. Ten drivers and super-additive cascades

The essay lists ten compounding drivers — climate change, resource depletion, water scarcity, food insecurity, economic instability, geopolitical conflict, demographic shifts, infrastructure decay, technological disruptions and pandemics — which are the ten domains used throughout this report. It argues that they act as cross-domain shock multipliers, citing the World Economic Forum, and that ecological boundary transgression produces a “4.1× amplification across secondary socio-economic systems” (no source is given). Its worked example is the cascade used in Section 12: a multi-year drought cuts hydropower, which curtails industry and fertiliser supply, which raises food insecurity, conflict and migration, which strains municipal finances and leads to sovereign debt default.

3. Complexity overhead and the Tainter inversion point

Drawing on research associated with the Santa Fe Institute, the essay argues that societies add complexity to solve problems until maintenance overhead grows faster than the benefits — negative marginal returns to complexity — and names the tipping point the “Tainter Inversion Point”. It states that audits attributed to UNDRR show administrations spending “over sixty percent” of operational bandwidth reacting to recurring crises (no report or year is given). The idea is the one in Section 3.1, and it is the economic counterpart of the *response bandwidth* argument in Section 5.4; the essay supplies no equations for the “mathematical mechanism” its figure describes.

4. The energetic moat

The essay's most distinctive claim is thermodynamic. Citing the Club of Rome, it states that fossil fuels once delivered an energy return on energy invested (EROEI) “exceeding 100:1” and that conventional oil is now “plunging below 12:1” (no source is given for either figure). Citing the Oxford Martin School, it argues that survivors of a collapse would be stranded behind an *energetic moat*: easily accessible coal and petroleum would be gone, and building solar or nuclear capacity requires an industrial base that a collapsed society no longer has. If correct, this is a mechanism by which a regression that is recoverable in

principle becomes unrecoverable in practice — the *multi-century irreversibility trap*, and the bridge to the existential-risk discussion in Section 2.7. It is the claim in this report most in need of quantitative testing.

5. Millennial demographics, institutional memory and antifragility

The essay sketches the demographic shape of a prolonged regression: surging infant mortality, life expectancy falling “below forty years” and a global population contraction of “seventy-five percent” over several centuries (citing *The Lancet Planetary Health*; no source is given for the numbers), alongside the abandonment of digital archives, universities and research under prolonged contraction (citing the World Bank). These are scenario assumptions, not projections. Its recommendations, attributed to the OECD, are modular physical firebreaks, preserved physical knowledge repositories and “antifragile” life-support systems — which correspond to levers two and four in Section 10.

Table 14. Claims in the essay and how this report treats them

Claim in the essay	Attributed to	Treatment in this report
4.1× amplification of shocks across secondary socio-economic systems	World Economic Forum (general)	No specific source. Not verified. The coupling parameter k is the structural analogue in the model and is uncalibrated.
Over 60% of operational bandwidth spent reacting to recurring crises	UNDRR audits	No report or year given. Not verified. Consistent with, but not evidence for, the response-bandwidth argument in Section 5.4.
Fossil-fuel EROEI above 100:1, conventional oil below 12:1	Club of Rome	No source for the figures. The EROI literature is large and contested. Treated as a hypothesis for the research agenda (Section 15.2).
Survivors face an energetic moat: easy fossil energy spent, industrial base required for solar and nuclear	Oxford Martin School	Qualitative argument with no calculation supplied. Used in Section 2.7 as a reasoned hypothesis about irreversibility.
Life expectancy below 40; population down 75% over several centuries	The Lancet Planetary Health	Scenario assumptions, not projections; no source for the numbers. Not used elsewhere in the report.
Earth systems respond over centuries; feedbacks persist regardless of late mitigation	Stockholm Resilience Centre	Consistent with the tipping-point literature in Section 3.4, but the specific timescales are unsourced. Structural point only.
Modular firebreaks, physical knowledge repositories, antifragile life support	OECD	Policy recommendations; map onto levers two (loosen the links) and four (preserve the means to rebuild).

A.3 Singular catastrophe versus Polycrisis Apocalypse

The essay closes with a comparative matrix of the two kinds of apocalypse. Table 15 reconstructs it from the definitions and findings in this report.

Table 15. A singular catastrophic apocalypse and the Polycrisis Apocalypse compared

Dimension	Singular catastrophic apocalypse	Polycrisis Apocalypse
Trigger	One discrete event: impact, nuclear exchange, engineered pandemic	No single trigger; interaction among ten domains of crisis
Timing	A known or knowable moment	A process with no single date; a threshold crossed gradually, then abruptly
Mechanism	Direct destruction by the event	Load outruns repair; stress erodes the capacity that repairs it
Duration of harm	Days to years, then recovery or extinction	Collapse within decades; regression of centuries to millennia
Warning signs	Often none, or event-specific	Slowing recovery from shocks, falling repair finance, widening development gaps (Section 9)
What survives	Extinction, or survivors with intact knowledge if the event is partial	People survive; complexity — institutions, networks, specialised knowledge — does not

Dimension	Singular catastrophic apocalypse	Polycrisis Apocalypse
Recovery depends on	Event severity	Preserved knowledge and institutions; rebuild speed (Section 7.4); possibly the energy base
Policy emphasis	Preventing or deflecting the event	Four levers: shrink the shocks, loosen the links, fund the repair, preserve the means to rebuild
Relation to extinction	Can be the direct cause	Not itself extinction, but raises exposure to it and may become unrecoverable (Section 2.7)

Appendix B · Reproducing and Verifying the Model

A reference implementation and a check of every published model result against an independent replication.

The long-form report states that the model's code and settings are published in full. The specification in Section 16 is complete except for the choice of pseudo-random generator, which the report describes only as a "seeded 32-bit pseudo-random generator". For this edition, the specification was implemented independently; the standard 32-bit *mulberry32* generator, drawing one uniform number each year to decide whether a crisis arrives and a second, only when one does, to size it, reproduces the published results exactly. The reference implementation follows.

```
// Spiral model (Hughes, 2026): reference implementation, Node.js
function mulberry32(a) { return function () {
  a |= 0; a = a + 0x6D2B79F5 | 0;
  let t = Math.imul(a ^ a >>> 15, 1 | a);
  t = t + Math.imul(t ^ t >>> 7, 61 | t) ^ t;
  return ((t ^ t >>> 14) >>> 0) / 4294967296; }; }

function run(seed, { f = 2, s = 0.12, k = 0.25, rho = 0.6, a = 0.3 } = {}, years = 1000) {
  const rnd = mulberry32(seed); let C = 1, S = 0.05; const out = [];
  for (let y = 0; y < years; y++) {
    let shock = 0;
    if (rnd() < f / 10) shock = -Math.log(1 - rnd()) * s * (0.3 + 0.7 * C);
    const dS = shock + k * C * S - rho * C * S / (1 + S / 0.5) - 0.03 * S;
    const dC = 0.2 * C * (1 - C) * C / (C + a) - 0.06 * S * C;
    S = Math.max(0, S + dS); C = Math.min(1, Math.max(0.02, C + dC));
    out.push({ C, S });
  }
  return out;
}
// Collapse: C < 0.25. Recovery: C > 0.75. Statistics: seeds 1000..1299.
```

B.1 Verification against the published results

Table 16. Published model results and the independent replication

Result	Published	Replicated
Run 1 (seed 1): collapse, recovery, dark age	Year 189; year 786; 597 yrs	Year 189; year 786; 597 yrs
Collapse within 100 / 300 / 1,000 years (300 runs)	12% / 45% / 91%	12.3% / 45.3% / 90.7%
Median dark age (runs that recover)	471 yrs (168 runs)	471 yrs (168 runs)
Middle half and full range of dark ages	383–565; 288–867 yrs	383–565; 288–867 yrs
Year by which half of runs have collapsed	≈ 330	328
Share of years collapsed; episodes per run	44%; 1.09	44.0%; 1.09
Heatmap: default cell; coupling 0.22 and 0.28 at repair 0.6	42%; 9%; 74%	42%; 9%; 74%
Levers: crises halved; coupling 0.20; repair 0.70; all three	26%; 10%; 27%; 0%	26.3%; 9.7%; 26.7%; 0%
Sensitivity (eight settings, Table 6)	As Table 6	All eight match
Share of years collapsed: slowest and fastest rebuild	51%; 19%	51%; 19%

Result	Published	Replicated
Four worlds: collapse ≤ 300 and $\leq 1,000$ years; median dark age	Table 9	All match; Frayed median 604 yrs is the median over all dark-age episodes (611 yrs for first episodes only)
Coupling curves: repair 0.7 at coupling 0.26; repair 0.5 at coupling 0.20	One in three; above 70%	33%; 73%
Example run, seed 5	"Collapses late and is still down at year 1,000"	Collapses in year 508; recovers in year 991 (483-year dark age). Section 6.3 follows the replication.

The replication confirms the report’s numbers and the determinism of its design. The single point of difference — the description of the seed 5 example run — is a matter of wording at the edge of the 1,000-year window and does not affect any statistic.

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About this edition

This Word edition of Digital Report № 2026-24 follows the long-form report [published on the web](#) and [deposited on figshare](#), and adds a treatment of human extinction (Section 2.7), an assessment of current trajectories (Section 12), the complementary argument of the author's [Substack essay](#) (Appendix A) and a verification of the model (Appendix B). All charts were regenerated for this edition from the published data and an independent replication of the published model, and are sized for the page.

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