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H HEURISTICS CENTURY PATHWAYS · CONCEPT AND EVIDENCE REPORT

Preventive Development Economics

Closing development deficits before they become crises



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H Heuristics Research Report · November 2026

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CONTENTS

Contents

PART I · SECTIONS 1–6

The Idea, the Economics and the Applications

Executive Summary 4

1 What Preventive Development Economics Is . . 6
1.1 The idea in plain language 6
1.2 Two paths for the same country 7
1.3 Three tests of a preventive investment 8
1.4 How it differs from its neighbours 8
1.5 Where the idea comes from 8
1.6 What is new, and what is not 9
1.7 Key terms in plain language 9

2 The Vulnerability Stack 11
2.1 From deficit to exposure 11
2.2 Counting the deficits 11
2.3 Deficits come in bundles 12
2.4 How much is income, and how much is foundations? 13

3 The Economics of Prevention 15
3.1 Two returns from one investment 15
3.2 Why prevention is under-supplied 15
3.3 What the returns look like 16
3.4 The time dimension: when does it pay back? . . . 17
3.5 When prevention alone is enough, and when it is not 18

4 Six Core Principles 19
4.1 Principle 1: Prevention through development 19
4.2 Principle 2: Technology-led risk reduction 19
4.3 Principle 3: Infrastructure as protection 19
4.4 Principle 4: Environmental vulnerability reduction . 20
4.5 Principle 5: Institutional capacity 20
4.6 Principle 6: Long-term economic efficiency 20
4.7 How the principles work together 21

5 Household Protection: Clean Cooking and Cooling 22
5.1 Clean cooking transitions 22
5.2 Cooling accessibility 23

6 Systems Protection: Infrastructure, Clean Industrialisation and Digital Development 24
6.1 Essential infrastructure: power, water and sanitation 24
6.2 Clean industrialisation 24
6.3 Digital economic development 25

PART II · SECTIONS 7–13

Evidence, Timing and the Research Agenda

7 Does Prevention Show Up in the Data? 27
7.1 Test 1: do early foundations predict later progress? 27
7.2 Test 2: is prevention visible in disaster deaths? . . 28
7.3 Test 3: do foundations cushion economic shocks? 29
7.4 What a better test would look like 29

8 Timing, Demography and the Window for Prevention 31
8.1 The cost of delay 31
8.2 Where the people will be 32
8.3 Where prevention pays most 33

9 Decision Rules, Institutions and Finance . . . 34
9.1 A prevention-adjusted appraisal 34
9.2 A screen for ranking preventive investments . . . 35
9.3 Money and institutions 36

10 Intersections: Bundles, Gates and the Household Stack 37
10.1 Six capitals, many returns 37
10.2 A cross-country check of the multiple dividends . 38
10.3 Joint gates 38
10.4 The household stack 38

11 Limits, Harmful Twins and What Would Prove the Idea Wrong 39
11.1 Limits of the evidence 39
11.2 Harmful twins 39
11.3 What would prove the idea wrong 40

12 Research Agenda and Roadmap to 2035 . . . 41
12.1 Seven research questions 41
12.2 A pathway campaign, not just a report 42
12.3 Roadmap to 2035 42

13 Data and Method Notes 44
13.1 Data sources 44
13.2 Definitions and calculations 44
13.3 Reproducibility and caveats 45

References 46

EXHIBITS

Figures, Tables and Boxes

Table 1 Report at a glance . . . 5
Figure 1 Reactive and preventive loops . . . 7
Table 2 PDE and nearby fields . . . 8
Table 3 Intellectual roots . . . 9
Figure 2 Prevention ladder . . . 10
Table 4 Key terms . . . 10
Table 5 Seven foundations . . . 11
Figure 3 People lacking each service . . . 12
Figure 4 Outcomes by number of deficits . . . 13
Table 6 Group outcomes . . . 13
Figure 5 Foundations Index and child mortality . . . 14
Figure 6 Reported benefit-cost ratios . . . 16
Figure 7 Payback curves . . . 17
Table 7 Payback years . . . 17
Table 8 Break-even grid . . . 18
Figure 8 Technology cost curves . . . 20
Table 9 Principles, measures and tests . . . 21
Table 10 Four layers of cooling . . . 23
Table 11 Five applications at a glance . . . 26
Figure 9 Foundations in 2000 and later progress . . . 27
Table 12 Lagged test results . . . 28
Figure 10 Natural-disaster death rates . . . 29
Table 13 Scorecard of tests . . . 30
Figure 11 Pace scenarios and delay . . . 31
Figure 12 Demography and the backlog . . . 32
Table 14 Priority countries table . . . 33
Table 15 Appraisal ledger . . . 34
Table 16 Prevention screen . . . 35
Table 17 Barriers and fixes . . . 36
Figure 13 Six capitals . . . 37
Figure 14 Multi-dividend grid . . . 38
Table 18 Limits and responses . . . 39
Table 19 Harmful twins . . . 40
Table 20 Research agenda . . . 42
Table 21 Roadmap . . . 43
Table 22 Data sources . . . 44

ABOUT THIS REPORT

Suggested citation. Hughes, H. (2026). *Preventive Development Economics: Closing Development Deficits Before They Become Crises.* H Heuristics Research Report, November 2026.

The concept. Preventive Development Economics is a concept developed by Hunter Hughes, Founder of H Heuristics. It belongs to the H Heuristics Century Pathways programme and builds on Sustainable Convergence, Polycrisis Resilience and the Positive Pathways framework.

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Data and methods. All data are public (World Bank, UN, WHO, INFORM, EM-DAT through Our World in Data). Indices, counts, pace scenarios, lagged tests and the screen are the author's calculations and judgements; Section 13 documents them. Blue text links to sources; figure, table and section references link within the document.

EXECUTIVE SUMMARY

Executive Summary

Many of the crises that hurt people most are not bolts from the blue. They land on gaps that development left open years earlier. Closing those gaps first is a way to prevent harm and to build prosperity at the same time.

When a flood, a heatwave, a price shock or a pandemic arrives, the damage depends on what was already in place. A family with clean cooking, reliable power, safe water, a phone and a vaccinated child is far less exposed than a family without them. **Preventive Development Economics** is the study of that difference, and of how societies can close the gaps early instead of paying for the damage later.

2.1 bn
people live in 64 countries that fall short on three or more of seven basic services

11×
higher child mortality in countries short on 5–7 services (58 per 1,000 births) than in countries short on none (5)

79%
of the world's population growth to 2050 happens in those countries

34%
of the benefit of proven-pace progress to 2050 is lost if the start slips by only five years

This report sets out the idea, tests it against public data and shows how it can guide decisions. Its main points are these.

- **The idea.** Development deficits (no clean cooking, no electricity, unsafe water, no internet, unvaccinated children, weak schooling) are also vulnerability. Closing them early earns a development return and a prevention return from one investment (Section 1).
- **The stack.** Across 202 economies, 4.6 billion people live in countries short on at least one of seven foundations and 2.1 billion on three or more. Child mortality, hunger, fertility and life expectancy all worsen steadily as the number of deficits rises (Section 2).
- **The economics.** Reported benefit-cost ratios for preventive investments run from about 2:1 to 16:1. Prevention pays slowly and unevenly, which is why it is under-supplied. A ten-year wait before benefits start can add a decade to the payback (Section 3).
- **The applications.** Five areas show the logic: clean cooking, cooling, essential infrastructure, clean industrialisation and digital development. Each has strong evidence in places and honest failures in others (Section 5, Section 6).
- **The test.** Countries with stronger foundations in 2000 grew faster and cut child mortality faster afterwards, even compared with equally rich peers (+1.3 percentage points a year per standard deviation, p under 0.001). The link weakens once regions are held fixed, and foundations did *not* cushion the GDP shocks of 2009 and 2020 (Section 7).
- **The clock.** At proven peer pace, unmet needs across five services fall from 6.7 billion today to 1.8 billion in 2050. At today's trend they reach 3.5 billion; frozen, 10.3 billion. Each year of delay adds about 1.7 billion person-years of unmet need (Section 8).

- **The method.** A prevention-adjusted appraisal counts both returns, a screen ranks investments, and money is tracked as a share of response spending. For every dollar of response aid in 2015–24, only about 8 cents went to prevention (Hughes, 2026f) (Section 9).

The report is optimistic about what is possible but careful about what is proven. It reports where the data support the idea, where they only partly do, and where they point the other way (Section 11). It ends with seven research questions and a roadmap to 2035 (Section 12).

Table 1 The report at a glance

Question	Short answer	Section
How big is the deficit?	4.6 bn people live in countries short on at least one foundation; 2.1 bn on three or more	2
Does it matter for outcomes?	Child mortality 58 against 5 per 1,000; life expectancy 64 against 80 years (5–7 deficits against none)	2
What do the returns look like?	Benefit-cost ratios from about 2:1 to 16:1; payback from about 4 to 27 years depending on size and timing	3
Which applications?	Clean cooking, cooling, essential infrastructure, clean industrialisation, digital development	5, 6
Does early investment predict progress?	Yes for income growth and child survival (with caveats); no cushion for GDP shocks	7
How much does timing matter?	A five-year delay forfeits 34% and a ten-year delay 62% of the gain to 2050	8
What should be done?	Prevention-adjusted appraisal, a screen, budget tags, and seven research questions	9, 12

Source: H Heuristics calculations.

GUIDE

How to read this report

Each section starts on a new page and can be read alone. **Sections 1 and 2** explain the idea and the problem it addresses. **Sections 3 and 4** give the economics and the six principles. **Sections 5 and 6** apply them. **Sections 7 and 8** test and time them. **Sections 9 to 11** turn them into decisions, intersections and limits. **Sections 12 and 13** set the research agenda and document the methods.

Numbers come from public data and are rounded. 'Deficit' means a country's coverage of a basic service is below 80%. 'Person-years of unmet need' counts each person without a service for each year. Scenarios are benchmarks, not forecasts.

SECTION 01

What Preventive Development Economics Is

A field built on one observation: the damage done by a crisis is shaped by the development gaps it finds. Closing those gaps early is cheaper, kinder and often more productive than repairing damage afterwards.

IN BRIEF

- Development deficits are vulnerabilities; closing them is prevention.
- A preventive investment passes three tests: it targets a deficit, it pays off even without a crisis, and it keeps protecting as hazards grow.
- The idea joins several older traditions rather than replacing them.

1.1 The idea in plain language

Most people already accept that prevention is better than cure when it comes to health. A vaccine costs a few dollars; treating the disease costs far more, and a life lost cannot be bought back. Preventive Development Economics applies the same logic to a country's whole development path. The question is simple: *which development gaps, if closed now, would most reduce the harm that future crises cause, and also lift living standards along the way?*

Preventive Development Economics

Preventive Development Economics is an approach to economic development that prioritises investments, policies and structural transformations capable of preventing or reducing future socioeconomic, environmental and systemic vulnerabilities. It examines how economic growth, technological diffusion, infrastructure development, institutional strengthening and human development can proactively reduce population exposure to interconnected risks while improving long-term living standards.

Concept developed by Hunter Hughes, Founder of H Heuristics

Three phrases in the definition do most of the work. **Proactively** means acting before the crisis, not after it. **Population exposure** means the number of people whose lives, health or income a hazard can reach. **Interconnected risks** means that heat, pollution, price shocks, disease and conflict rarely arrive one at a time: a household without electricity, clean cooking and safe water is exposed to many of them at once.

CENTRAL THESIS

Development as a mechanism of prevention

Many of the vulnerabilities that amplify the consequences of future crises are rooted in existing development deficits. Energy poverty, inadequate infrastructure, environmental pollution, limited healthcare access and technological inequalities can increase population exposure to interconnected risks.

Preventive Development Economics proposes that addressing these deficits through strategically prioritised development investments can simultaneously advance economic prosperity and reduce future vulnerability.

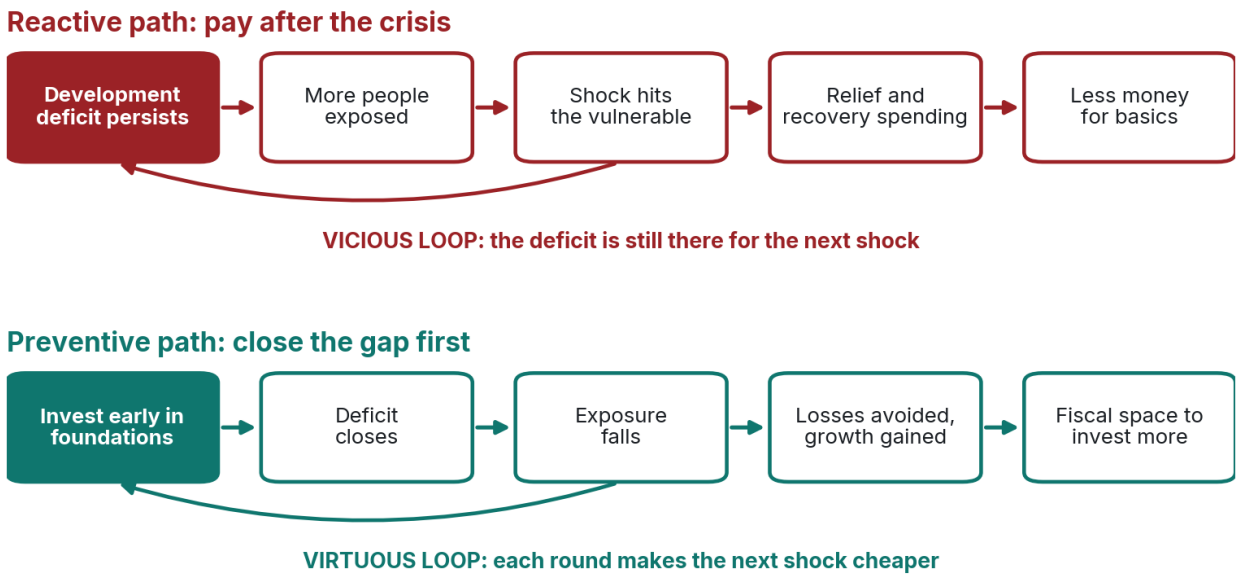
Rather than treating development and risk prevention as separate policy objectives, it integrates them into a common economic framework.

1.2 Two paths for the same country

Picture two countries with the same income, the same hazards and the same budget. The first spends little on foundations and keeps cash for emergencies. When a shock comes it pays for relief, rebuilding and lost output, and the money for next year's foundations shrinks. The second spends early on cooking, power, water, schooling and connectivity. Its shocks still happen, but fewer people are exposed, losses are smaller and the savings fund more foundations (Figure 1).

Figure 1 A deficit left open feeds the next crisis; a deficit closed pays for the next investment

Reactive and preventive loops



Source: H Heuristics. Conceptual diagram.

The two paths are not a matter of caring more. They reflect how budgets, timing and visibility work. The benefits of the second path are spread over many years and show up as things that did *not* happen: a disease not caught, a flood not deadly, a shock absorbed. Section 3 explains why such benefits are easy to overlook and how to count them.

1.3 Three tests of a preventive investment

Not every good development project is preventive, and not every preventive measure is a development project. An investment belongs in the field when it passes three tests.

- **It closes a deficit that raises exposure.** The gap must be one that makes a defined group more likely to be harmed by a defined risk, for example household smoke, unsafe water, unreliable power or no warning.
- **It pays off even if the feared crisis never comes.** A good preventive investment has a development return of its own: time saved, health gained, income earned. This makes it a 'no-regret' choice, and it is what lets the case survive when budgets are tight.
- **It keeps protecting as hazards grow.** Because hazards are rising in many places, an investment that protects more, not less, over time has extra value. Durable assets such as wells, grids, clinics and schools do this; one-off relief does not.

The tests also say what Preventive Development Economics is *not*. It does not claim that development removes all risk, that response and relief are unnecessary, or that every poor country is equally vulnerable. It claims that a large and neglected part of the risk can be reduced upstream, and that doing so is often a better use of money than waiting.

1.4 How it differs from its neighbours

Several fields already work on parts of this problem. Preventive Development Economics sits between them and borrows from each (Table 2).

Table 2 Preventive Development Economics compared with nearby fields

Field	Main question	When it acts	What PDE adds
Humanitarian response	How do we help people in a crisis?	During and after	Moves attention and money upstream, to the gap the crisis exploited
Disaster risk reduction	How do we cut losses from known hazards?	Before the hazard	Treats everyday development gaps as a form of risk, not only hazard-specific measures
Conventional development economics	How do incomes and living standards rise?	Over the long run	Asks which investments also lower future vulnerability and ranks them on both returns
Preventive public health	How do we stop disease before it starts?	Before illness	Extends the logic from disease to cooking, water, power, heat, pollution and connectivity
Climate adaptation	How do we adjust to a changing climate?	Before and during change	Covers deficits that are not climate-specific but still raise exposure to climate shocks

Source: H Heuristics synthesis.

1.5 Where the idea comes from

The field is new as a label but not as a set of ideas. It rests on at least seven traditions, each of which supplies a piece (Table 3).

Table 3 The intellectual roots of the field

Tradition	Key source	What PDE takes	What PDE adds
Capabilities	Sen (Sen, 1999)	Poverty is lacking the real freedoms to live a healthy, educated life	A forward-looking test: which capability gaps make future shocks worse?
Poverty traps	Kraay and McKenzie (Kraay and McKenzie, 2014); Balboni et al. (Balboni et al., 2022)	Some gaps reinforce themselves; evidence for traps is mixed	Focus on the deficits where self-reinforcement is best documented
Public-health prevention	Rose (Rose, 1985); Jamison et al. (Jamison et al., 2013)	Shifting a whole population's risk beats treating only the sickest	Applies the population view to energy, water, digital and housing deficits
Disaster economics	Hallegatte et al. (Hallegatte et al., 2017; Hallegatte, 2019); Mechler (Mechler, 2016)	Benefit-cost evidence that resilience pays	Counts everyday development gaps, not just hazard-specific works
Early-action economics	Stern (Stern, 2007); Global Commission on Adaptation (Global Commission on Adaptation, 2019)	Acting early is cheaper than paying for damage	Adds a development return so that early action also stands on its own
Lock-in and catch-up	Arthur (Arthur, 1989); Unruh (Unruh, 2000); Gerschenkron (Gerschenkron, 1962)	Early choices are hard to reverse; latecomers can leap	Treats the next two decades as a window for building the right systems once
Resilience dividend	Rodin (Rodin, 2014)	Resilience investments pay off even without disasters	Extends it to the full range of development deficits and measures it

Source: H Heuristics synthesis of the cited works.

1.6 What is new, and what is not

It is worth being plain about novelty. Each tradition above makes a strong case for part of the idea. What Preventive Development Economics adds is a way to *combine* them: one framework that treats development deficits as the main target, counts both the development and the prevention return, and asks for evidence on timing and scale. The claim is practical, not grand. If the framework helps finance ministries, development banks and researchers rank investments more sensibly, it has done its job.

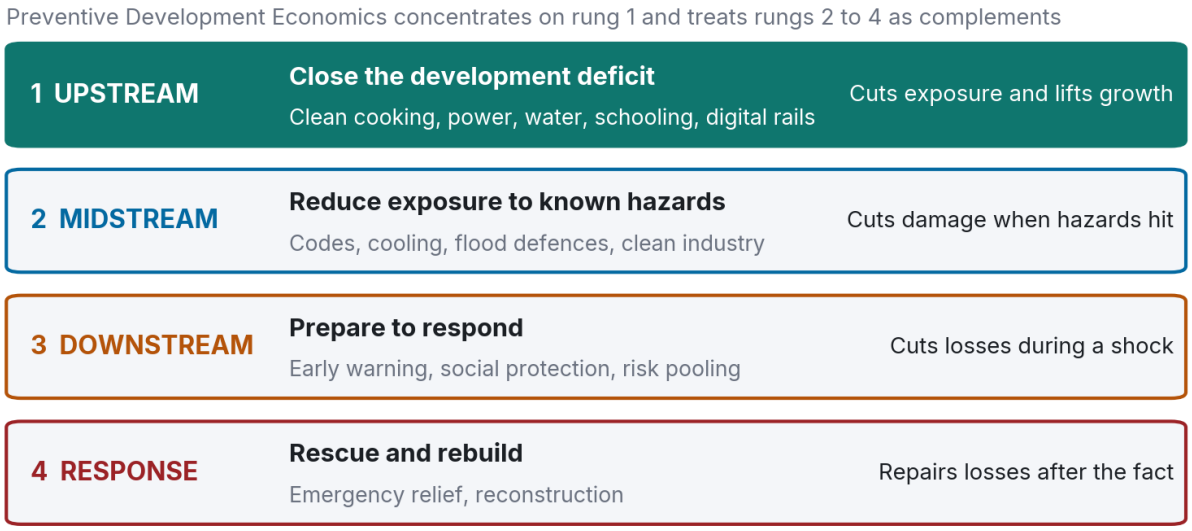
The concept sits inside the wider H Heuristics programme. *Sustainable Convergence* describes the path of narrowing gaps with richer economies (Hughes, 2026d); *Polycrisis Resilience* describes the protection that path should buy (Hughes, 2026c); and *Century Pathways* describes the loops that make both faster (Hughes, 2026a; Hughes, 2026b). Preventive Development Economics supplies the economic logic that connects them: why closing development gaps early is a form of prevention, and how to count it.

1.7 Key terms in plain language

The report uses a small set of terms repeatedly. Table 4 gives each in everyday words.

Figure 2 The field concentrates on the upstream rung of prevention

Four rungs of prevention and response



Source: H Heuristics. Conceptual diagram.

Table 4 Key terms

Term	What it means here
Development deficit	A gap in a basic service or capability, such as no clean cooking, power, safe water or schooling
Exposure	The number of people a hazard can reach
Vulnerability	How badly a hazard hurts the people it reaches; development deficits raise it
Foundations Index	Average coverage of seven basic services in a country, from 0 to 100
Development return	What an investment earns in a normal year: income, time, health, learning
Prevention return	The harm avoided in future shocks because the investment exists
Proven pace	The speed reached by the fastest quarter of comparable countries; a benchmark, not a forecast
Person-year of unmet need	One person lacking one service for one year
Gate	A condition, such as reliable power, that must be met before an investment can work
Harmful twin	The damaging way an investment can go wrong or feed the problem it aims to solve

Source: H Heuristics.

SECTION 02

The Vulnerability Stack

Development deficits come in bundles. The more basic services a country lacks, the worse its people fare on almost every measure of health, hunger and survival, and the faster its population is likely to grow.

IN BRIEF

- 2.3 bn people lack internet use, 2.0 bn clean cooking, 1.5 bn basic sanitation.
- Countries short on 5–7 services have child mortality 11 times that of countries short on none.
- Much of the gradient is shared with income, but foundations add information beyond it.

2.1 From deficit to exposure

A development deficit becomes a vulnerability through a specific path. Smoke from cooking fires harms lungs, and polluted air of all kinds is linked to about nine million deaths a year (Fuller et al., 2022); household air pollution alone is responsible for roughly three million (WHO, 2024). Without electricity, clinics cannot keep vaccines cold and families cannot pump water or charge a phone for a flood warning. Without safe water and sanitation, diarrhoeal disease spreads (WHO, 2023). Without a phone or an account, cash cannot be sent quickly to a household after a shock (Suri, 2016; World Bank, 2025). Table 5 lists the seven foundations used in this report.

Table 5 Seven foundations and how a deficit in each raises exposure

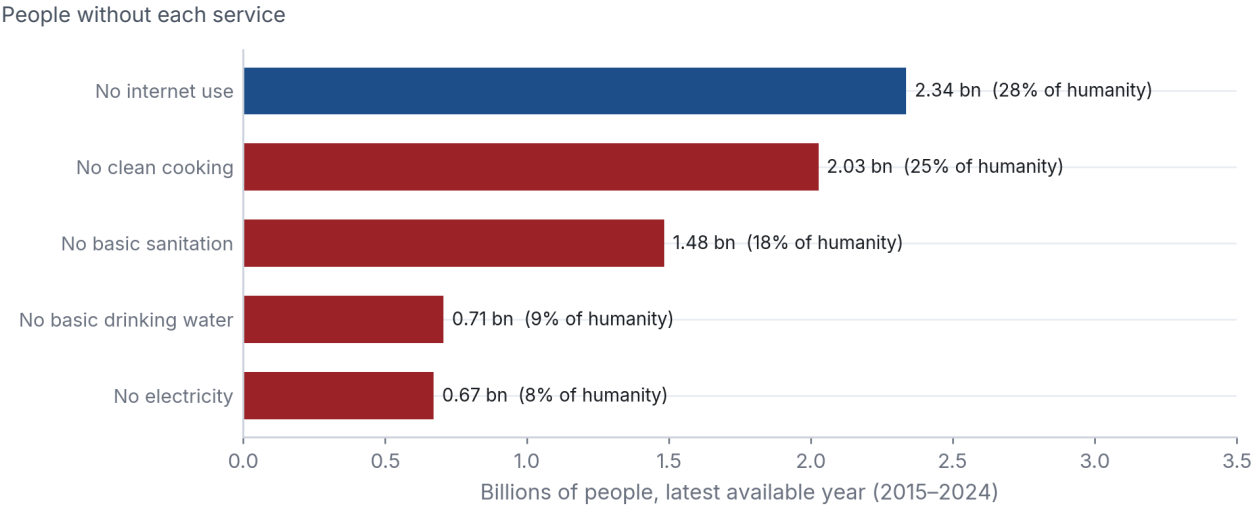
Foundation	How a deficit raises exposure	Examples of extra returns when closed
Electricity	No cold chain, lighting, pumping, fans or phone charging	Clinics, schools, small firms, warning messages
Clean cooking	Household smoke; time and fuel burden; forest loss	Lung health, women's time, cleaner local air
Basic drinking water	Waterborne disease; collection time	Child survival, school attendance
Basic sanitation	Faecal contamination; outbreaks after floods	Child growth, dignity, safer cities
Internet use	No warning, price information, learning or digital payments	Jobs, markets, public services
DPT3 immunisation	Preventable outbreaks and child deaths	Child survival, schooling, adult earnings
Primary completion	Low capability to adapt, work and use services	Earnings, health decisions, lower fertility

Source: H Heuristics, drawing on (WHO, 2024; WHO, 2023; Hallegatte, 2019).

2.2 Counting the deficits

The first step is to count. Using the latest World Bank data for 2015–2024 (World Bank, 2026), Figure 3 shows how many people lack each population-wide service. Internet use is the largest gap at 2.3 billion people (28% of humanity), followed by clean cooking at 2.0 billion and basic sanitation at 1.5 billion. 0.7 billion lack basic drinking water and 0.7 billion lack electricity. These figures are close to those in the international tracking reports (IEA, IRENA, UNSD, World Bank and WHO, 2025; WHO, 2023; GSMA, 2025), which is a useful check on the data.

Figure 3 Billions of people still lack the basics, led by internet use, clean cooking and sanitation



Source: World Bank WDI (World Bank, 2026); UN World Population Prospects 2024 (United Nations, 2024); H Heuristics calculations. Coverage rate times population, latest value in 2015–2024.

Immunisation and primary completion are rates for particular age groups (infants and children), so they are not turned into headcounts here. They still enter the stack below, because a country that fails to immunise or school its children has a deficit that matters just as much.

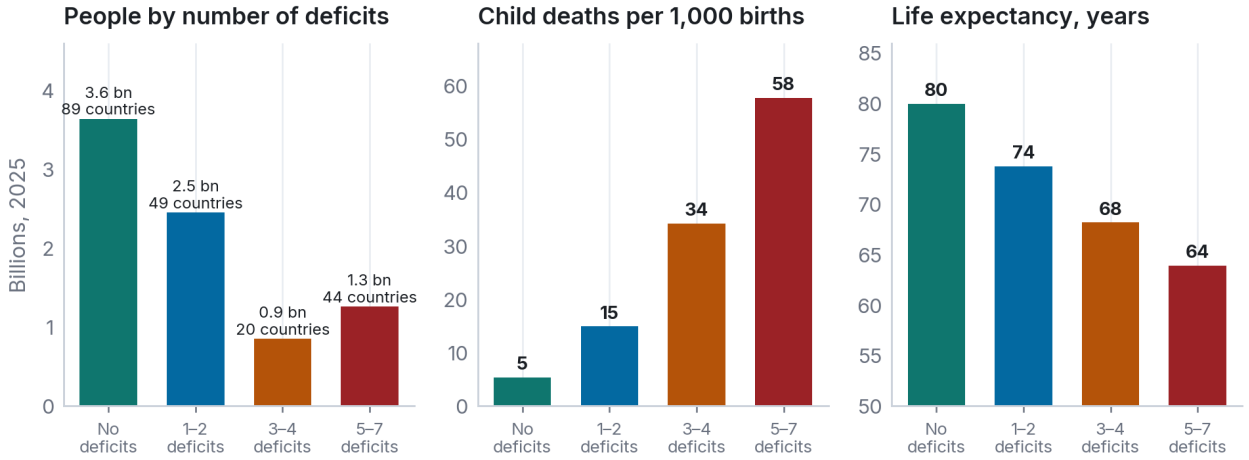
2.3 Deficits come in bundles

Deficits rarely occur alone. For each of 202 economies we counted how many of the seven foundations fall below 80% coverage, then grouped them (Figure 4, Table 6). 3.6 billion people live in 89 countries with no deficit. At the other end, 1.3 billion live in 44 countries short on five to seven services. The bundles are not scattered randomly: 45 of the 64 countries with three or more deficits are in Sub-Saharan Africa, and 24 of the 25 low-income countries are among them.

Moving from no deficits to five or more goes with child mortality rising from 5 to 58 deaths per 1,000 births, life expectancy falling from 80 to 64 years, undernourishment rising from 2.5% to 20.1%, and births per woman rising from 1.5 to 4.1. The pattern holds if the cut-off is set at 60% or 90%: 16% of humanity lives in a country with three or more deficits at the 60% line, 26% at 80% and 51% at 90%.

Figure 4 As deficits pile up, child survival and life expectancy fall away

Population, child mortality and life expectancy by number of foundation deficits



Source: World Bank WDI, UN WPP 2024; H Heuristics calculations. Medians across countries within each group.

Table 6 Countries grouped by number of foundation deficits

Deficits	Countries	People (bn)	Under-5 deaths per 1,000	Life expectancy	Undernourished %	Births per woman
None	89	3.64	5	80	2.5	1.5
1-2	49	2.45	15	74	4.7	2.0
3-4	20	0.85	34	68	14.3	2.7
5-7	44	1.26	58	64	20.1	4.1

Source: World Bank WDI, UN WPP 2024; H Heuristics calculations. Group medians; a deficit is coverage below 80%.

2.4 How much is income, and how much is foundations?

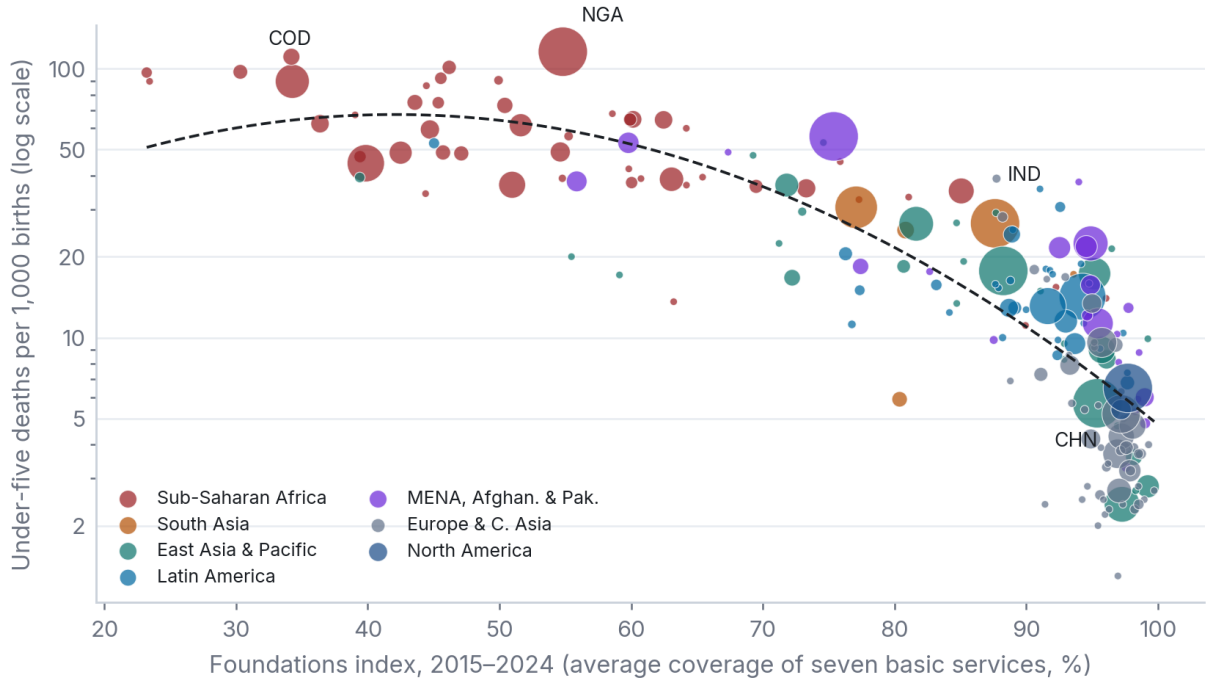
An obvious objection is that all of this is just income: richer countries have more of everything. That is partly right, and it matters for how the results are read. Figure 5 shows the Foundations Index (the average coverage across the seven services) against child mortality for every country.

Among developing economies, the Foundations Index is strongly related to child mortality (correlation -0.80), life expectancy (+0.82) and hunger (-0.71). Once income is held constant, the relationships weaken but remain: partial correlations are -0.44 for child mortality, +0.53 for life expectancy and -0.33 for hunger (all p under 0.01). Income alone explains 73% of the variation in child mortality across 186 countries; adding foundations raises that to 75%. In plain terms, income and foundations travel together, and foundations carry some extra information. They are not a substitute for income, and the data cannot by themselves show which causes which.

A second look compares countries of similar income. Within the low-income group, the third of countries with the strongest foundations has median child mortality of 40 per 1,000 against 90 in the weakest third. In the lower-middle-income group the gap is 18 against 51, and in the upper-middle-income group 9 against 20. Equally poor countries with stronger foundations look safer. This is consistent with prevention, though other differences between countries (institutions, conflict, geography) also play a part.

Figure 5 Child mortality falls steeply as foundations rise; the poorest, most populous countries sit on the steep part

Foundations Index and under-5 mortality, 2015–2024



Source: World Bank WDI; H Heuristics calculations. Bubble size shows 2025 population. Dashed line: quadratic fit to log child mortality.

CAUTION

Reading the stack: what it can and cannot say

It can say where the deficits are, how they cluster, how many people they touch and how strongly they go with worse outcomes, including among countries of similar income.

It cannot say that closing a deficit will cause the outcome to improve by the size of the gap. Some of the gradient reflects income, institutions and history. Section 7 tests the stronger claim with lagged data, and Section 11 lists what would count against it.

One result does not follow the pattern. Fine-particle air pollution is only weakly related to the Foundations Index once income is held constant (partial correlation -0.14, not significant). Growth does not clean the air automatically, which is why clean industrialisation is treated as its own application.

SECTION 03

The Economics of Prevention

A preventive investment earns two kinds of return: the ordinary development return, and the value of harm that never happens. Counting both changes which projects look worthwhile, and explains why prevention is so often left undone.

IN BRIEF

- Total return = development return + prevention return + option value.
- Prevention is under-supplied because its benefits are invisible, distant and split across budgets.
- Reported benefit-cost ratios are high but slow; a long wait before benefits start can double the payback time.

3.1 Two returns from one investment

Take a village well. Its first return is the ordinary one: people spend less time carrying water, children miss less school and the village earns more. Its second return is protection: when a dry spell or a flood hits, the village is less likely to suffer disease or move away. The second return is real but harder to see, because it shows up only as harm that did not happen.

RULE

The dual-return rule

Total return = development return + prevention return + option value.

Development return: the value of the extra income, time, health and learning the investment produces in a normal year.

Prevention return: in each future year, the chance of a shock, times the damage it would do, times the share of that damage the investment removes, all discounted to today.

Option value: the extra worth of keeping future choices open when the future is uncertain and some decisions cannot be undone (Arrow and Fisher, 1974).

Conventional appraisal usually counts only the first term and sometimes a narrow slice of the second. A project that scores 1.5 on development benefits alone can score 3 or more once avoided losses are added; one that looks marginal may become clearly worthwhile. The reverse also happens: a project that is mainly a hazard-specific defence may add little development value, and should be judged on prevention alone. The point of the rule is to put both on the same page.

3.2 Why prevention is under-supplied

If prevention pays so well, why is it so rare? The literature points to four reasons, and each suggests a remedy.

- **The disaster that did not happen is invisible.** In a study of US counties, voters rewarded incumbents for relief spending after disasters but not for preparedness spending, even though

one dollar spent on preparedness was estimated to save about fifteen dollars of future damage (Healy and Malhotra, 2009). Officials who respond to this signal under-invest in prevention.

- **People and governments favour the present.** Hyperbolic discounting makes distant benefits feel small (Laibson, 1997), and the right rate for very long horizons is itself uncertain; allowing for that uncertainty lowers the effective rate and favours long-lived investments (Weitzman, 2001).
- **Benefits fall in other budgets.** A cooking programme run by an energy ministry saves money for health, forestry and education ministries. Each counts only its own benefit, so the programme looks weak to its funder.
- **Capital is costly where it is needed most.** Higher financing costs in emerging economies raise the price of long-lived assets such as grids and water systems (IEA, 2024).

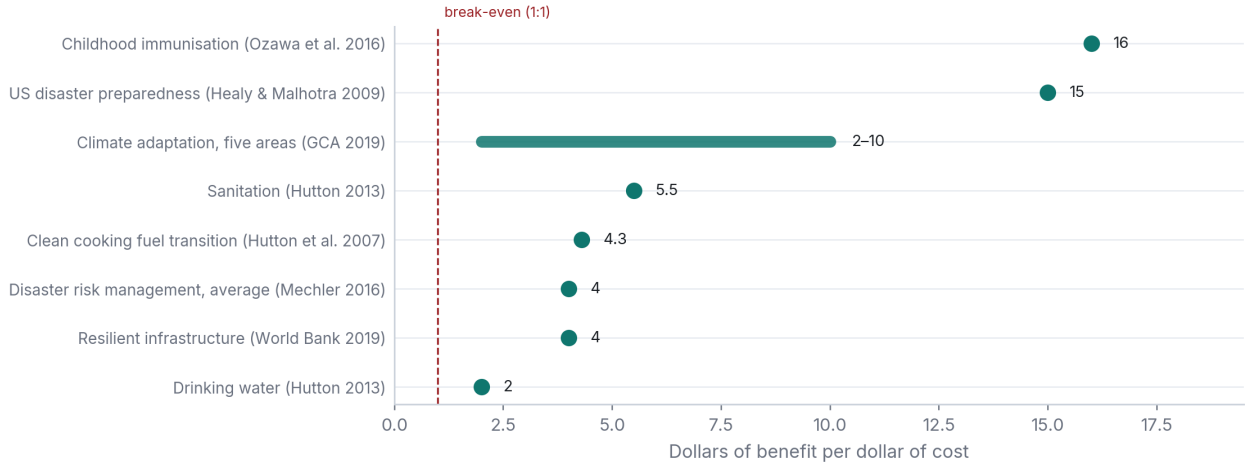
The imbalance shows up in aid flows. For every dollar of official humanitarian response (emergency aid and reconstruction) given in 2015–24, only about eight cents went to disaster prevention and preparedness, after removing the large host-country costs that Türkiye reports as aid (Hughes, 2026f). Prevention is not unknown; it is simply under-funded relative to response.

3.3 What the returns look like

Measured returns for preventive investments are high, though they come from different methods, countries and time horizons and should not be compared too closely (Figure 6). Water, sanitation and clean cooking have long-standing global estimates (Hutton, 2013; Hutton et al., 2007). A major review of disaster risk management found that benefits exceed costs by about four times on average (Mechler, 2016). The Global Commission on Adaptation put the ratio for five climate-resilience areas at roughly 2:1 to 10:1 (Global Commission on Adaptation, 2019). The World Bank found that resilient infrastructure in low- and middle-income countries returns about four dollars per dollar (Hallegatte, 2019). Childhood immunisation has been estimated at about sixteen to one (Ozawa et al., 2016).

Figure 6 Reported benefit-cost ratios for preventive investments are high, but the methods differ

Dollars of benefit per dollar of cost



Source: as labelled (Hutton, 2013; Global Commission on Adaptation, 2019; Hallegatte, 2019; Mechler, 2016; Hutton et al., 2007; Healy and Malhotra, 2009; Ozawa et al., 2016). Ratios are not strictly comparable.

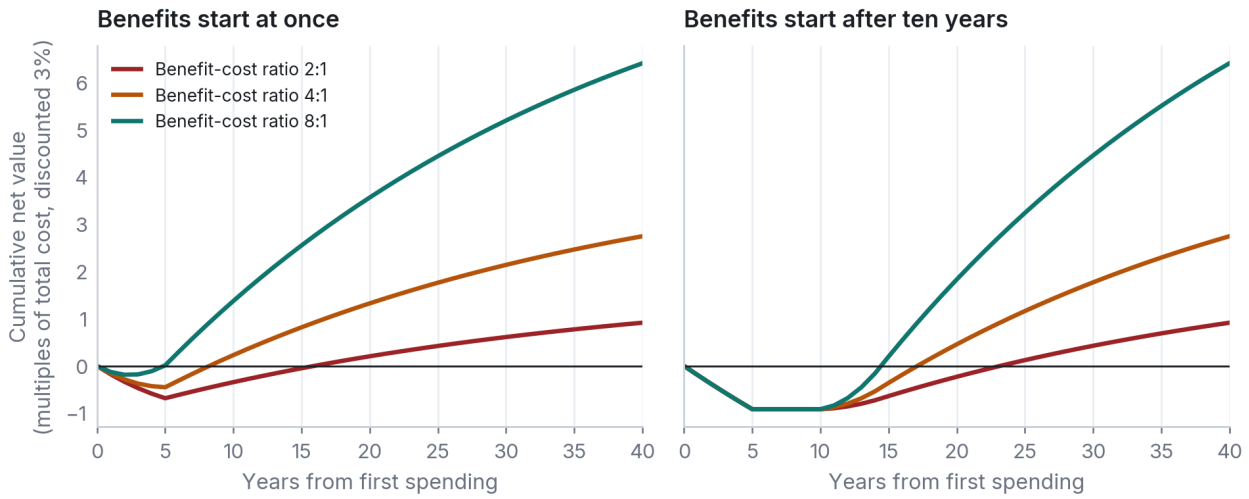
Three cautions apply. First, ratios depend heavily on the discount rate, time horizon and what is counted. Second, studies are more likely to be done on projects that look good. Third, a high average hides a wide range: for clean cooking, country studies range from about 3 to 15, and the biggest ratios come from switching away from the dirtiest stoves; the 2025 estimate of $1.4 trillion in net benefits across 120 low- and middle-income countries from 2020 to 2050 is for the most ambitious policy scenario (Das et al., 2025). A ratio is a signpost, not a promise.

3.4 The time dimension: when does it pay back?

Prevention is a long game. Costs come first and benefits build over years. Figure 7 shows the cumulative net value of an investment that costs one unit spread over five years, for benefit-cost ratios of 2, 4 and 8 over forty years at a 3% discount rate. On the left benefits start at once; on the right they start after ten years.

Figure 7 A ten-year wait before benefits start pushes payback out by about a decade

Cumulative net value by year



Source: H Heuristics model. Cost of one unit over years 1–5; benefits ramp up over five years and last to year 40; ratio defined over the 40-year, discounted stream.

Table 7 Years until cumulative benefits exceed cumulative costs

Benefit-cost ratio	Benefits start at once (3%)	Start after 5 years (3%)	Start after 10 years (3%)	After 5 years, no discounting	After 5 years, 6% discount
2:1	16	20	24	24	17
4:1	9	13	18	16	12
8:1	5	10	15	12	9

Source: H Heuristics model, years from first spending.

A 4:1 investment whose benefits start at once pays back in about 9 years; if benefits take ten years to start, in about 18. A 2:1 investment with a ten-year wait needs about 24 years. These are well within the life of a well, a grid or a school, but beyond most election cycles and many funding horizons. That mismatch is the heart of the under-supply problem.

3.5 When prevention alone is enough, and when it is not

How large must the hazard be for the prevention return alone to justify the cost? Table 8 gives a simple answer. It assumes the investment costs 10% of the value exposed, lasts thirty years and is discounted at 3%. The cells show benefits per dollar of cost from avoided losses only, ignoring any development return.

Table 8 Benefit-cost ratio from avoided losses alone

Expected annual loss (share of exposed value)	Investment removes 20% of loss	Removes 40%	Removes 60%
1% a year	0.4	0.8	1.2
2% a year	0.8	1.6	2.4
4% a year	1.6	3.1	4.7
8% a year	3.1	6.3	9.4

Source: H Heuristics calculation. Cost 10% of exposed value; 30 years; 3% discount rate. Ratio above 1 means avoided losses exceed cost.

Where expected losses are about 1% to 2% of exposed value a year, avoided losses alone fall short unless the investment removes most of the damage. Where losses are 4% or more, the prevention return alone can clear the bar. In the lower-hazard cases the development return carries the investment. This is exactly why the dual-return rule matters: for the foundations in this report the development return is large, so the project stands even when the hazard is modest.

Losses are also lumpy. In an earlier H Heuristics simulation built on global disaster records, a 4:1 prevention investment paid back within a single decade in only about seven cases out of ten, because most losses arrive in a few extreme years (Hughes, 2026g). Lumpiness argues for long horizons, pooled risk and patience, and against judging prevention on a short window.

SECTION 04

Six Core Principles

Six principles turn the idea into practice. Each states a claim, shows the best evidence for it and names a measure and a result that would count against it.

IN BRIEF

- Prevention through development; technology-led risk reduction; infrastructure as protection.
- Environmental vulnerability reduction; institutional capacity; long-term economic efficiency.
- Every principle has a metric and a way to be proved wrong.

4.1 Principle 1: Prevention through development

Using economic development to address the structural conditions that create vulnerability. This is the central principle. It says that the most effective protection against many future crises is to finish the unfinished business of development. The evidence in Section 2 supports the direction of the claim: child mortality is 11 times higher where five or more foundations are missing. An earlier H Heuristics ledger of preventable deaths found that closing development gaps to the level of income peers would protect about 7.0 million lives a year, against 4.6 million from riskspecific measures, and 8.6 million when the two are combined (Hughes, 2026h). The metric is the deficit stack; the claim fails if closing deficits does not lower harm.

4.2 Principle 2: Technology-led risk reduction

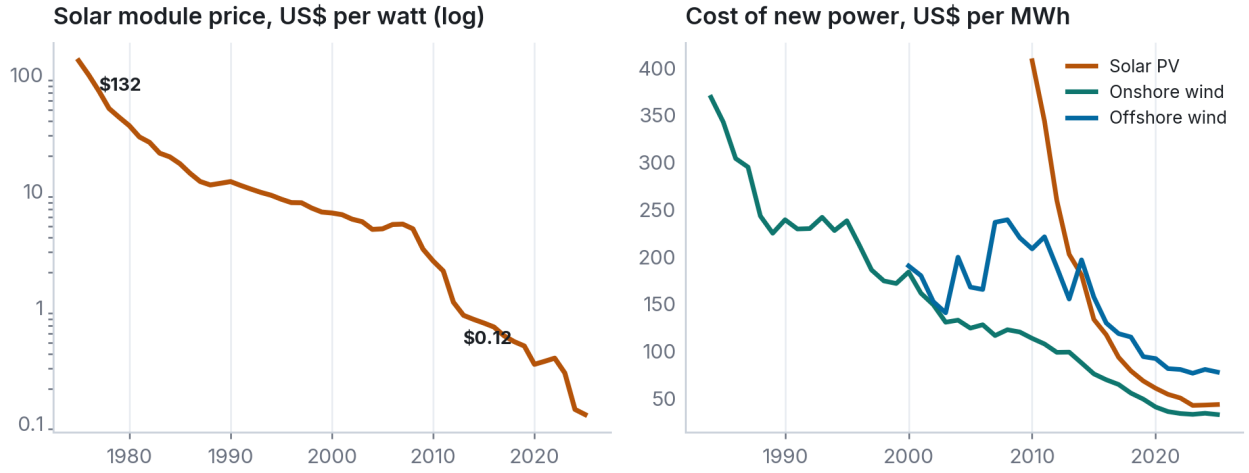
Accelerating access to technologies that improve productivity, environmental quality and essential services. Technology matters because it changes what prevention costs. The price of solar modules fell from $132 per watt in 1975 to $0.12 in 2025, a drop of 99.9% (Our World in Data, 2025); new solar and wind are now among the cheapest sources of new power in much of the world (Our World in Data, 2025c). Learning curves of this kind (Wright, 1936) and the S-shaped spread of successful technologies (Rogers, 2003; Bass, 1969) mean that a service that was unaffordable a decade ago can be within reach now. The metric is cost per person served; the claim fails if falling costs do not translate into faster access.

4.3 Principle 3: Infrastructure as protection

Expanding reliable electricity, clean cooking, water, sanitation, healthcare, cooling and digital connectivity. Infrastructure is the physical form of prevention. The World Bank found that, in low- and middle-income countries, making new infrastructure more resilient would return about four dollars of benefit per dollar and could save trillions over its life (Hallegatte, 2019). Because networks last for decades, the choices made now are hard to reverse (Arthur, 1989; Unruh, 2000). The metric is the share of people with reliable service; the claim fails if new connections do not stay in use or do not raise welfare.

Figure 8 Falling technology costs make preventive services affordable that were out of reach a decade ago

Solar module price and cost of new power



Source: Our World in Data (Our World in Data, 2025; Our World in Data, 2025c), based on Nemet, Farmer and Lafond, and IRENA. Left: global module price. Right: global average levelised cost.

4.4 Principle 4: Environmental vulnerability reduction

Integrating pollution reduction, climate adaptation and clean industrialisation into development pathways. A development path that adds pollution adds vulnerability. Pollution is linked to about nine million deaths a year (Fuller et al., 2022), and adaptation investments return roughly two to ten dollars per dollar (Global Commission on Adaptation, 2019). The data show why this needs its own principle: fine-particle pollution is only weakly tied to the Foundations Index once income is held constant (partial correlation -0.14). The metric is person-years of exposure to unsafe air and heat; the claim fails if cleaner industry does not reduce exposure.

4.5 Principle 5: Institutional capacity

Strengthening governance, public institutions and economic systems to anticipate and manage future risks. Prevention needs people and rules: warning systems that reach the last mile, budgets that reward preparedness, and statistics that show who is left out. Bangladesh's cyclone deaths fell more than a hundredfold between 1970 and 2007, which analysts credit to warnings, shelters and trained volunteers working together (Haque et al., 2012). Where institutions are weak, the incentive problem described in Section 3 bites harder (Healy and Malhotra, 2009). The metric is the share of public spending tagged and tracked as preventive; the claim fails if better institutions do not improve preparedness outcomes.

4.6 Principle 6: Long-term economic efficiency

Evaluating development investments against both immediate economic returns and the future costs of vulnerabilities they prevent. The Stern Review's central estimate was that acting on climate change would cost about 1% of global output a year while inaction could cost 5% to 20% or more (Stern, 2007). Whatever one thinks of those numbers, the logic is general: early action is cheaper than late repair when damage grows over time. The metric is the prevention-adjusted benefit-cost ratio; the claim fails if adding avoided losses never changes a ranking.

Table 9 The six principles with their measures and tests

Principle	Core measure	Result that would count against it
1 Prevention through development	Foundation deficit stack; deaths and exposure avoided	Closing deficits does not lower harm among comparable countries
2 Technology-led risk reduction	Cost per person served; time from 10% to 50% access	Falling costs do not speed up access
3 Infrastructure as protection	Share with reliable service; losses avoided in outages	New connections go unused or do not raise welfare
4 Environmental vulnerability reduction	Person-years of unsafe air and heat avoided	Cleaner industry leaves exposure unchanged
5 Institutional capacity	Prevention share of budgets; warning reach	Better institutions do not improve preparedness
6 Long-term economic efficiency	Prevention-adjusted benefit-cost ratio	Counting avoided losses never changes a ranking

Source: H Heuristics.

4.7 How the principles work together

The principles are not a menu; they form a chain. Technology (2) lowers the cost of services; infrastructure (3) delivers them; environmental measures (4) make sure delivery does not create new exposure; institutions (5) keep it all running and honest; and long-term appraisal (6) decides what to build first. All of it serves the first principle: closing the development deficits that make crises worse.

Take a fast-growing coastal city. Technology offers cheap solar power and mobile payments. Infrastructure puts in drains, clean water, sanitation and a reliable grid. Environmental measures keep new industry and transport clean and shade the neighbourhoods most exposed to heat. Institutions run a warning system that reaches every phone and enforce building rules. Appraisal compares the plan with the alternative of repairing damage after each storm. None of these steps is unusual; the novelty is doing them together, early and on the same books.

SECTION 05

Household Protection: Clean Cooking and Cooling

The most intimate exposures happen at home: the smoke in the kitchen and the heat in the room. Two of the clearest applications of the idea are the clean cooking transition and affordable, sustainable cooling.

IN BRIEF

- 2.0 billion people still cook with polluting fuels; about 1 billion face high risk from a lack of cooling.
- Clean cooking has strong benefit-cost evidence but mixed trial results; the design must reach full switching.
- Cooling is a protection against heat that no hazard defence can remove, and it depends on reliable power.

5.1 Clean cooking transitions

Cooking with wood, charcoal, dung or kerosene exposes 2.0 billion people, about a quarter of humanity, to smoke every day. Household air pollution is responsible for roughly three million deaths a year (WHO, 2024). Women and children are most exposed, and women and girls also spend hours collecting fuel. Clean cooking is a textbook preventive investment: it removes a cause of disease before illness begins, and it returns time, fuel savings and cleaner local air.

The evidence for the investment is strong on average. A global analysis found a benefit-cost ratio of about 4 for the switch to clean fuels (Hutton et al., 2007), and a 2025 study estimated net benefits of $1.4 trillion over 2020–2050 across 120 low- and middle-income countries under the most ambitious policy scenario (Das et al., 2025). In the cross-country data, clean cooking access is linked to better child survival, longer life and lower fertility after holding income constant (3 of 5 outcomes favourable and significant).

The evidence for how well *particular programmes* work is more mixed, and honesty here is essential. Two large randomised trials in the HAPIN study gave households liquefied petroleum gas stoves and fuel. The trials found no significant effect on birth weight (Clasen, 2022) or on severe infant pneumonia (HAPIN Investigators, 2024). Researchers point to incomplete switching: families kept using their old stoves alongside the new one (called 'fuel stacking'), so exposure fell less than hoped. The lesson is not that clean cooking fails, but that *full* switching, not partial adoption, is the goal, and that affordability, fuel supply and habits decide whether it happens.

EVIDENCE LEDGER

The clean cooking evidence ledger

For: large global benefit-cost ratios (Hutton et al., 2007; Das et al., 2025); strong cross-country links to child survival and life expectancy; a clear mechanism.

Against or mixed: trials of single-fuel interventions showed no clear health gain in the first year (Clasen, 2022; HAPIN Investigators, 2024), and fuel stacking is common.
Design lessons: aim for full switching; keep fuel affordable and available; support women's time use; avoid exposing households to price spikes in imported fuel. Measure the full-switch rate, not the stove count.

The pace data show the size of the opportunity. If access rates froze at today's levels, 2.9 billion people would still lack clean cooking in 2050 because populations keep growing. At today's trend the figure is 1.3 billion; at the pace of the fastest quarter of peer countries it is 0.8 billion. Person-years without clean cooking over 2026–50 fall from 37 billion at trend to 31 billion at proven pace.

5.2 Cooling accessibility

Heat is the second household exposure. Rising temperatures, urban growth and rising incomes are pushing up the need for cooling at the same time. A 2025 assessment found just over one billion people at high risk from a lack of access to cooling, with a further 2.8 billion at medium risk (SEforALL, 2025). The International Energy Agency has projected that the stock of air conditioners could more than triple, from about 1.6 billion in 2018 to about 5.6 billion by 2050 if left to current trends (IEA, 2018). Heat now sits among the largest climate-related health risks (Romanello, 2025).

Cooling poses both sides of the prevention problem. It protects people from heat that no flood wall or early warning can remove, and the demand for it can strain grids and add emissions if it is met with inefficient equipment (UNEP, 2025). A preventive approach therefore treats cooling as a bundle, not a machine. Table 10 sets out four layers, in order of cost and durability.

Table 10 Four layers of sustainable cooling

Layer	What it is	Why it is preventive	Main gate
1 Passive design	Shade, reflective roofs, ventilation, green space, building codes	Lowers indoor heat for decades at little running cost	Building rules and enforcement
2 Efficient equipment	Efficient fans, air conditioners and cold chains	Cuts power demand and emissions per degree cooled	Price and standards
3 Reliable clean power	Grids, solar and storage that keep cooling on in a heatwave	Cooling fails exactly when it is needed if the power fails	Grid capacity and finance
4 Heat warnings and refuges	Alerts, cooling centres, work-hour rules	Protects people who cannot buy cooling	Institutions and outreach

Source: H Heuristics, drawing on (UNEP, 2025; IEA, 2018; SEforALL, 2025).

The electricity gate matters because 0.7 billion people still lack electricity at all, and many more have supply that fails in a heatwave. Cooling access is therefore tied to the power build-out discussed in Section 6. Evidence on the economic return to cooling is thinner than for cooking or water. Studies of heat and work suggest large productivity losses, but few rigorous benefit-cost estimates for low-income households exist. H Heuristics therefore rates cooling as *plausible but under-measured*, and makes measuring it a research priority (Section 12).

SECTION 06

Systems Protection: Infrastructure, Clean Industrialisation and Digital Development

Beyond the home, three systems carry whole economies through shocks: the networks that deliver power, water and sanitation; the factories and cities that decide how clean growth is; and the digital rails that connect people to markets, money and warnings.

IN BRIEF

- Infrastructure returns are high on average but depend on reliability and use.
- Clean industrialisation matters because growth alone does not clean the air.
- Digital access helps, but trials show it is not automatic.

6.1 Essential infrastructure: power, water and sanitation

Power, water and sanitation are the backbone of public health and the economy. 0.7 billion people still lack electricity, 0.7 billion basic drinking water and 1.5 billion basic sanitation. In the cross-country data, electricity and sanitation are the most consistently favourable foundations: after holding income constant, each is linked to better child survival, longer life, lower fertility and less hunger (4 of 5 outcomes each), and water to 3 of 5.

Global studies find that reaching universal water and sanitation pays: about two dollars back per dollar for drinking water and about five and a half for sanitation (Hutton, 2013). The World Bank's *Lifelines* report estimated that making new infrastructure in low- and middle-income countries more resilient would return about four dollars per dollar over the assets' lives (Hallegatte, 2019). Mission 300, led by the World Bank and the African Development Bank, aims to connect 300 million more Africans to electricity by 2030 (World Bank, 2024).

The evidence also carries a warning. A large randomised study of grid connections in rural Kenya found that connecting households raised their incomes and assets by less than the connection cost (Lee et al., 2020). Two lessons follow. First, a connection is not the same as useful service: reliability and affordability decide whether electricity is used. Second, the return comes from what the power is *used for*, for example pumps, cold storage, workshops and clinics. A preventive programme should therefore pair connections with productive uses and with reliable supply. The metric is the share of people with *reliable* service, not the share connected.

6.2 Clean industrialisation

Industry and cities decide whether growth brings new exposure. Pollution is linked to about nine million deaths a year (Fuller et al., 2022). The data show that growth alone does not fix this: the median fine-particle level in countries with no deficits is 14 micrograms per cubic metre and in countries with five to seven deficits 26; both are far above the World Health Organization guideline of 5 (WHO, 2021). Among developing economies, the partial correlation between foundations and fine-particle pollution is only -0.14 once income is held constant.

There is a second concern. Many developing economies now reach their peak share of manufacturing employment at lower income levels than earlier industrialisers did, a pattern called 'premature deindustrialisation' (Rodrik, 2016). That narrows the traditional factory route to jobs and makes it more important that whatever industry and services do grow are productive and clean from the start. Choices about plants, power sources and transport made now will last for decades (Unruh, 2000).

Cleaner industry is possible, but rules alone are not enough. A study of Indian cities found that air-quality regulations improved air but produced only small and statistically uncertain declines in infant deaths, and water rules showed no measurable benefit, pointing to weak enforcement (Greenstone and Hanna, 2014). Falling prices for clean power and storage (Our World in Data, 2025c) and better financing terms (IEA, 2024) now make it cheaper to build clean at the outset than to retrofit later. The metric is person-years of exposure to unsafe air; the harmful twin is a fossil-intensive catch-up that locks in pollution.

6.3 Digital economic development

Digital access is the newest foundation and the one with the biggest gap. 2.3 billion people do not use the internet. The GSMA reports that 3.4 billion people were not using mobile internet in 2024 and that just over 90% of them live inside areas already covered by a network (GSMA, 2025). The barrier is mostly not the tower; it is price, devices, skills and trust. Financial access has advanced further: 79% of adults worldwide, and 75% in low- and middle-income economies, now have an account (World Bank, 2025).

Evidence that digital tools help is good but conditional. Mobile money lifted about 2% of Kenyan households out of poverty and especially helped women (Suri, 2016). The arrival of fast internet raised employment across African cities (Hjort, 2019). Mobile phones improved market information and cut price differences for traders and farmers (Aker and Mbiti, 2010). Phones also carry warnings and cash payments after shocks (United Nations, 2022). But benefits are not automatic: in an experiment with Kenyan entrepreneurs, an AI mentor helped those who were already doing well and hurt those who were struggling (Otis, 2024). In the country data, internet use is linked to better outcomes after holding income constant (3 of 5 outcomes favourable). The metric is the share who use, not merely have access to, the internet; the digital twin to avoid is a new form of exclusion for those left offline.

Table 11 The five applications at a glance

Application	Gap today	How it prevents harm	Strongest evidence	Main caution
Clean cooking	2.0 bn people	Removes household smoke before disease begins	Benefit-cost about 4 (Hutton et al., 2007)	Fuel stacking; trials found little clear health gain (Clasen, 2022)
Cooling	About 1 bn at high risk (SEforALL, 2025)	Protects against heat that cannot be prevented	Heat is a leading climate health risk (Romanello, 2025)	Thin return evidence; grid and emissions strain
Essential infrastructure	0.7 bn no power; 1.5 bn no sanitation	Builds basic health and shock absorption	Water 2:1, sanitation 5.5:1 (Hutton, 2013); resilient assets 4:1 (Hallegatte, 2019)	Connection is not use; Kenya grid study (Lee et al., 2020)
Clean industrialisation	Fine particles well above guideline	Avoids building new exposure into growth	Pollution linked to about 9 m deaths (Fuller et al., 2022)	Enforcement; mixed results (Greenstone and Hanna, 2014)
Digital development	2.3 bn offline	Carries warnings, cash, learning and markets	Mobile money and fast internet studies (Suri, 2016; Hjort, 2019)	Benefits uneven; AI mentor study (Otis, 2024)

Source: H Heuristics, as cited.

EVIDENCE

A note on evidence quality

The five applications are not equally well proven. Water, sanitation and warning systems rest on decades of data. Clean cooking has strong cost-benefit estimates but mixed trial results. Cooling, clean industrialisation and digital learning rest on thinner or more conditional evidence. The report therefore ranks them as *established*, *promising* or *to be proved* rather than treating them alike.

Three lessons run across the five applications. First, **use matters more than connection**: stoves, grids, phones and accounts protect only when they are used. Second, **the best evidence is for basic, proven measures** such as water, sanitation, immunisation and warnings, while the newest applications (cooling, clean industry, digital learning) have thinner evidence. Third, **every application depends on another**: cooling needs power, digital services need power and affordable devices, and clean cooking is easier where electricity is reliable. Section 10 returns to these links.

SECTION 07

Does Prevention Show Up in the Data?

A good idea should leave a trace. This section tests Preventive Development Economics against country data with three questions: do early foundations predict later progress, is prevention visible in disaster deaths, and do foundations cushion shocks?

IN BRIEF

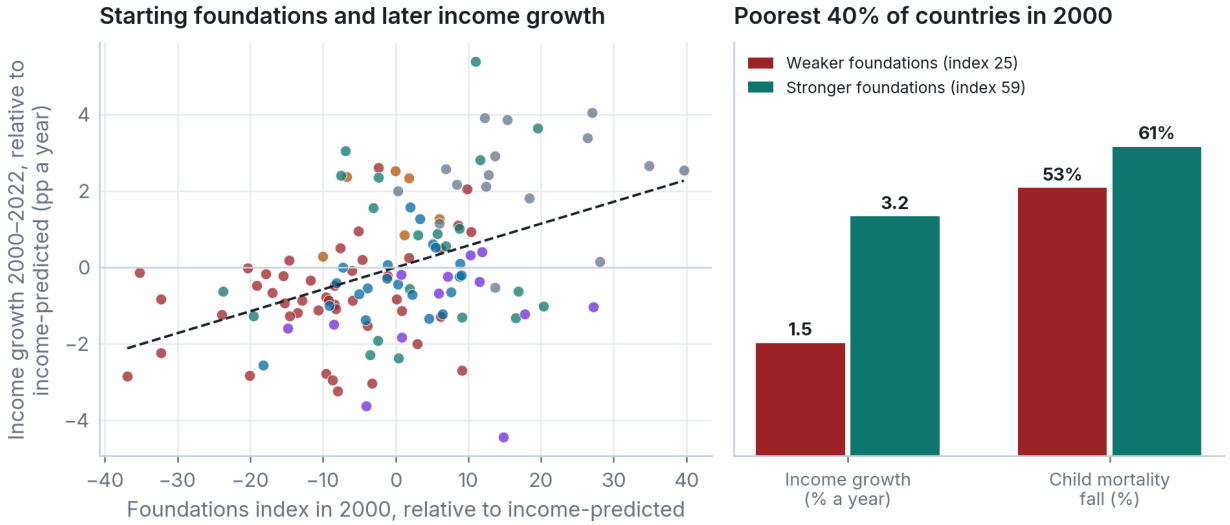
- Stronger foundations in 2000 predicted faster income growth and faster falls in child mortality, with caveats.
- Disaster deaths have fallen sharply with preparedness, though hazard-by-hazard comparison is inconclusive.
- Foundations did not cushion GDP in 2009 or 2020, so the claim must be about human harm, not output volatility.

7.1 Test 1: do early foundations predict later progress?

The strongest observational test of prevention is a lagged one: measure foundations *first*, then see what happens. For 122 developing economies we built the Foundations Index as of 2000 and compared it with progress to 2022, holding fixed the starting income and, for child mortality and life expectancy, the starting level. A higher index is a standardised measure (one standard deviation is about 22 index points).

Figure 9 Countries that started with stronger foundations grew faster, even compared with equally rich peers

Early foundations and later progress



Source: World Bank WDI; H Heuristics calculations. Left: partial plot of income growth 2000–22 against the Foundations Index in 2000, both measured relative to what starting income predicts. Right: medians for the poorest 40% of countries in 2000, split at the median index.

Stronger early foundations predict faster income growth and a faster fall in child mortality. Among the poorest 40% of countries in 2000, those with a stronger index (about 59) grew by 3.2%

Table 12 Foundations in 2000 and progress to 2022

Outcome (2000–2022)	Effect of +1 standard deviation	p-value	With region fixed	Excluding East Asia
Faster fall in child mortality	-0.24 log points (about 21% lower in 2022)	0.001	-0.09 (p=0.30)	-0.24 (p=0.02)
Faster income growth	+1.28 points a year	under 0.001	+0.64 (p=0.04)	+1.38 (p under 0.001)
Larger gain in life expectancy	+0.7 years	0.36	not tested	not tested

Source: H Heuristics calculations; OLS with robust standard errors, 122 developing economies (101 excluding East Asia and Pacific). Controls: log GDP per capita 2000 and, for mortality and life expectancy, the 2000 level.

a year and cut child mortality by 61%; those with a weaker index (about 25) grew by 1.5% and cut it by 53%. Life expectancy is the exception: gains were smaller where foundations were stronger (6.0 years against 9.4), most likely because countries with the weakest starting health, many in southern Africa, recovered from the HIV epidemic after 2004, and the regression finds no overall effect.

CAUTION

How far to trust the lagged test

The result is robust to dropping East Asia and Pacific, the region where foundations and fast growth went together most strongly.

It is partly absorbed by region. With regional differences held fixed, the growth effect halves (to +0.6 points, still significant) and the child-mortality effect is no longer distinguishable from zero.

It is an association. Unmeasured traits such as institutions, conflict, geography and policy quality could drive both early foundations and later growth. The test supports the direction of the claim; it does not measure a causal return.

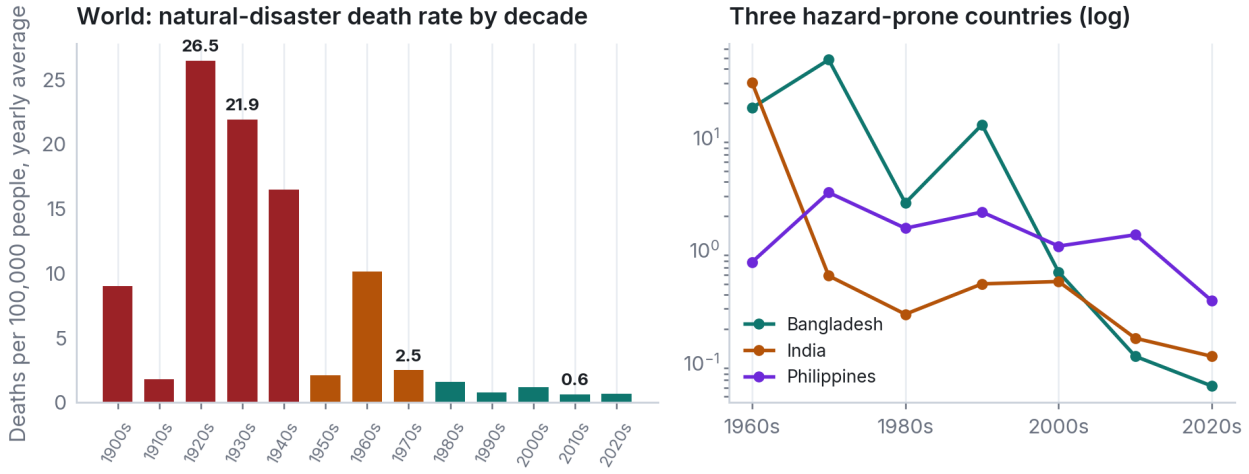
7.2 Test 2: is prevention visible in disaster deaths?

Disasters offer the clearest historical case of prevention working. Worldwide, the average annual death rate from natural disasters was about 26 per 100,000 people in the 1920s and about 0.6 in the 2010s, a fall of 98% (Ritchie et al., 2025). Rising income, better building, forecasting and preparedness all contributed. Bangladesh is the best-known case: cyclone deaths fell from roughly 500,000 in 1970 to about 4,200 in 2007, a drop of more than a hundredfold, which analysts credit to warnings, shelters and trained volunteers (Haque et al., 2012). In the decade averages used here, Bangladesh's disaster death rate fell from 48 per 100,000 in the 1970s to 0.1 in the 2010s (Figure 10).

A harder test holds the hazard roughly constant. Among 66 countries with high INFORM hazard scores (5 or more), we compared disaster death rates in 2000–19 for countries with two or fewer foundation deficits against those with three or more. The population-weighted rate was 1.8 per 100,000 a year in the high-deficit group against 0.6 in the other, nearly three times as high. But the *median* country shows no gap (0.14 against 0.18), and a regression finds no relationship between the Foundations Index and disaster deaths. The mean is driven by a few catastrophes in places such as Haiti, Myanmar and the Indian Ocean coast. Disaster deaths are too rare and lumpy to settle the question; the honest conclusion is that this test is inconclusive.

Figure 10 Natural-disaster death rates have fallen steeply, and fastest where warning and shelter systems were built

Death rate per 100,000 people, decade averages



Source: EM-DAT through Our World in Data (Ritchie et al., 2025); H Heuristics calculations. Decade averages; the 2020s are partial. Estimates of individual events vary widely.

7.3 Test 3: do foundations cushion economic shocks?

The third test asks whether countries with stronger foundations lost less output in two global shocks, the financial crisis of 2009 and the pandemic of 2020. We measured each country's GDP growth in the shock year against its growth in the preceding years and related the gap to its Foundations Index just before the shock, holding income constant.

The result does not support the cushioning idea for GDP. In 2009 there is no relationship (effect -0.1 points per standard deviation among developing economies, p=0.91). In 2020 countries with stronger foundations saw *bigger* falls in growth (-2.0 points among developing economies, p=0.02; -3.1 across all 190 countries). The likely reason is that 2020's output losses reflected lockdown policy and exposure of tourism and services, which are larger in better-connected economies, rather than weak foundations. This is a useful correction. The claim of Preventive Development Economics concerns *human harm* (deaths, disease, hunger, lost years) and long-run growth, not the size of short-run swings in GDP. It should be tested on those outcomes, which is a task for the research agenda.

7.4 What a better test would look like

The three tests above are a first look. Stronger evidence would come from designs that separate cause from correlation:

- **Natural experiments.** Compare areas that received a service earlier or later for reasons unrelated to their outcomes, such as the staggered rollout of grid connections, vaccination drives, mobile towers or warning systems.
- **Sub-national panels.** Follow districts and households, not just countries, so that averages do not hide who gains.
- **Long follow-up.** Many prevention benefits take years to appear; trials that follow people for a decade will say more than one-year results, as the clean cooking trials show.

Table 13 Scorecard of the three tests

Test	Finding	Verdict
Early foundations predict later income growth	Positive and large; halves with regional controls	Supported, with caveats
Early foundations predict faster child-mortality decline	Positive; weakens with regional controls	Partly supported
Early foundations predict life expectancy gains	No overall effect	Not supported
Prevention is visible in disaster deaths	Large falls over time; cross-country test inconclusive	Supported historically; inconclusive across countries
Foundations cushion GDP shocks	No effect in 2009; larger falls in 2020	Not supported

Source: H Heuristics.

- **Direct harm outcomes.** Use deaths, illness, hunger and exposure person-years as the measures, rather than GDP alone.

IMPLICATIONS

What the tests mean for policy

Invest in foundations for their own sake first. The best-supported link is between early foundations and later income and child-survival progress. That is a reason to build them, not a promise of a particular return.

Do not sell prevention as a shock absorber for GDP. The evidence does not support that claim. Sell it for what it protects: lives, health, learning and long-run growth.

Measure harm directly. Track deaths, illness, hunger and exposure person-years, not only output, so that prevention can be seen when it works.

SECTION 08

Timing, Demography and the Window for Prevention

Prevention pays most when it comes early, and the next twenty-five years are when most of the world's population growth happens, in the countries with the largest deficits. The window is open, and it is closing.

IN BRIEF

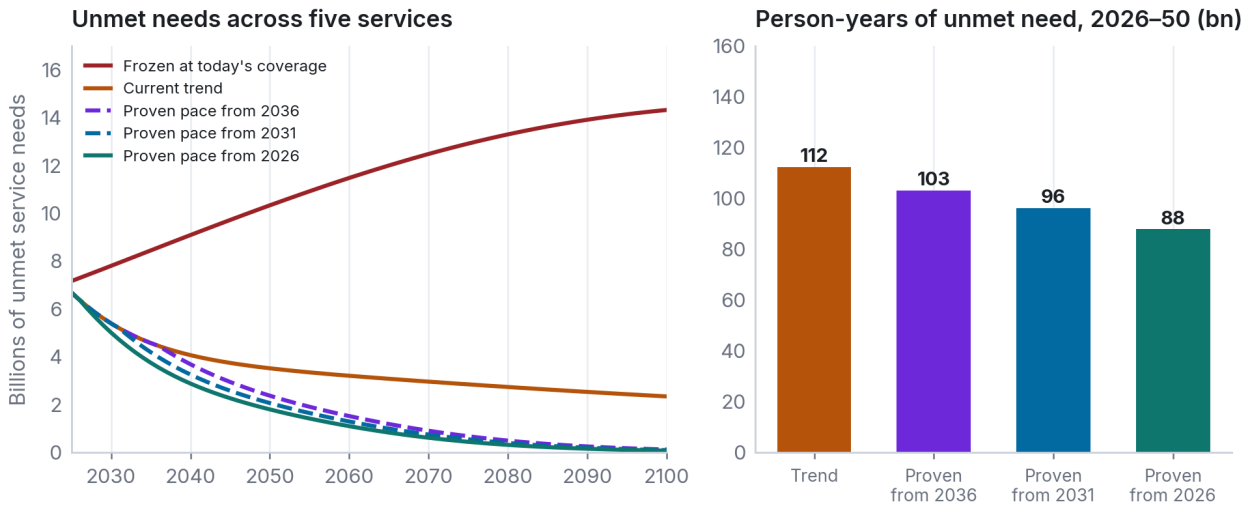
- Each year of delay adds about 1.7 billion person-years of unmet need across five services.
- 79% of the world's growth to 2050 is in countries with three or more deficits.
- Ten countries hold more than half of the 2050 backlog if coverage stays frozen.

8.1 The cost of delay

To see what timing is worth, we built a simple pace model for five population-wide services: electricity, clean cooking, basic water, basic sanitation and internet use. For each country we measured the speed of recent progress, then compared four futures: coverage frozen at today's level; the current trend; *proven pace*, the speed reached by the fastest quarter of peers at a similar stage, starting in 2026; and proven pace starting in 2031 or 2036. 'Proven pace' is a benchmark of what other countries have already done, not a forecast.

Figure 11 Starting at proven pace sooner removes billions of person-years of unmet need

Unmet needs 2025–2100 and person-years 2026–2050



Source: World Bank WDI, UN WPP 2024; H Heuristics model. Logit-pace paths for five services; 'proven' is the 75th-percentile peer pace in 2012–24. Person-years sum across the five services.

Unmet needs fall from 6.7 billion today to 3.5 billion in 2050 at current trend, and to 1.8 billion at proven pace from 2026. A frozen world would reach 10.3 billion because of population growth.

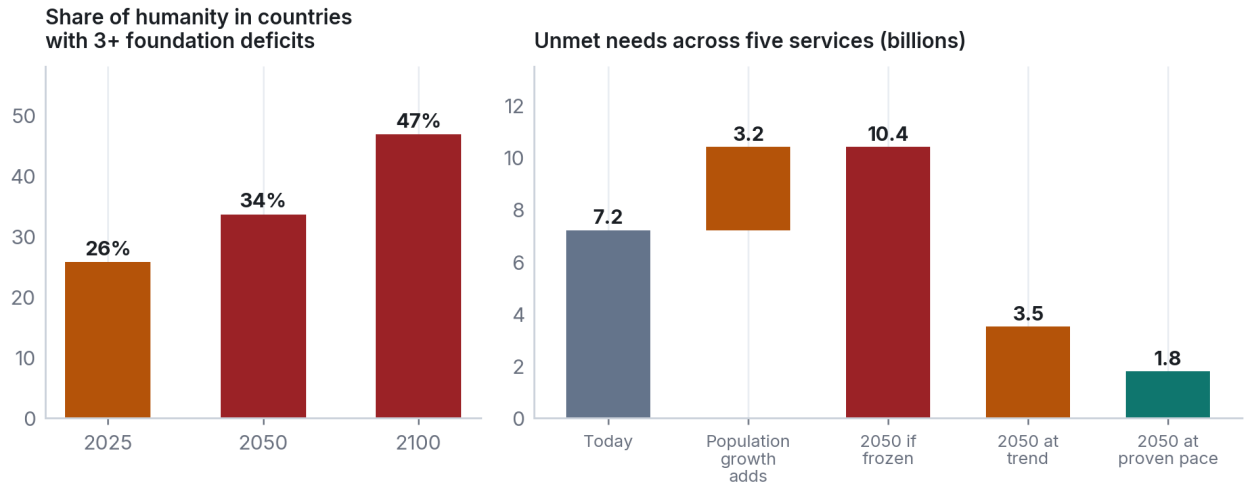
Over 2026–2050, proven pace from 2026 avoids 24 billion person-years of unmet need compared with trend. A five-year delay to 2031 gives up 34% of that gain, and a ten-year delay to 2036 gives up 62%. Over the whole century the loss is smaller (10% and 20%) because both paths eventually reach universal coverage; the cost of delay is concentrated in the decades when people live with the gap.

8.2 Where the people will be

Population growth is the second clock. 26% of humanity lives today in countries with three or more foundation deficits. That share is projected to reach 34% in 2050 and 47% in 2100, because those countries are growing while richer ones are flat or shrinking (United Nations, 2024). Sub-Saharan Africa alone accounts for 59% of world population growth to 2050. Cities add to the challenge: the United Nations expects the world's city population to rise by almost a billion by 2050, with more than half of that growth in seven countries: India, Nigeria, Pakistan, DR Congo, Egypt, Bangladesh and Ethiopia (UN DESA, 2025).

Figure 12 Population growth adds billions of unmet needs unless coverage keeps pace

Share of humanity in deficit countries and unmet needs to 2050



Source: World Bank WDI, UN WPP 2024; H Heuristics model. Right panel: person-service gaps for electricity, clean cooking, water, sanitation and internet.

The backlog behaves like a treadmill. Counted across the five services, 7.2 billion needs are unmet today. If coverage stayed frozen, population growth alone would add 3.2 billion more by 2050. Access has to grow faster than population just to stand still. The 'Momentum-Breaking Pace' of the earlier H Heuristics work is the speed at which that stops being true (Hughes, 2026a).

Demography and deficits also feed each other. Among developing economies, a ten-point higher Foundations Index goes with 0.37 fewer births per woman, holding income constant (partial correlation -0.50). This fits what is known about child survival, schooling and women's time: when more children survive and girls stay in school, families choose smaller families. Slower population growth, in turn, makes it easier to close the gaps and can bring a demographic dividend, as it did for East Asia (Bloom and Williamson, 1998). This is an association, not a measured effect, and it is one of the seven questions in the research agenda.

8.3 Where prevention pays most

If coverage stayed frozen, the 2050 backlog would be concentrated. Sub-Saharan Africa would hold 61% of it, up from 52% today. The ten countries with the largest backlogs would hold 56% (Table 14). India leads in raw numbers because of its size, even with relatively good coverage; DR Congo, Nigeria and Ethiopia lead on both size and depth of the deficits.

Table 14 The fourteen countries with the largest 2050 backlog at frozen coverage

Country	Population 2050 (m)	Foundations Index	Deficits (of 7)	Unmet needs 2025 (m)	2050, frozen (m)
India	1,680	88	1	1,099	1,261
DR Congo	218	34	7	452	875
Nigeria	359	55	5	566	855
Ethiopia	225	40	7	472	784
Pakistan	372	75	4	341	496
Tanzania	130	51	6	214	394
Bangladesh	215	77	3	266	326
China	1,260	95	0	348	310
Uganda	85	42	6	178	296
Mozambique	64	45	7	117	209
Kenya	84	63	5	144	209
Niger	53	34	6	108	203
Sudan	85	52	7	123	203
Madagascar	53	36	7	120	195

Source: World Bank WDI, UN WPP 2024; H Heuristics calculations. Unmet needs are person-service gaps across electricity, clean cooking, water, sanitation and internet.

The list is not a ranking of need or a recommendation for aid. It shows where the numbers of people, and so the leverage, are largest. Different countries need different bundles: in India the biggest gaps are internet use, clean cooking and sanitation; in Pakistan and Bangladesh clean cooking comes first, then internet use and sanitation; in DR Congo and Ethiopia almost everything. Country-by-country cards belong to a later report in the series.

SECTION 09

Decision Rules, Institutions and Finance

An idea changes outcomes only if it changes decisions. This section turns the framework into three tools: a prevention-adjusted appraisal, a screen for ranking investments, and a short list of money and institutional fixes.

IN BRIEF

- Appraise on both returns and show the ranges.
- Screen on six criteria, then bundle by complementarity rather than funding the top score alone.
- Track prevention as a visible share of budgets.

9.1 A prevention-adjusted appraisal

The dual-return rule of Section 3 becomes a practical appraisal in six steps. The aim is not to replace existing methods but to add what they leave out.

Table 15 A prevention-adjusted appraisal ledger

Step	Question	Typical source
1 Name the deficit	Which gap does this close, for how many people?	Household surveys, WDI, national statistics
2 Name the exposure	Which risks does that gap make worse, and for whom?	Hazard maps, health data, INFORM
3 Count the development return	What does it earn in a normal year (income, time, health, learning)?	Impact evaluations, trials
4 Count the prevention return	What damage does it avoid, in which scenarios, over what years?	Disaster and health loss data; climate scenarios
5 Add cross-sector benefits	Who else gains (health, education, environment) and is not counted?	Multi-sector models; 'who benefits' tables
6 Report the range	How wide is the uncertainty, and when do benefits start?	Sensitivity runs, payback years, unmeasured items listed

Source: H Heuristics.

Two habits make the ledger honest. First, show the *development return and the prevention return separately*, so that a project that works only on one is visible as such. Second, show the *timing*: a ratio that is only reached after fifteen years should say so, using the payback logic of Section 3.

ILLUSTRATION

An illustrative example (made-up numbers)

A village water system costs $100,000. In a normal year it saves time and raises income, worth $220,000 over its life in today's money, so a conventional appraisal gives a ratio of 2.2.

Now add prevention: the system also lowers the chance and cost of disease outbreaks and dry-spell losses. If that is worth $90,000 in expected avoided losses, the total return is $310,000 and the ratio 3.1. If the benefits start only after five years, the payback is a few years later, which the ledger reports.

The numbers are invented to show the method. In practice each line comes from local data, with a range.

9.2 A screen for ranking preventive investments

Finance ministries and development banks must choose among many good projects. A simple screen can help. We score twelve candidate investments on six criteria on a scale of zero to two, using the results of this report where they exist and documented judgement where they do not (Table 16).

The six criteria are **breadth** (how many outcomes improve, scored from the cross-country test in Section 10 where available), **lock-in avoided**, **evidence** (strength and consistency, including nulls), **speed** of benefits, **affordability** per person and **readiness** of delivery today.

Table 16 A prevention screen of twelve investments (0–2 per criterion, maximum 12)

Investment	Breadth	Lock-in	Evidence	Speed	Afford.	Ready	Score
Childhood immunisation	●	○	●●	●●	●●	●●	9
Reliable electricity	●●	●●	●	●	●	●	8
Water and sanitation	●●	●	●●	●	●	●	8
Digital ID and payments	●	●	●	●●	●●	●	8
Early warning systems	●	○	●●	●●	●●	●	8
Resilient infrastructure design	●	●●	●●	○	●	●	7
Quality primary schooling	●●	●	●●	○	●	●	7
Social protection (cash)	●	○	●●	●●	●	●	7
Mobile and internet access	●	●	●	●●	●	●	7
Clean cooking	●	●	●	●	●	●	6
Passive and efficient cooling	●	●●	○	●	●	○	5
Clean industrial zones	●	●●	●	○	○	○	4

Source: H Heuristics. ●● = 2, ● = 1, ○ = 0. Breadth for electricity, sanitation, water, internet, clean cooking from Section 10; other scores are documented judgements and are open to challenge.

The scores are a conversation starter, not a verdict. Three points stand out. Cheap, fast, well-proven measures such as immunisation, warning systems and digital payments score high on readiness and speed. Infrastructure scores high on lock-in avoided and breadth but lower on speed and cost. And cooling and clean industry score lower mainly because the evidence is thin and delivery models are young, which is a case for more research and pilots rather than for neglect. Because the investments reinforce one another, the right use of the screen is to pick *bundles* (Section 10), not to fund only the top of the list.

9.3 Money and institutions

Better appraisal helps only if money and institutions follow. The barriers from Section 3 each suggest a fix (Table 17). Two figures show why the fixes matter. Prevention received about eight cents for every dollar of response in 2015–24 (Hughes, 2026f). And in 34 countries holding about 2.7 billion people, governments spent more on interest than on health in the latest data, leaving little room for upstream investment (Hughes, 2026i). Meanwhile official development assistance fell sharply in 2025 (OECD, 2026).

Table 17 Barriers to prevention and how to ease them

Barrier	Fix	Who acts
Invisible counterfactual	Publish an annual 'avoided harm' account next to the damage account; reward preparedness in performance reviews	Finance ministries, auditors
Short horizons	Multi-year, ring-fenced prevention funds; payback-year reporting	Legislatures, development banks
Split budgets	Appraise across sectors; pool funds for multi-benefit programmes such as cooking or water	Planning ministries, donors
High cost of capital	Blended finance, guarantees and concessional lending for long-lived assets (IEA, 2024)	Development banks, climate funds
Weak enforcement	Independent monitoring; community and volunteer networks (Haque et al., 2012); open data	Regulators, civil society
Poor measurement	A national Foundations Index and prevention budget tag, reported annually	Statistical offices

Source: H Heuristics.

SECTION 10

Intersections: Bundles, Gates and the Household Stack

Foundations pay more together than apart. One investment strengthens several kinds of capital at once, and one blocked gate can hold back the rest.

IN BRIEF

- Each of six foundations is linked to three or four of five good outcomes.
- Reliable power is the keystone gate for many other services.
- Design bundles, not single projects.

10.1 Six capitals, many returns

Prevention strengthens six kinds of capital: human, infrastructure, digital, environmental, institutional and financial (Figure 13). The best preventive investments raise several at once. Clean cooking builds human capital (health), environmental capital (cleaner air) and women's time. Digital payments build digital, institutional and financial capital together. Distributed power builds infrastructure, digital and human capital. This is the 'multi-dividend' idea of the H Heuristics programme: prefer investments that serve several goals at once (Hughes, 2026a; Hughes, 2026b).

Figure 13 Preventive investments strengthen several kinds of capital at once

Six capitals and example investments



Source: H Heuristics. Conceptual diagram.

10.2 A cross-country check of the multiple dividends

To check whether services really bring several benefits, we related each service to five outcomes among developing economies, holding income constant: child survival, life expectancy, lower fertility, less hunger and cleaner air (Figure 14). Electricity and sanitation are favourable on 4 of 5; water, clean cooking, internet and immunisation on 3 of 5. Air quality is the outcome that services rarely change, a reminder that cleaner industry and cooking need their own policy.

Figure 14 Every foundation is linked to at least three of five good outcomes; air quality is the exception

Services and outcomes

	Child survival	Life expectancy	Lower fertility	Less hunger	Cleaner air
Electricity (4 of 5)	✓	✓	✓	✓	–
Basic sanitation (4 of 5)	✓	✓	✓	✓	–
Clean cooking (3 of 5)	✓	✓	✓	–	–
Basic water (3 of 5)	✓	✓	✓	–	–
Internet use (3 of 5)	✓	✓	✓	–	–
DPT3 immunisation (3 of 5)	✓	✓	✓	–	–

Source: World Bank WDI; H Heuristics calculations. ✓ = favourable and significant at 5% (robust OLS holding log income); – = not significant. Developing economies, n of 100 to 124 per cell.

10.3 Joint gates

A gate is a condition that must be met before an investment can work. The same few gates appear again and again.

- **Reliable power.** Digital services, cold chains, cooling, pumps and clinics all need it. Earlier H Heuristics work found internet use rarely runs more than five points ahead of electricity access (179 of 181 countries) (Hughes, 2026b).
- **Affordability.** Devices, connections and fuel must be within reach of the poorest. Without it, services stay unused, as the GSMA usage gap shows (GSMA, 2025).
- **Skills and trust.** People must know how and be willing to use a service; the AI mentor and rural electrification results show the cost of ignoring this (Otis, 2024; Lee et al., 2020).
- **Institutions and finance.** Someone must maintain, regulate and pay for assets for decades.

10.4 The household stack

For a household, the foundations form a stack: power, clean cooking, water, sanitation, a phone and an account. The stack is only as strong as its weakest layer. A home with a clean stove but no safe water is still exposed; a home with a phone but no power cannot charge it. Seen this way, the 2.0 billion without clean cooking and the 2.3 billion without internet are two overlapping groups of households, not two separate problems. The sequencing rule that follows is simple: secure the keystone gate (reliable power and affordability) first, then add the services that depend on it.

SECTION 11

Limits, Harmful Twins and What Would Prove the Idea Wrong

An idea earns trust by saying what it cannot do. This section lists the main limits of the evidence, the damaging twins that each preventive investment can have, and the results that would count against the framework.

IN BRIEF

- The tests show association, not proven cause.
- Each investment has a harmful twin to design around.
- Seven findings would weaken the framework; we commit to reporting them.

11.1 Limits of the evidence

The tests in this report are observational and use country-level data, so they carry the usual limits of that kind of evidence. Table 18 lists the main ones and what the report does about each.

Table 18 Main limits and how they are handled

Limit	Why it matters	What this report does
Association is not cause	Income, institutions and geography may drive both foundations and outcomes	Holds income fixed; uses lagged data; reports regional controls; calls results associations
Reverse causation	Healthier, richer countries can afford more foundations	Tests whether foundations measured *first* predict later change
Unequal deficits	A 1-point gap in sanitation is not the same as one in internet	Shows each service separately and averages only in the index
Averages hide people	National figures conceal poor regions and groups	Flags this; recommends sub-national work in the research agenda
Rare, lumpy events	Disaster deaths are too few to test cleanly	Reports the inconclusive result and avoids over-reading
Benefit-cost ratios	Methods, discounting and selection differ	Shows ranges; uses ratios only as signposts
Scenario benchmarks	Proven pace is not a forecast	Labels all scenarios as benchmarks; reports sensitivity

Source: H Heuristics.

11.2 Harmful twins

Almost every preventive investment has a damaging twin, a way it can go wrong or feed the problem it aims to solve. Naming it in advance is part of good design (Table 19).

Table 19 Harmful twins of the five applications

Application	Harmful twin	Design response
Clean cooking	Fuel stacking; exposure to imported-fuel price spikes	Aim for full switching; support local and electric options; stable pricing
Cooling	Energy-hungry equipment that strains grids and adds emissions	Passive design first; efficiency standards; clean power
Essential infrastructure	Connections that go unused; assets that fail in the next shock	Pair with productive use; build for resilience (Hallegatte, 2019)
Clean industrialisation	Fossil-intensive catch-up that locks in pollution	Build clean from the start; enforce standards
Digital development	New exclusion, data misuse, harm to struggling users	Affordability, skills, consumer protection; test before scaling

Source: H Heuristics.

11.3 What would prove the idea wrong

A framework is worth having only if it can fail. Preventive Development Economics would be weakened by any of the following findings, and we commit to report them if they appear.

- Within matched countries, closing foundation deficits does *not* reduce child deaths, hunger or exposure to heat and pollution.
- Prevention-adjusted benefit-cost ratios never change the ranking of investments compared with conventional ones.
- Falling technology costs do not speed up access in the poorest countries.
- Better institutions do not raise preparedness or preventive spending.
- The lagged link from early foundations to later progress vanishes in better-identified studies (for example, using natural experiments).
- Foundations fail to reduce *human* harm in shocks (deaths and illness), not only output swings.
- Preventive programmes with full delivery show no benefits beyond those of ordinary development spending.

Two of these are already partly in view. The cross-country life expectancy test found no overall effect (0.36), and foundations did not cushion GDP in 2009 or 2020 (Section 7). The first reminds us that the lagged link is not uniform; the second that the claim concerns human harm. Optimism here means committing to the evidence, including the parts that do not flatter the idea.

SECTION 12

Research Agenda and Roadmap to 2035

Seven research questions would turn the concept into a tested field. Each is stated so that it can be proved wrong, and each has a first output and a place in a ten-year roadmap.

IN BRIEF

- Seven questions: exposure, pollution, digital diffusion, African cities, cooling, clean industry and demography.
- Each links a data source, a method and a falsifiable claim.
- Each report starts a campaign: publish, translate, engage, commit, track.

12.1 Seven research questions

The agenda comes from the founding concept and covers the economics of prevention across five applications and two cross-cutting themes (Table 20). Each question needs a data source, a method and a claim that could fail.

1. The economics of preventing climate-related human exposure

What does it cost to remove a person-year of exposure to extreme heat, flooding or drought through development investments, compared with response and adaptation alone? Start with the person-year ledger of earlier H Heuristics work and add costs by intervention.

2. Economic returns on air pollution prevention in developing economies

What do cleaner cooking, transport and industry return in health, productivity and fiscal savings, and when does regulation without enforcement fail? Section 6 shows the weak link between growth and cleaner air, and the Indian regulation study shows enforcement matters (Greenstone and Hanna, 2014).

3. The role of digital technology diffusion in accelerating human development

Which digital services convert into earnings, savings and safety, and for whom? Evidence on mobile money and fast internet is positive, while the AI mentor result is a warning (Suri, 2016; Hjort, 2019; Otis, 2024).

4. Preventive infrastructure investment in rapidly growing African cities

What does it cost and return to build water, sanitation, power, drainage and cooling into new settlements, rather than retrofit them? With Africa's cities growing fast (UN DESA, 2025), a few years of timing could decide the shape of cities for a century.

5. The economic benefits of cooling accessibility in tropical and subtropical regions

How much work, health and learning do households and workplaces gain from passive and efficient cooling, and at what cost to the grid? Evidence here is thinnest of all the applications, which makes it a high-value question.

6. Clean industrialisation as a mechanism of long-term vulnerability reduction

Do clean industrial zones lower long-run exposure to pollution and carbon lock-in without sacrificing jobs and growth, given premature deindustrialisation (Rodrik, 2016)?

7. Demographic growth, development deficits and future systemic risk

How do population growth, deficits and exposure interact over time, and can closing deficits speed the demographic transition? Section 8 finds that 79% of growth to 2050 is in countries with three or more deficits and that foundations go with lower fertility; a causal test is still needed.

Table 20 The research agenda: data, method and falsifiable claim

Question	Main data	Method	Claim that could fail
1 Climate exposure	Hazard grids, population, cost data	Cost per person-year avoided; scenarios	Development routes cost more per person-year than response
2 Air pollution	Satellite PM2.5, health data, rules and enforcement	Panel and event studies; benefit-cost	Clean-air policies pay back slower than ten years
3 Digital diffusion	Findex, usage, trial data	Conversion-chain tests; trials	Digital access does not raise earnings of the poorest
4 African cities	Urban growth, settlement and cost data	Build-in versus retrofit costing	Retrofit costs less than building in
5 Cooling	Heat, power and productivity data; pilots	Randomised and quasi-experimental	Cooling gives no productivity or health gain at its cost
6 Clean industry	Plant, employment, emissions data	Comparative case and panel	Clean zones lose jobs without lasting benefit
7 Demography	UN projections, surveys, foundations	Longitudinal and instrument-based tests	Deficits do not affect the pace of demographic transition

Source: H Heuristics.

12.2 A pathway campaign, not just a report

Research matters only if it changes what decision-makers measure, target and fund. For this field the path has five steps: **publish** open evidence; **translate** it into briefs and country cards; **engage** finance ministries, development banks, statisticians and researchers; **commit** by seeking specific, measurable targets; and **track** progress each year in a ledger. Influence is claimed as contribution, not attribution, and an honest baseline is that uptake of this research is still early (Hughes, 2026a).

12.3 Roadmap to 2035

A ten-year roadmap sets milestones that can be checked (Table 21).

Table 21 Roadmap for Preventive Development Economics, 2026–2035

When	Milestone	Output
2026–27	Define and measure	This report; a public Foundations Index; Prevention Ledger version 1; first appraisal template
2027–28	Test and replicate	Panels, trials and case studies for the seven questions; replications; critique from others
2028–29	Translate and engage	Briefs and country cards for the largest-backlog countries; dialogue with finance ministries and development banks
2029–30	Commit and check	Pace gap against proven pace; prevention budget tags piloted; adoption in at least three appraisal guides
2030–35	Track and revise	Annual ledger; 2035 review of the deficit stack and avoided exposure; revise or retire parts that fail

Source: H Heuristics proposal. Commitments depend on partners; none is assumed.

CONCLUSION

In one paragraph

The most reliable way to reduce the harm of future crises is often to finish the unfinished business of development. A quarter of humanity lives where basic services are thin; population growth is fastest there; and each year of delay adds about 1.7 billion person-years of unmet need. Closing the gaps early earns two returns at once, and the evidence supports the direction of the claim while showing its limits. The task now is to measure it carefully, appraise it honestly and fund it before the next crisis arrives.

SECTION 13

Data and Method Notes

How the numbers in this report were made, so that they can be checked, challenged and improved.

IN BRIEF

- All data are public; calculations are scripted and repeatable.
- Thresholds and benchmarks are choices, and the sensitivity is reported.
- Scenarios are benchmarks, not forecasts.

13.1 Data sources

Every number comes from a public source. Table 22 lists the main ones; each is linked in the reference list.

Table 22 Main data used

Item	Source	Notes
Coverage of services; mortality; life expectancy; fertility; GDP	World Bank WDI (World Bank, 2026)	Latest value in 2015–2024 for the stack; values near 2000 for the lagged test
Population and projections to 2100	UN World Population Prospects 2024 (United Nations, 2024)	Medium variant
Hazard exposure	INFORM Risk Index 2026 (European Commission JRC, 2026)	Hazard and exposure score (0–10); not used for the vulnerability components, to avoid circularity
Disaster deaths	EM-DAT through Our World in Data (Ritchie et al., 2025)	Decade averages per 100,000
Solar and power costs	Our World in Data (Our World in Data, 2025; Our World in Data, 2025c)	Global series
Benefit-cost ratios, quotes and context	Sources cited in text	Not strictly comparable

Source: H Heuristics.

13.2 Definitions and calculations

- **Foundations Index.** The simple average of coverage (percent) across seven indicators: access to electricity, access to clean cooking fuels and technologies, basic drinking water, basic sanitation, internet use, DPT3 immunisation and primary completion. At least five of seven are required; coverage above 100 is capped at 100.
- **Deficit and stack.** A deficit is coverage under 80% on an indicator. The stack is the number of deficits (0 to 7). Sensitivity at 60% and 90% is reported in Section 2.

- **People lacking a service.** (100 minus coverage) times 2025 population, for the five population-wide services only. Immunisation and completion are age-group rates and are not turned into headcounts.
- **Associations.** Ordinary least squares with robust (HC3) standard errors. Partial correlations residualise both variables on log GDP per capita. Developing economies are low-, lower-middle- and upper-middle-income countries in the World Bank classification.
- **Lagged test.** Foundations Index near 2000 (within two years) for countries with at least four of seven indicators; outcomes 2000 to 2022 (child mortality log change, life expectancy change, annual income growth); controls log GDP per capita 2000 and the starting level. 122 developing economies.
- **Shock test.** Shock size is GDP growth in 2009 (or 2020) minus the average of the four (or five) preceding years; Foundations Index near 2005 (or 2018); controls log income; extreme values trimmed.
- **Hazard-held-constant test.** Countries with INFORM hazard and exposure 5 or more; average decade death rate in 2000s and 2010s; high-deficit group has three or more deficits.
- **Pace model.** For each country and service, the slope of logit coverage over 2012–2024; proven pace is the 75th percentile of slopes among countries starting between 5% and 90%; future coverage follows the logit path from the last observation; people lacking equal (1 minus coverage) times projected population; delay scenarios start the proven slope in 2031 or 2036.
- **Payback and break-even models.** Costs are one unit spread over years 1 to 5; benefits ramp over five years after the start lag and last to year 40; the ratio is defined on the discounted stream. The break-even grid assumes cost equal to 10% of exposed value, a 30-year annuity at 3%.
- **Screen.** Six criteria scored 0 to 2; breadth uses the number of favourable, significant outcomes in Section 10 where measured; other scores are documented judgements.

13.3 Reproducibility and caveats

All calculations are scripted from public data and can be rerun. World Bank series are revised, so numbers may shift slightly with new vintages. Country coverage varies by indicator. The pace model extrapolates recent progress and does not model shocks, conflict or policy change. Population projections are medium-variant and uncertain, especially for Africa. Benefit-cost ratios from the literature use different methods and are not directly comparable. The prevention screen and the interpretation of results are the author's, and corrections are welcome.

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