H HEURISTICS

*Navigating a Changing World*

# Building Adaptive Capacity Across the Emerging World Before 2050

*Infrastructure and Institutions for Managing Increasingly Interconnected Global Risks*

Two Engines, Built Together: Why Resilience Is a Meta-Capability the Emerging World Must Build Before the Window Closes

H Heuristics · Hunter Hughes

Research Report · September 2026

## Abstract

The risks facing the emerging world are increasingly interconnected. A drought becomes a harvest failure, a price spike, a run on reserves, a migration wave, and a strain on health systems, in sequence or all at once; a pandemic becomes a supply-chain crisis, an inflation shock, and a sovereign-debt crisis across much of the developing world. When shocks transmit this way, the variable that decides a country's fate is not how many hazards it can forecast but how much adaptive capacity it holds — the standing, general ability to anticipate, absorb, adapt to, and transform in the face of whatever arrives. This report argues that adaptive capacity, so defined, is the decisive development variable of the century to 2050, and that the emerging world holds too little of it.

The central thesis is that adaptive capacity is produced by two engines that must be built together: infrastructure and institutions. Infrastructure — power that stays on, water that keeps flowing, transport and digital networks that route around failure — supplies the physical buffering, redundancy, and flexibility to absorb a shock. Institutions — early-warning agencies, fiscal buffers and shock-responsive finance, adaptive social protection, data systems, and the state capacity to run them — convert that physical potential into timely, coordinated action. The two are complements, not substitutes: infrastructure without the institutions to operate and finance it is brittle, and institutions without the infrastructure to act on are hollow. The report's analytical core is a two-by-two framework in which genuine adaptive capacity lies only where both engines are built, and a mapping of each engine onto the four functions of adaptive capacity.

The report measures the emerging world's adaptive-capacity gap along the two axes of the ND-GAIN framework — high vulnerability combined with low readiness — and traces it to two proximate causes: thin fiscal buffers, with 3.4 billion people living in countries that spend more on debt interest than on health or education, and a cost-of-capital penalty of several hundred basis points that makes capacity-building investment most expensive exactly where it is most needed. The financing shortfall is stark: the UN Environment Programme estimates developing-country adaptation needs at roughly US$215–387 billion a year against international public flows of about US$28 billion, an eight- to fourteen-fold gap. Yet the returns to building capacity are exceptional — benefit-cost ratios reaching ten to one for early warning and resilient infrastructure — which makes the gap a failure of finance and accounting rather than of underlying value.

The implication is an agenda and a timetable. Build both engines together, funding operations and institutions alongside every asset; prioritise the double-duty investments — digital public infrastructure, distributed clean energy, adaptive social protection — that strengthen both engines with a single outlay; fix the financing by buying down the cost of capital, rebuilding fiscal space, and reforming the multilateral banks; and value capacity at its full risk-reduction return across the whole portfolio of shocks it mitigates. Above all, move early: the quarter-century to 2050 is the window in which most of the emerging world's infrastructure and much of its institutional architecture will actually be built, and capacity designed in now is cheap where retrofitting it later is not. Grounded in the experience of Bangladesh, Kenya, Morocco, Vietnam, Barbados, and Rwanda — where infrastructure and institutions built together turned survivable hazards into contained disruptions — the report's central finding is that adaptive capacity is not given by geography but built by choice, in time, and that building it across the emerging world before the window closes is the most consequential investment in human security available this century.



**Keywords:** adaptive capacity; resilience; interconnected risk; systemic risk; emerging markets and developing economies; climate adaptation; resilient infrastructure; institutions; anticipatory governance; early-warning

systems; adaptive social protection; shock-responsive finance; fiscal space; cost of capital; adaptation finance gap; lock-in; digital public infrastructure; maladaptation; development finance; polycrisis

**JEL classification:** Q54, O13, H54, F34, O19; climate and natural disasters; agriculture and natural resources in development; infrastructure and public investment; international lending, debt and finance; international linkages to development

**Data and method:** This report synthesises institutional and peer-reviewed research on adaptive capacity, resilience, and development finance, including the *IPCC Sixth Assessment Report* (Working Group II); the socio-ecological resilience tradition (Holling; Folke); the WMO *Atlas of Mortality and Economic Losses (1970–2021)*; the Notre Dame Global Adaptation Initiative (*ND-GAIN*) country index; the UNEP *Adaptation Gap Report 2024*; the Global Commission on Adaptation's *Adapt Now* and the World Bank's *Lifelines*; UNCTAD's *A World of Debt (2025)*; the *IEA World Energy Investment 2025*; the World Economic Forum *Global Risks Report*; and primary reporting on country programmes in Bangladesh, Kenya, Morocco, Vietnam, Barbados, and Rwanda. Every quantitative claim is attributed inline to a primary or authoritative secondary source. Figures 1, 2, and 5 are conceptual schematics; Figure 3's regional positions are stylised after the ND-GAIN framework; Figure 8's trajectories are illustrative of the lock-in argument; Figures 4, 6, and 7 report values from the cited primary sources. The report is analytical rather than predictive.

# Contents

# 1. Introduction: The Age of Interconnected Risk

> *The defining feature of the risks now facing the emerging world is not their number but their connectedness. A drought is no longer only a drought; it is a harvest failure, a spike in food prices, a run on foreign reserves, a wave of migration, and a strain on a health system, arriving in sequence or all at once. When shocks travel this way, the quality that decides a country's fate is not how many hazards it can predict but how much capacity it holds to anticipate, absorb, adapt to, and recover from whatever arrives. This report is about that capacity — what it is, why the emerging world is short of it, and how it can be built before 2050.*

For most of the modern development era, risk was managed one silo at a time. Ministries of health prepared for epidemics, disaster agencies for floods, finance ministries for balance-of-payments crises, and each did so on the working assumption that shocks were largely independent — that they would arrive singly and could be met from a dedicated reserve. That assumption has quietly stopped holding. The early twenty-first century has produced a densely coupled system in which a climatic shock transmits into food and water systems, food and water stress transmits into public finances and health, financial stress transmits into the ability to respond to the next shock, and each event leaves the system more exposed to the one that follows. The World Economic Forum's Global Risks Report has for several years described a risk landscape defined less by any single peril than by the interconnections between them.

The consequences of this interconnection fall most heavily on emerging markets and developing economies. They sit, on average, in more hazard-exposed geographies; they depend more directly on climate-sensitive sectors such as rain-fed agriculture; they carry thinner fiscal and institutional buffers with which to absorb a blow; and they face a cost of capital that makes the very investments that would build resilience the most expensive to finance. The result is a form of double exposure: greater sensitivity to shocks combined with a weaker capacity to respond. It is this asymmetry — not a shortage of hazard forecasts or engineering blueprints — that turns manageable shocks into development reversals.

The argument of this report is that the right unit of analysis for this predicament is adaptive capacity: the capability of a country, a city, or a system to adjust to shocks and stresses — to foresee them, to withstand them, to reorganise in their wake, and, where necessary, to transform so as to reduce future exposure. Adaptive capacity is a meta-capability. It does not target any single hazard; it governs how well a society converts whatever it faces into a contained disruption rather than a cascading crisis. Two societies exposed to the identical cyclone, harvest failure, or price shock can experience radically different outcomes, and the difference is very largely the difference in their adaptive capacity.

The report's central claim is that adaptive capacity rests on two engines that must be built together: infrastructure and institutions. Infrastructure — power that stays on, water that keeps flowing, transport and digital networks that route around failure — provides the physical buffering, redundancy, and flexibility that let a system absorb a shock. Institutions — the rules, coordinating bodies, fiscal buffers, information systems, and social-protection mechanisms that decide who does what, with what money, on what warning — convert that physical potential into timely action. Neither engine works alone. Infrastructure without the institutions to operate and finance it is brittle; institutions without the infrastructure to act on is hollow. Only when the two advance together does a society move toward genuine adaptive capacity.

This framing has a practical payoff. It cuts against the two most common failure modes in resilience policy: pouring concrete without building the coordinating and financing arrangements that keep it useful, and drafting plans, strategies, and mandates without the physical means to execute them. It directs attention to the investments that strengthen both engines at once, and it explains why so much well-intentioned adaptation spending underperforms. The report develops the framing, quantifies the gap the emerging world must close, and sets out what building both engines would require in the quarter-century to 2050 — the window in which most of the infrastructure and many of the institutions of the emerging world's future will actually be built.

The report proceeds as follows. Section 2 defines adaptive capacity and distinguishes it from neighbouring ideas such as robustness and resilience. Section 3 sets out why interconnection has made adaptive capacity the decisive variable. Section 4 measures the adaptive-capacity gap between the emerging world and the advanced economies. Section 5 develops the two-engine framework at the heart of the report. Sections 6 and 7 examine each engine in turn — infrastructure and institutions — and Section 8 shows how they reinforce each other. Section 9 addresses financing; Section 10 examines the investment window to 2050 and the cost of delay; Section 11 confronts the failure modes and limits of the argument; Section 12 grounds it in country experience; and Section 13 concludes with an agenda.

## 2. What Adaptive Capacity Is

> *Before an argument can be built on adaptive capacity, the term must be pinned down. It is used loosely — as a synonym for resilience, for wealth, for good governance — and the looseness hides the specific thing that matters for policy. This section defines adaptive capacity, distinguishes it from its neighbours, and sets out the four functions that any account of it must explain.*

The concept has two intellectual roots. The first is the study of socio-ecological systems, where the ecologist C.S. Holling and those who followed him distinguished the mere ability of a system to return to its prior state from its deeper capacity to absorb disturbance while retaining its essential function, and — further still — to learn, reorganise, and transform. The second is the climate-adaptation literature codified by the Intergovernmental Panel on Climate Change, whose Sixth Assessment Report frames risk as the product of hazard, exposure, and vulnerability, and treats vulnerability as compounded of sensitivity and a lack of adaptive capacity. In that framing, adaptive capacity is the part of vulnerability a society can actively build down: the resources and abilities it can mobilise to moderate harm and exploit opportunity.

It helps to separate three ideas that are often merged. Robustness is the ability to withstand a defined shock without changing — a sea wall built to a hundred-year flood. Resilience, narrowly understood, is the ability to recover function after a shock — to bounce back. Adaptive capacity is broader than either: it is the standing ability to adjust, and it spans the whole life of a shock, from foresight before impact to transformation afterward. Robustness fails silently when a shock exceeds its design threshold; adaptive capacity is precisely what a society draws on when its defences are overtopped. In a world of novel and compounding shocks, where the next hazard rarely matches the last, adaptive capacity is the more valuable and the more general asset.

Any working account of adaptive capacity must explain four distinct functions, which unfold over the life of a shock. To anticipate is to see a shock coming and prepare — through forecasting, early warning, contingency planning, and pre-arranged finance. To absorb is to take the blow while continuing to function — through buffers, redundancy, reserves, and protection that limit the depth of the disruption. To adapt and recover is to restore function and adjust arrangements in light of what happened — through flexible systems, rapid finance, and the ability to reallocate resources. To transform is to change the system itself so that the same shock does less damage next time — relocating exposed assets, diversifying an economy, rewriting the rules. Figure 1 renders these four functions as the trajectory of a system's performance through a shock, and contrasts a high-capacity society with a low-capacity one.

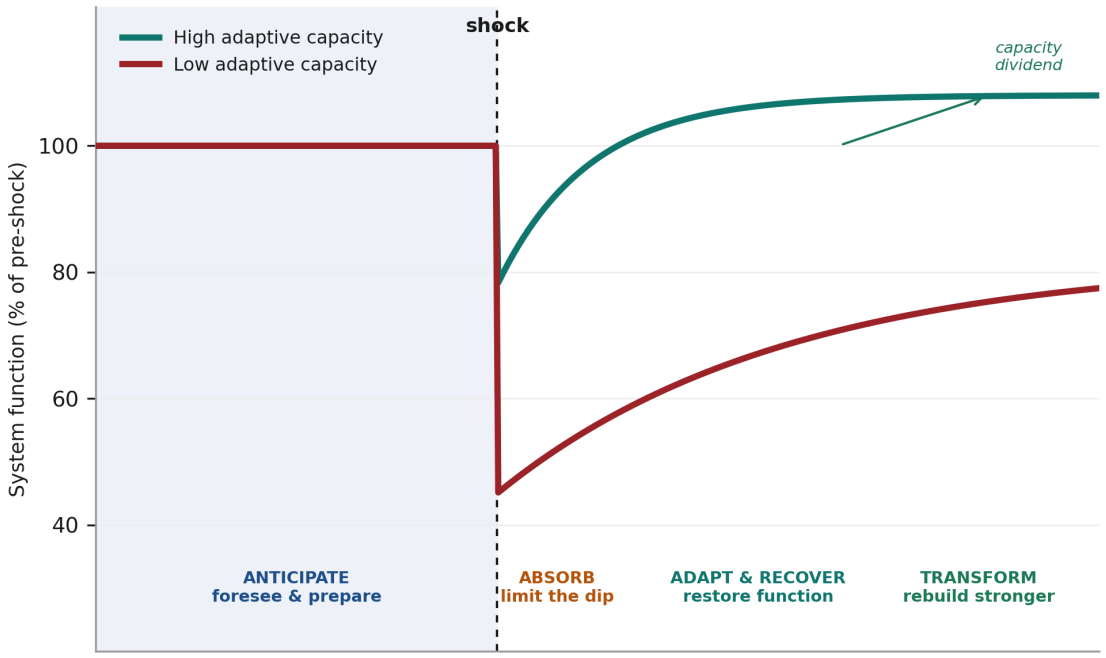


***Figure 1.*** *The four functions of adaptive capacity over the life of a shock: a high-capacity system anticipates and absorbs, recovers quickly, and rebuilds stronger; a low-capacity system suffers a deeper fall and a slower, incomplete recovery.*
Schematic by the author, after the resilience-curve tradition in socio-ecological systems research (Holling; Folke) and the IPCC AR6 WGII treatment of adaptive capacity.

The figure makes the stakes visible. The two curves begin at the same level of function; a shock strikes at the same moment. The high-capacity system, having anticipated the shock, suffers a shallow dip, recovers quickly, and — because it treats the event as information — rebuilds to a higher level of function than before: a capacity dividend. The low-capacity system, caught unprepared, suffers a deep fall, recovers slowly, and settles at a permanently lower level, its development trajectory bent downward by an event the other system merely weathered. The gap between the two curves, integrated over time, is the true cost of an adaptive-capacity deficit — and it is a cost paid not once but at every shock, with each event leaving the low-capacity system lower still.

## 2.1 Determinants: what adaptive capacity is made of

If adaptive capacity is the ability to move through those four functions well, its determinants are the resources and arrangements that ability draws on. The literature converges on a recognisable set: financial resources and fiscal space; physical assets and infrastructure; human capital, skills, and information; the strength and flexibility of institutions and governance; social capital and equity; and access to technology. These determinants are not a menu from which a society picks one. They are complements: finance without institutions to allocate it is wasted; infrastructure without the human capital to operate it decays; early warning without the physical means to act on it saves no one. This complementarity is the reason the report organises the determinants into two mutually dependent engines — the physical (infrastructure) and the organisational (institutions) — rather than treating them as a checklist.

Two further properties of adaptive capacity deserve emphasis because they shape everything that follows. First, adaptive capacity is generic as well as specific: some of it is tuned to a known hazard (a flood-warning

system), but much of it — fiscal reserves, a functioning payments system, a capable civil service, a diversified economy — pays off against shocks of every kind, including ones never specifically foreseen. Generic capacity is the hedge against an uncertain future, and it is chronically under-provided because no single hazard budget will pay for it. Second, adaptive capacity is largely built in advance. It cannot be conjured in the days after a shock; it is the product of investments and institutional arrangements made, often unglamorously, in the calm before. The implication is that the returns to building capacity are realised precisely when they are hardest to attribute — as disasters that did not happen and crises that did not cascade.

## 2.2 Why capacity, not hazard, is the right target

It is tempting to organise resilience policy around hazards: a strategy for floods, another for droughts, another for pandemics, another for financial crises. The hazard-by-hazard approach has a fatal weakness in an interconnected world — it prepares for the last shock and the anticipated one, while the damage increasingly comes from novel shocks and from the transmission of one hazard into another. Targeting adaptive capacity instead has three advantages. It builds the generic buffers that pay off across the whole distribution of possible futures. It concentrates attention on the transmission channels through which shocks cascade, which is where interconnected risk does its damage. And it is measurable in terms of determinants a government can actually invest in — finance, infrastructure, institutions — rather than in terms of hazards it cannot control. The rest of the report takes adaptive capacity, so defined, as its object.

## 3. Why Adaptive Capacity Matters Now: The Rising Interconnection of Risk

> *Adaptive capacity has always mattered. The claim of this section is narrower and more urgent: that the structure of global risk has changed in ways that make adaptive capacity the decisive variable now, and increasingly so to 2050. Two shifts drive the change — hazards are intensifying, and the systems they strike are more tightly coupled than before.*

Take the intensification first. The World Meteorological Organization's Atlas of Mortality and Economic Losses, covering 1970 to 2021, records a roughly fivefold rise in the number of reported weather, climate, and water disasters over that half-century and a roughly sevenfold rise in reported economic losses, to a cumulative US$4.3 trillion. The same record carries the report's most important encouragement: reported deaths fell sharply over the period even as events multiplied, because early warning and preparedness — adaptive capacity, in other words — improved. The hazard curve and the mortality curve diverged, and the wedge between them is the measure of what capacity can buy.

The second shift is coupling. The systems that underpin modern economies — energy, food, water, finance, supply chains, public health — have become more efficient, more specialised, and more interdependent, and interdependence is a double-edged property. It raises productivity in normal times and transmits stress in bad ones. A disruption at any one node now propagates to the others with a speed and reach that would have been unusual a generation ago. Figure 2 renders this as a network: six domains of risk, densely linked, in which a shock originating at any node travels along the edges to the rest.

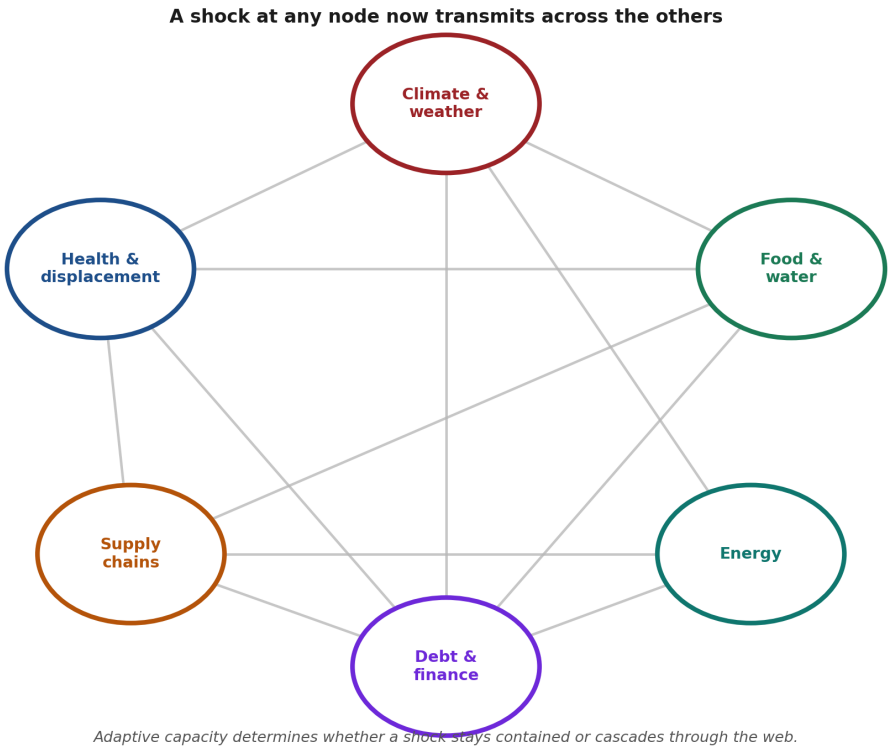


***Figure 2.*** *The interconnection of systemic risk: a shock originating at any node now transmits across the others. Adaptive capacity is what determines whether a shock stays contained or cascades through the web.*

Schematic by the author, after the interconnected-risk framing of the World Economic Forum Global Risks Report and the polycrisis literature.

The events of the 2020s supplied a live demonstration. A pandemic became a supply-chain crisis, then an inflation shock, then — as interest rates rose to meet the inflation — a sovereign-debt crisis across much of the developing world; a war in a major grain- and energy-exporting region became, within months, a food-price emergency in import-dependent economies thousands of miles away and a fiscal emergency for those that subsidised fuel and food. In each case the initiating hazard was survivable; the damage came from transmission, and the difference between countries that contained the cascade and those that did not was very largely a difference in adaptive capacity — in reserves, in social-protection systems that could be scaled, in the institutional ability to respond coherently under pressure.

## 3.1 Compounding, cascading, and the erosion of buffers

Interconnection produces three distinct dangers, each of which raises the premium on capacity. Compound shocks arrive together — a heatwave during a drought during a power shortage — and overwhelm defences designed for one hazard at a time. Cascading shocks propagate through the network, as a climatic event triggers a financial one. And, most insidiously, each shock erodes the buffers that would have absorbed the next: a drought drains the reserves, a debt crisis consumes the fiscal space, a disaster diverts the administrative attention, so that a society emerges from one shock less able to meet the following one. This last dynamic — the serial depletion of adaptive capacity — is why the emerging world's predicament is not a series of separate emergencies but a single, accumulating condition, and why rebuilding capacity is as important as responding to any individual event.

None of this implies that interconnection should be reversed even if it could be. The gains from integrated energy, food, and financial systems are real and largely irreversible. The implication is rather that the benefits of interconnection must be paired with deliberate investment in the capacity to manage its costs — in redundancy where efficiency has removed slack, in buffers where just-in-time systems have removed reserves, and in the institutions that can see across the silos through which shocks now travel. Adaptive capacity is the price of admission to an interconnected world, and it is a price the emerging world has so far paid only partially.

## 4. The Adaptive-Capacity Gap in the Emerging World

> *The emerging world does not lack for exposure to shocks; it lacks the capacity to meet them. This section measures that gap along the two dimensions that matter — vulnerability and readiness — and traces its two proximate causes: thin fiscal buffers and a punishing cost of capital. The gap is large, it is measurable, and, crucially, it is a product of investment choices rather than an immutable fact of geography.*

The most widely used lens on the gap is the Notre Dame Global Adaptation Initiative's ND-GAIN index, which scores 185 countries on two axes. The first is vulnerability — a country's exposure, sensitivity, and lack of adaptive capacity across six life-supporting sectors: food, water, health, ecosystems, human habitat, and infrastructure. The second is readiness — its ability to convert investment into adaptation, built from economic, governance, and social components. Plotting the two together, as Figure 3 does in stylised form, reveals the structure of the problem: the advanced economies cluster in the low-vulnerability, high-readiness corner, while much of the emerging world — and above all sub-Saharan Africa, South Asia, and the small island states — occupies the opposite corner, combining the highest vulnerability with the lowest readiness. That corner is the adaptive-capacity gap.

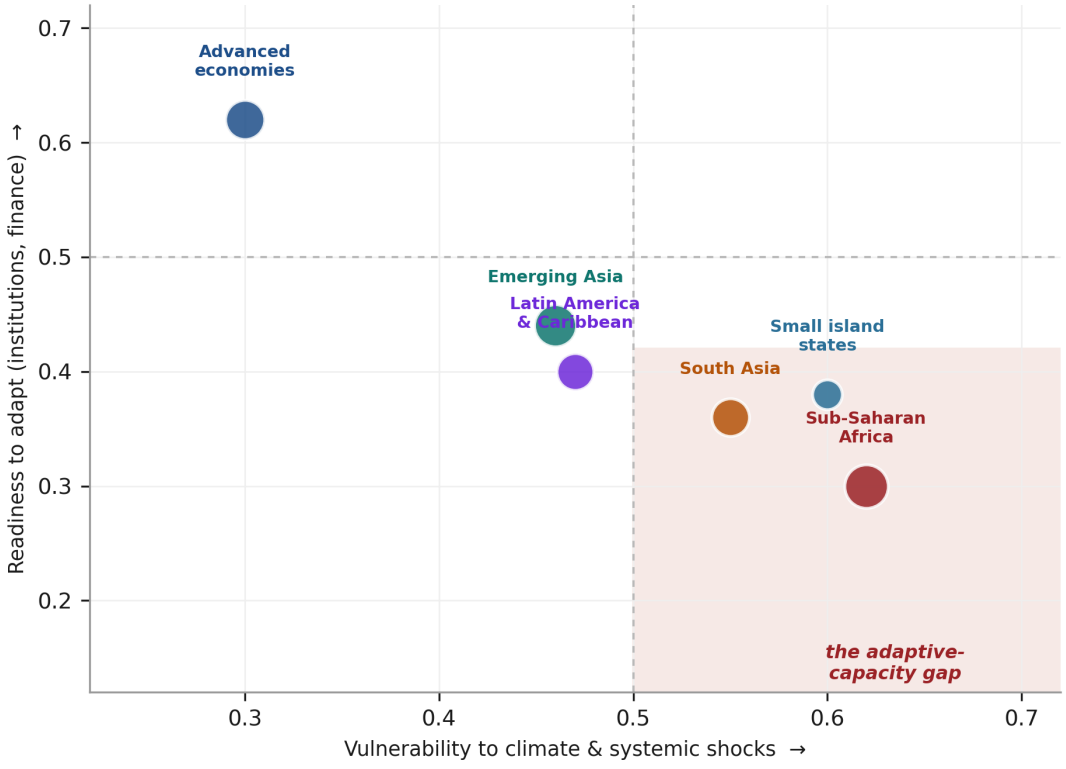


***Figure 3.*** *The adaptive-capacity gap: emerging and developing regions combine high vulnerability to shocks with low readiness to adapt, while advanced economies occupy the opposite corner. Positions are illustrative, after the ND-GAIN framework.*

Schematic by the author, after the Notre Dame Global Adaptation Initiative (ND-GAIN) country index, which pairs vulnerability with readiness. Positions are stylised for exposition, not precise index values.

The ND-GAIN framing is useful precisely because its two axes map onto the report's two engines. Readiness — economic, governance, and social — is very nearly a measure of a country's institutional engine: its ability to accept and direct investment toward adaptation. Vulnerability, in turn, reflects the state of its physical systems: whether its infrastructure buffers or amplifies a hazard. A country improves its position on the chart by building both — moving left by hardening its physical systems and up by strengthening its institutions — and the emerging world's problem is that it starts low on both axes at once.

## 4.1 The fiscal-buffer deficit

The first proximate cause of the gap is a shortage of fiscal space. Adaptive capacity is expensive to exercise: absorbing a shock means spending — on relief, on reconstruction, on scaled-up social protection — precisely when revenues fall and borrowing costs rise. The emerging world enters each shock with less room to do so. UNCTAD's *A World of Debt* reports developing-country external debt at a record US$11.4 trillion and net interest payments of US$921 billion in 2024, and finds that some 3.4 billion people live in countries that spend more on servicing debt than on health or education. A government that spends more on interest than on its clinics has, by definition, little fiscal capacity left to absorb a shock, and each shock it borrows to meet erodes the space to meet the next. The debt overhang is therefore not merely a financial problem; it is an adaptive-capacity problem, because it consumes the buffer on which absorption depends.

## 4.2 The cost-of-capital penalty

The second proximate cause compounds the first. The investments that build adaptive capacity — resilient infrastructure, clean and reliable power, water systems, digital networks — are overwhelmingly upfront-capital-intensive, so their viability is exquisitely sensitive to the cost of finance. And that cost is far higher in the emerging world. A developing-economy borrower typically faces a risk premium of several hundred basis points over an advanced-economy counterpart for an otherwise identical project, so that the same solar array or flood defence can cost two to three times as much to finance in Lagos or Dhaka as in Frankfurt. Figure 5, in Section 9, quantifies this wedge. Its effect is perverse: capacity-building investment is most expensive exactly where the capacity is most needed, which is one reason the emerging world under-invests in its own resilience even when the underlying returns are high.

The finance gap that results is stark. The UN Environment Programme's *Adaptation Gap Report 2024* estimates that developing countries will need on the order of US$215–387 billion a year this decade for adaptation, against international public adaptation-finance flows of roughly US$28 billion in 2022 — an eight- to fourteen-fold shortfall, illustrated in Figure 4. Even the pledged doubling of adaptation finance would close only a small fraction of it. The gap is not evidence that adaptive capacity is unaffordable; as later sections show, its returns are among the highest in development. It is evidence of a financing system that under-prices resilience and over-charges those who need it most.

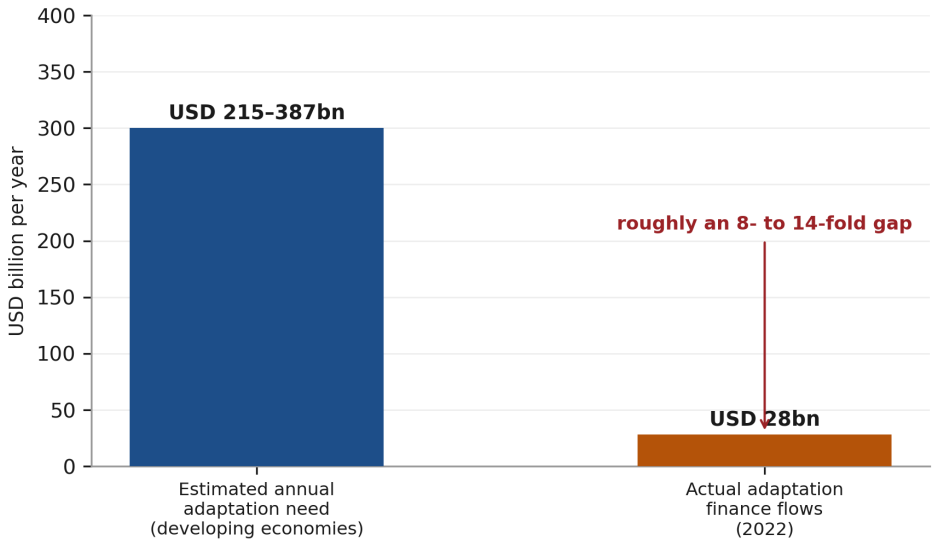


***Figure 4.*** *The adaptation finance gap: estimated annual adaptation needs of developing economies against actual international public adaptation-finance flows.*

UN Environment Programme, Adaptation Gap Report 2024. Needs of roughly US$215–387bn/yr this decade against flows of about US$28bn in 2022.

Taken together, the thin buffer and the high cost of capital define the gap and explain its persistence. But they also point to the remedy. Neither is a fact of nature; both are the products of a financial architecture that can be reformed, and of an investment record that can be changed. The gap is closable — which is what makes the quarter-century to 2050 a genuine window rather than a countdown.

## 5. The Two Engines: Infrastructure and Institutions

> *This section sets out the analytical core of the report. Adaptive capacity is produced by two engines — infrastructure and institutions — that are complements rather than substitutes, and the practical task of building capacity is the task of advancing both together. The framework explains the most common failures of resilience policy and points to the investments that matter most.*

Return to the determinants of adaptive capacity catalogued in Section 2: finance, physical assets, human capital, institutions, social capital, technology. These sort naturally into two families. One is physical — the built systems that give a society the material means to buffer, reroute, and reserve: power, water, transport, digital networks, protective works. Call this the infrastructure engine. The other is organisational — the rules, bodies, budgets, and information systems that decide whether and how those means are used: coordinating agencies, fiscal buffers and contingency finance, early-warning and data systems, social protection, and the state capacity to run them. Call this the institutional engine. Adaptive capacity is what the two engines produce when they run together.

The relationship between them is multiplicative, not additive. Infrastructure supplies the physical potential to act; institutions convert that potential into timely, coordinated action. A flood-control system is only as good as the agency that operates its gates and the warning system that tells people when to move. A fiscal reserve is only as useful as the payment system that can disburse it in days rather than months. A grid is only as resilient as the market and regulatory arrangements that keep power flowing to where it is most needed under stress. Because the product depends on both factors, a large quantity of one cannot compensate for the absence of the other — which is the formal statement of why the two engines must be built together.

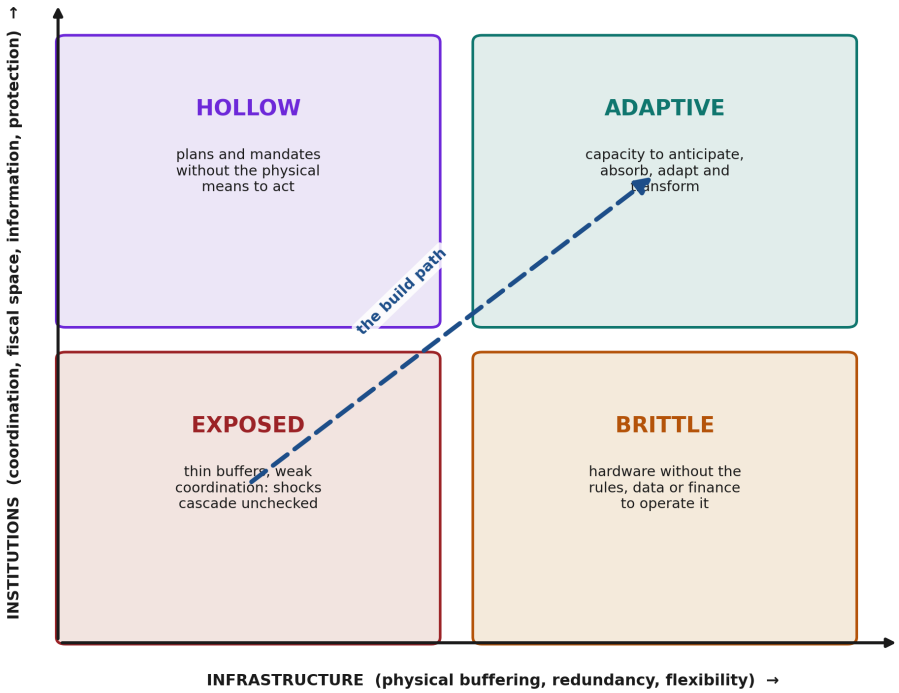


***Figure 5.*** *The two engines of adaptive capacity. Infrastructure and institutions are complements: high provision of one without the other yields brittle or hollow systems, and genuine adaptive capacity lies only where both are built together.*
Framework by the author. The vertical axis is the institutional engine (coordination, fiscal space, information, social protection); the horizontal axis is the infrastructure engine (physical buffering, redundancy, flexibility).

Figure 5 states the framework as a simple two-by-two, and the four quadrants name the four conditions a society can occupy. In the bottom-left is the exposed state: thin infrastructure and weak institutions together, where shocks cascade unchecked because there is neither the physical means to absorb them nor the organisational means to respond. Much of the adaptive-capacity gap of Section 4 lives here. The two off-diagonal quadrants are the instructive failures. In the bottom-right is the brittle state: a society that has built the hardware — dams, grids, hospitals, digital systems — but lacks the institutions to operate, maintain, and finance it, so that the assets underperform, decay, or sit idle in the moment they are needed. In the top-left is the hollow state: a society rich in plans, strategies, mandates, and coordinating committees but without the physical means to act on them, so that its readiness is a paper readiness. Only the top-right quadrant — both engines built — is genuinely adaptive.

The framework's value is that it diagnoses real and common failures. The brittle state is the fate of infrastructure programmes that fund construction but not the operations, maintenance, and institutional arrangements that keep assets useful; the developing world is littered with early-warning equipment that no agency maintains, irrigation schemes with no water-user associations to run them, and power plants stranded by the absence of a functioning utility. The hollow state is the fate of resilience strategies that produce documents rather than defences — national adaptation plans with no capital behind them, disaster agencies with mandates but no equipment, social-protection registries with no funds to disburse. The two failure modes look opposite but share a cause: investing in one engine while neglecting the other. The build path in Figure 5 runs diagonally, and a programme that moves along only one axis does not reach the adaptive corner.

Table 1 makes the complementarity concrete by mapping each engine onto the four functions of adaptive capacity from Section 2. Read across any row, and the point recurs: at every stage in the life of a shock, the physical and the organisational contributions are both necessary and neither is sufficient. Anticipation needs both the sensors and the agency that acts on them; absorption needs both the buffers and the rules that release them; recovery needs both the flexible systems and the finance that funds their repair; transformation needs both the new assets and the governance that reallocates toward them.

**Table 1. The two engines across the four functions of adaptive capacity. At every stage, physical and organisational contributions are complements — both necessary, neither sufficient.**

| Function | Infrastructure engine (physical means) | Institutional engine (organisational means) |
|---|---|---|
| Anticipate | Monitoring networks, sensors, forecasting and data systems, hardened communications | Early-warning agencies, contingency plans, pre-arranged (anticipatory) finance, risk information |
| Absorb | Redundant power, water and transport; reserves and storage; protective works; flexible design | Fiscal buffers, insurance and risk transfer, scalable social protection, emergency coordination |
| Adapt & recover | Modular systems that reroute around failure; rapid-repair capacity; interoperable networks | Fast, flexible finance; clear decision rights; procurement and reconstruction capacity; learning loops |
| Transform | New, relocated or reconfigured assets; diversified energy, water and economic base | Land-use and regulatory reform; long-horizon planning; fiscal reallocation; standards and codes |

The two-engine framework reframes the rest of the report. The financing problem of Section 9 is the problem of funding both engines, not just the visible infrastructure. The investment window of Section 10 is the window in which both can be built ahead of the shocks. And the failure modes of Section 11 are, at bottom, failures of complementarity — of building one engine and calling the job done. The next two sections take each engine in turn.

# 6. Infrastructure for Adaptive Capacity

> *Infrastructure is the physical engine of adaptive capacity: the systems that let a society buffer a shock, reroute around a failure, and keep essential functions running under stress. This section sets out what kind of infrastructure builds capacity — which turns less on the sector than on the design principles of redundancy, modularity, flexibility, and decentralisation — and why the emerging world's coming build-out is the opportunity to embed those principles from the start.*

Not all infrastructure builds adaptive capacity, and some undermines it. A single large power station, a centralised water intake, a lone bridge on a critical corridor: each is efficient in normal times and a single point of failure in a crisis. Infrastructure that builds capacity shares a different set of properties. It is redundant, with spare paths and reserve margins so that the failure of one component does not bring down the system. It is modular, built of units that can be added, repaired, or replaced quickly rather than as monolithic assets that fail whole. It is flexible, able to operate across a range of conditions rather than optimised for one. And it is often decentralised, distributing both the assets and the risk so that a local failure stays local. These principles — not any particular technology — are what distinguish capacity-building infrastructure from the brittle kind.

## 6.1 The systems that matter most

Four infrastructure systems carry most of the weight. Energy comes first, because almost every other system now depends on it: water pumps, hospitals, cold chains, communications, and payments all fail when the power does. Reliable, and increasingly clean and distributed, power is therefore foundational to adaptive capacity — and the shift from a few large fossil plants toward distributed renewables, storage, and interconnected grids happens to align the resilience objective with the decarbonisation one. Distributed solar with storage keeps a clinic's vaccines cold through a grid failure; a diversified, interconnected grid routes power around a damaged line; and clean domestic generation severs the imported-fuel channel through which a distant price shock becomes a local fiscal crisis.

Water is the second system, and the one through which climate change is most directly felt. Infrastructure that stores water against drought, drains it against flood, and delivers it safely against contamination is adaptive capacity in its most literal form — and here the natural and the engineered must work together. Watersheds, wetlands, and mangroves are infrastructure too: they buffer floods, recharge aquifers, and protect coasts at a fraction of the cost of their concrete equivalents, and they strengthen rather than degrade under good management. The third system is digital connectivity and data, the nervous system of modern adaptive capacity: it carries the early warning, enables the targeted payment, coordinates the response, and — through mobile money and digital identity — lets a government reach its citizens in days rather than months. The fourth is transport and logistics, whose redundancy determines whether relief and commerce can route around a damaged corridor or halt at it.

## 6.2 The build-out as an opportunity

The emerging world's decisive advantage is that much of the infrastructure it will operate in 2050 has not yet been built. Africa's urban population is projected to roughly double by mid-century; across the developing world, power systems, water networks, transport corridors, and whole cities are still to be

constructed. This is usually described as a financing burden, and it is one. But it is also the report's central opportunity: infrastructure built now can embed the principles of redundancy, modularity, flexibility, and decentralisation from the outset, at a small premium over the brittle alternative, rather than being retrofitted at great cost after the fact. The advanced economies are largely locked into infrastructure designed for a stationary climate and must pay to unwind it; the emerging world, building fresh, can design for the climate and the risk landscape of the century ahead. Section 10 develops this window and the lock-in that closes it. But the opportunity is real only if the infrastructure engine is built alongside the institutional one — the subject of the next section — because hardware without the institutions to run it is exactly the brittle state the framework warns against.

# 7. Institutions for Adaptive Capacity

> *Institutions are the organisational engine of adaptive capacity: the rules, bodies, budgets, and information systems that convert physical potential into timely action. They are harder to build than infrastructure, easier to neglect, and more decisive under stress. This section sets out the four institutional capabilities that matter most — anticipatory governance, fiscal and financial buffers, adaptive social protection, and the data and state capacity that underpin them all.*

If infrastructure is what a society has, institutions are what it does with it. They are also, for that reason, the harder engine to build and the one more often skipped: a ribbon can be cut on a dam, but not on a functioning disaster-coordination agency or a well-run contingency fund. Yet institutions are what the case studies of Section 12 repeatedly show to be decisive — the reason two countries with similar infrastructure and similar hazards experience such different outcomes. Four institutional capabilities do most of the work.

## 7.1 Anticipatory governance and early warning

The first is the capacity to see a shock coming and to act before it lands. Its infrastructure — sensors, forecasts, communications — is cheap; its institutions are the hard part: the agencies that translate a forecast into a warning, the protocols that pre-authorise action, and, increasingly, the anticipatory finance that releases money on a forecast rather than after a disaster. The payoff is exceptional. The Global Commission on Adaptation found early-warning systems among the highest-return adaptation investments available, with benefit-cost ratios reaching about ten to one, and the WMO's mortality record shows what they buy in lives. The Early Warnings for All initiative, launched in 2022, aims for universal early-warning coverage by 2027 — a target that is, tellingly, as much institutional as technological, since roughly half the world's countries still lack adequate systems.

## 7.2 Fiscal buffers and shock-responsive finance

The second capability is the ability to fund a response without triggering a fiscal crisis. This means pre-arranged financing layered by frequency and severity: reserves and contingency budgets for common events, contingent credit lines for larger ones, and insurance or risk-transfer instruments for the rare and catastrophic. It also means designing debt so that it flexes under stress. Climate-resilient debt clauses — pioneered by Barbados under the Bridgetown Initiative and now spreading to other issuers and to multilateral lenders — pause debt-service payments automatically after a qualifying disaster, freeing cash for response exactly when it is needed. At the multilateral level, the IMF's Resilience and Sustainability Trust offers long-maturity financing for resilience-building, and the Fund for responding to Loss and Damage, operationalised at COP28, is a first attempt at a global backstop. Each is an instrument for holding fiscal buffers a poor country cannot easily hold on its own.

## 7.3 Adaptive social protection

The third capability delivers help to households when a shock hits, and it may be the highest-leverage institution of all. Adaptive social protection — safety-net systems designed in advance to scale up rapidly in response to a shock — lets a government reach affected households in days, preventing the distress sales, school dropouts, and skipped meals through which a temporary shock becomes permanent damage. The

World Bank's work on adaptive social protection documents the model, and its leading examples — Ethiopia's Productive Safety Net Programme, the largest in Africa, and Kenya's Hunger Safety Net Programme, which can scale payments to registered households on a drought trigger — show its power. The institution and the infrastructure are inseparable here: a scalable safety net depends on a digital registry, a payment system, and often mobile money, so that adaptive social protection is precisely a place where the two engines fuse.

## 7.4 Data, coordination, and state capacity

Underlying all three is a fourth, more diffuse capability: the data systems, coordinating arrangements, and basic state capacity without which the others cannot function. A government cannot target relief it cannot see, coordinate a response across ministries that do not talk, or disburse funds through a bureaucracy that cannot execute. Digital public infrastructure — identity, payments, and data-exchange layers — has emerged as a powerful multiplier of this capacity: India's digital stack allowed the government to transfer cash to hundreds of millions of people within weeks during the pandemic, an act of adaptive capacity that would have been impossible a decade earlier. But digital systems only amplify an underlying institutional capability; they do not substitute for it. The unglamorous work of building capable, coordinated, adequately funded public institutions is the deepest and slowest form of adaptive-capacity investment, and the one least served by the project-by-project financing that dominates development. It is also, as the next section argues, what makes the infrastructure engine pay.

## 8. How the Two Engines Reinforce Each Other

> *The report's framework insists that infrastructure and institutions are complements. This section makes the interaction precise: it shows how each engine raises the return on the other, why the highest-value investments strengthen both at once, and what the failure to pair them looks like in practice — the brittle and hollow states made concrete.*

The complementarity runs in both directions. Institutions raise the return on infrastructure: a grid is worth more when a competent regulator and a functioning market keep power flowing under stress; a flood defence is worth more when an agency maintains it and a warning system tells people when to move behind it; a hospital is worth more when it is staffed, supplied, and connected to a referral network. And infrastructure raises the return on institutions: an early-warning agency is worth more when the sensors work and the roads allow evacuation; a social-protection system is worth more when a digital payment rail can disburse it; a contingency fund is worth more when there is resilient infrastructure to rebuild. Each engine is a multiplier on the other, which is why the product — adaptive capacity — collapses when either is missing.

This has a direct implication for where scarce capital should go. The highest-value investments are the ones that strengthen both engines simultaneously — that are, in the report's terms, double-duty. A digital identity-and-payments system is such an investment: it is physical infrastructure that also constitutes an institutional capability, enabling targeted subsidies, rapid transfers, and financial inclusion at once. Distributed clean energy is another: it is hardware that also, by severing the imported-fuel channel, strengthens the fiscal institution. A scalable safety net is a third, fusing a registry and payment rail (infrastructure) with a disbursement rule and a funding mechanism (institution). Investments of this kind climb the diagonal of Figure 5 directly toward the adaptive corner, and they should be the first claim on constrained budgets precisely because they build both engines with one outlay.

The converse — the failure to pair the engines — is visible everywhere in the development record, and it is worth naming concretely because it is the most common and most avoidable waste in resilience spending. The brittle state appears as the early-warning network whose sensors were installed by a donor project and abandoned when the project closed; the irrigation scheme with no water-user association to allocate the water; the fleet of ambulances with no fuel budget; the sea wall with no maintenance line. The hollow state appears as the national adaptation plan with no capital behind it; the disaster agency with a mandate and no equipment; the social registry with no funds to disburse. In each case the failure was not of ambition or even of money in total, but of complementarity — of building one engine and assuming the other would follow. The framework's central practical instruction is to fund the pair, budget for the operations and institutions alongside the asset, and treat a resilience investment as unfinished until both engines are in place.

# 9. Financing Adaptive Capacity to 2050

> *Adaptive capacity that cannot be financed will not be built. This section confronts the financing problem directly: the diffuse, deferred, and partly non-market character of the returns; the cost-of-capital penalty that falls hardest where capacity is scarcest; and the instruments and reforms that could close the gap. The obstacle is real, but it is an obstacle of finance and accounting rather than of underlying value.*

The returns to adaptive capacity are high but awkward. They take the form of avoided losses — disasters that did not happen, crises that did not cascade — which are diffuse, deferred, probabilistic, and largely non-market. A market prices such returns harshly: they accrue to many parties, over long horizons, in the form of events that by construction cannot be observed. This is why adaptive capacity is systematically under-provided even when its benefit-cost ratios are exceptional. Figure 7 assembles those ratios for the principal categories of capacity-building investment. Early-warning systems return up to ten to one; climate-resilient infrastructure and coastal protection reach similar multiples; dryland agriculture, adaptive social protection, and resilient water and sanitation all clear the break-even line comfortably. The Global Commission on Adaptation's headline estimate — that US$1.8 trillion of adaptation investment over 2020–2030 could yield US$7.1 trillion in total net benefits — captures the pattern: the returns are large, and they are left on the table.

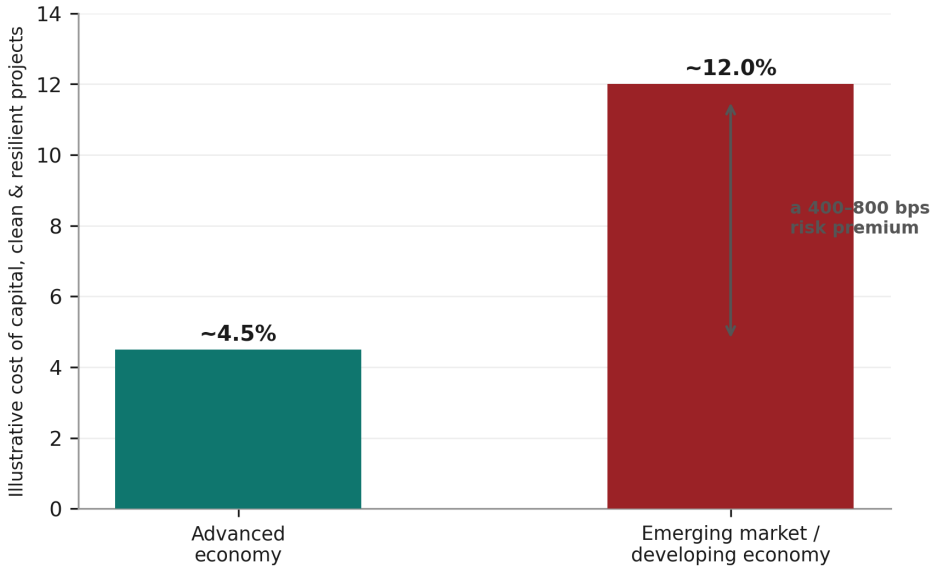


***Figure 6.*** *The cost-of-capital penalty: an identical clean or resilient project typically carries a risk premium of several hundred basis points in an emerging or developing economy over an advanced one, raising the effective cost of capacity-building investment where it is most needed.*

Illustrative, after estimates of the emerging-market cost-of-capital premium for clean and resilient infrastructure (IHLEG; LSE Grantham Research Institute; IEA).

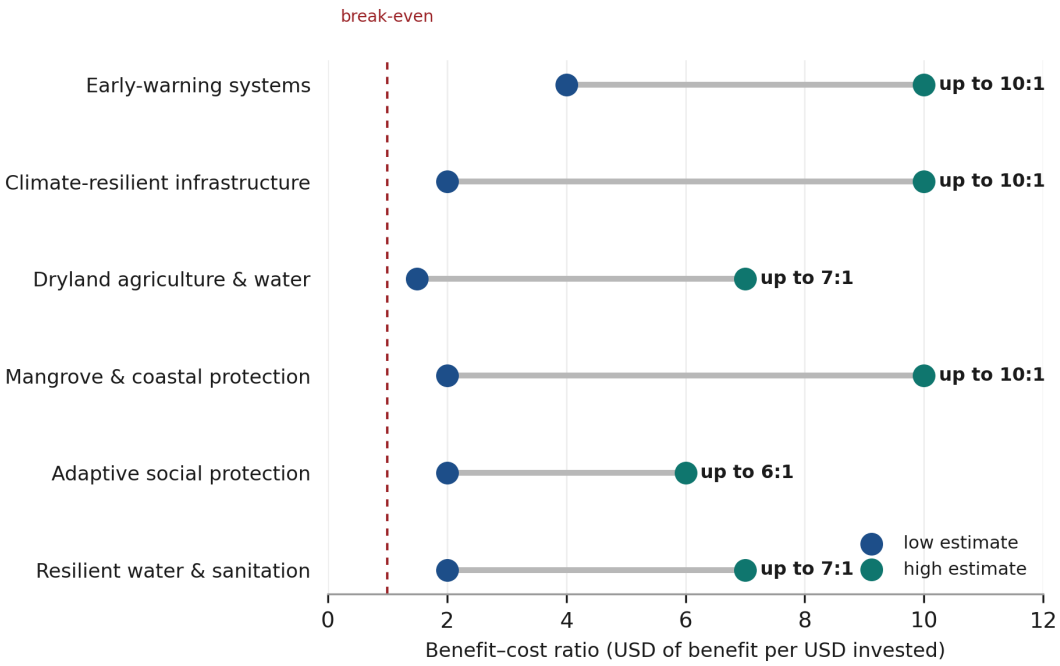


***Figure 7.*** *Benefit-cost ratios of adaptive-capacity investments. Each returns well above break-even; early warning, resilient infrastructure, and coastal protection reach the highest multiples.*

Global Commission on Adaptation, Adapt Now (2019); World Bank, Lifelines (2019). Ranges are indicative and vary by context.

The awkwardness of the returns is compounded by the cost-of-capital penalty introduced in Section 4 and quantified in Figure 6. Because capacity-building investment is upfront-capital-intensive, a higher discount rate falls on it with particular force, and the emerging world's several-hundred-basis-point risk premium can double or triple the effective cost of a resilient project relative to an identical one in an advanced economy. High-return investments are thereby rendered unbankable, not because the returns are absent but because the cost of accessing them is too high — a failure of the financial system rather than of the project.

The remedies follow from the diagnosis, and they operate on both the cost of capital and the accounting of returns. On the cost of capital: concessional and blended finance to buy down the premium; guarantees and first-loss capital to crowd in private investment; local-currency lending to remove the exchange-rate risk that inflates the premium; and reform of the multilateral development banks to expand their lending headroom and their risk appetite. On the fiscal side: debt relief and restructuring to rebuild the space that debt service has consumed, and instruments — the climate-resilient debt clauses, the Resilience and Sustainability Trust, the Loss and Damage Fund of Section 7 — that hold buffers on behalf of countries that cannot hold them alone. And on the accounting: valuing adaptive-capacity investments at their full risk-reduction return across the whole portfolio of shocks they mitigate, rather than against a single objective, so that their exceptional value is visible to the budget process that must approve them.

Table 2 organises the principal instruments by the function they serve, from risk information through risk reduction, retention, and transfer to the reconstruction that follows. The table is a reminder that financing adaptive capacity is not a single instrument but a layered stack, matched to the frequency and severity of the shocks it must meet — frequent, minor events funded from reserves; rare, catastrophic ones transferred to insurance and backstops — with each layer requiring its own institutional home.

**Table 2. Instruments for building and financing adaptive capacity, by function. Financing capacity is a layered stack, not a single instrument, matched to the frequency and severity of shocks.**

| Function | Instruments | What it does |
|---|---|---|
| Risk information | Early-warning systems, risk data and modelling, disclosure standards | Lets governments and investors see and price risk, and act ahead of a shock |
| Risk reduction | Resilient and clean infrastructure, nature-based systems, land-use planning | Lowers the exposure and sensitivity of physical systems before a shock arrives |
| Risk retention | Reserve and contingency funds, contingent credit lines, budget buffers | Funds the response to frequent, lower-severity events without new borrowing under stress |
| Risk transfer | Sovereign and parametric insurance, catastrophe bonds, regional risk pools | Moves the cost of rare, high-severity events off the national balance sheet |
| Shock-responsive support | Adaptive social protection, anticipatory finance, digital payment rails | Reaches affected households quickly, preventing lasting damage to human capital |
| Debt & recovery | Climate-resilient debt clauses, IMF RST, Loss and Damage Fund, restructuring | Preserves fiscal space and funds reconstruction after a shock rather than deepening crisis |

## 10. The Investment Window: Lock-In and the Cost of Delay

> *The report's horizon — before 2050 — is not arbitrary. It is the window in which most of the emerging world's infrastructure and much of its institutional architecture will actually be built, and therefore the window in which adaptive capacity can be designed in cheaply rather than retrofitted at great cost. This section sets out why the window is real, why it is closing, and what delay costs.*

Infrastructure is long-lived. A power plant, a road network, an urban layout, a water system is built once and shapes a society's risk profile for forty to a hundred years. This longevity is the source of both the opportunity and the danger. The opportunity is that the emerging world is at the start of its build-out: because much of the infrastructure it will use in 2050 does not yet exist, the incremental cost of building it to be resilient, redundant, and clean — rather than brittle and carbon-intensive — is small compared with the cost of retrofitting it later. The danger is that the same longevity means that infrastructure built badly now locks in vulnerability for decades: a city laid out in a floodplain, a grid built around a few fossil plants, a water system with no storage will impose their fragility on generations that had no say in the decision.

This is the logic of lock-in, and it inverts the usual framing of the emerging world as a laggard. On adaptive capacity, the emerging world holds an advantage the advanced economies have lost: it is mostly deciding what to build, not unwinding what it already built. The advanced economies are burdened with a stock of infrastructure designed for a stationary climate and a fossil-fuel system, and must pay to strand and replace it. The emerging world, building fresh, can leapfrog the brittle model — as it leapfrogged fixed telephony for mobile — and embed adaptive capacity from the foundation. But the advantage is temporary. Each year of business-as-usual construction pours more concrete into the brittle pattern, and the window in which capacity can be designed in cheaply narrows with every high-carbon plant, unprotected settlement, and centralised system that is built to last.

Figure 8 renders the stakes of the window as two divergent pathways for the emerging world's adaptive capacity to 2050. On the business-as-usual path, capacity erodes: infrastructure is built to the brittle pattern, institutions lag, and the rising frequency of shocks outpaces the slow accumulation of buffers, so that the society becomes progressively less able to meet each successive blow. On the invest-now path — both engines built together, ahead of the shocks — capacity rises steadily, and the gap between the two paths widens into what earlier sections called the capacity dividend: the disasters averted, the crises contained, and the development trajectory protected. The area between the curves is the cost of delay, and it compounds, because capacity built early pays off at every shock in the intervening years while capacity deferred is absent for all of them.

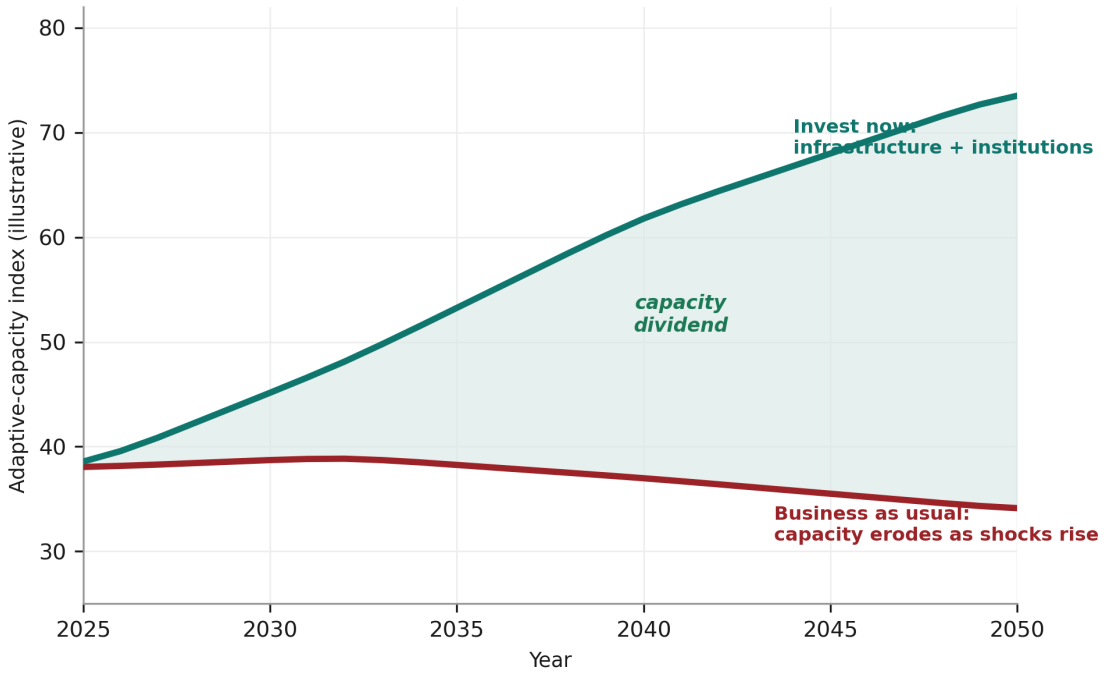


***Figure 8.*** *Two pathways for adaptive capacity to 2050. Investing in both engines now raises capacity ahead of rising shocks; business-as-usual lets capacity erode. The widening gap is the capacity dividend — and the cost of delay.*

Schematic by the author. Trajectories are illustrative, not forecasts, and depict the structure of the lock-in and delay argument developed in the text.

The window has a demographic and an urban dimension that sharpen it further. The emerging world's population and cities will grow most rapidly precisely in the decades to 2050, so the infrastructure and institutional decisions of this window will determine the risk exposure of far larger populations than exist today. Building adaptive capacity ahead of that growth is cheap; retrofitting it into dense, already-built cities is expensive and sometimes impossible. The quarter-century to 2050 is therefore not merely a convenient horizon but the decisive one: the period in which the emerging world's adaptive capacity for the rest of the century is very largely set. The cost of delay is not a delay in benefits but a permanent forfeiture of them, shock after shock, for the life of the assets built wrong.

# 11. Failure Modes: Maladaptation, Unused Capacity, and the Limits of the Argument

> *Intellectual honesty requires the counter-case. Building adaptive capacity is not a guaranteed good: it can be done in ways that entrench vulnerability, waste resources, or benefit the few. This section sets out the principal failure modes — maladaptation, unused capacity, capture, and measurement — and the conditions under which the report's argument does not hold.*

The first failure mode is maladaptation: an investment intended to reduce vulnerability that increases it, often by transferring risk across space or time. A sea wall that protects one stretch of coast can intensify erosion on the next. Irrigation that secures a harvest today can deplete an aquifer and deepen the drought of tomorrow. Air-conditioning that shields the wealthy from heat raises the emissions and the grid load that worsen it for everyone. Maladaptation typically arises from the single-objective myopia the report warns against throughout — optimising for one hazard or one group while ignoring the system — and it is the mirror image of the multiplier logic: just as a well-designed investment reduces several risks at once, a poorly designed one can raise several at once. The remedy is the same in reverse: appraise investments against the whole system and the whole portfolio of risks, not one at a time.

The second failure mode is unused capacity — the brittle and hollow states of Section 5, seen from the perspective of waste. Capacity built but not maintained, staffed, or financed is capacity that will not be there when the shock comes, and the resources spent on it are lost twice: once in the building and again in the false confidence it creates. The early-warning system with dead sensors, the contingency fund that is raided for other purposes, the safety net with no standing finance are all capacity on paper that evaporates under stress. This failure is not an argument against building capacity; it is an argument for building both engines, and for treating operations, maintenance, and institutional arrangements as part of the investment rather than an afterthought.

The third failure mode is capture and inequity. Adaptive capacity, like any valuable asset, can be captured by those with power: flood defences that protect the wealthy district and divert water to the poor one; resilient infrastructure that follows political rather than risk priorities; social protection that reaches the connected rather than the exposed. Because the poor are both the most vulnerable to shocks and the least able to command capacity, resilience investment that is blind to distribution can widen the very gap it claims to close. Building adaptive capacity equitably — targeting the most exposed, and designing institutions that are accountable to them — is not an add-on to the agenda but a condition of its success, since a society whose capacity is captured by the few remains, as a whole, exposed.

The fourth difficulty is measurement, and it shadows the whole enterprise. The return on adaptive capacity is an avoided loss, and an avoided loss is, by construction, unobservable: one cannot point to the disaster that did not happen. This makes capacity hard to justify against interventions with visible, attributable outputs, and it biases budgets toward the tangible and against the preventive. The report's response is to measure capacity by its determinants — the infrastructure and institutions that produce it, which are observable and investable — rather than by outcomes that cannot be seen. But the difficulty is genuine, and it is one reason adaptive capacity is chronically under-funded even where its value is understood.

Finally, the limits of the argument. Adaptive capacity is not limitless. The IPCC distinguishes soft limits to adaptation — set by a shortage of finance, institutions, or political will, and therefore removable — from

hard limits, set by physics, beyond which no capacity suffices and only loss remains. Much of the emerging world's predicament lies at the soft limits, which is precisely why this report is optimistic: those limits can be pushed back by the investments it describes. But hard limits are real and approaching for some systems and some places — low-lying islands, glacier-fed rivers, the hottest and most humid regions — and for them, adaptive capacity must be paired with mitigation to hold the hazard down and with loss-and-damage arrangements for what cannot be adapted to. Adaptive capacity is the central lever of this century, but it is not the only one, and honesty about its limits is part of using it well.

## 12. Country Experience

> *The argument is general; the evidence is specific. This section grounds the two-engine framework in real programmes, chosen because each shows infrastructure and institutions working together — or reveals what happens when one outruns the other. The cases are drawn from across the emerging world and span the four functions of adaptive capacity.*

The clearest demonstration is Bangladesh, whose transformation of cyclone mortality is the emerging world's outstanding adaptive-capacity success. The 1970 Bhola cyclone killed on the order of 300,000 people; the 1991 cyclone around 138,000; by the 2020s, storms of comparable power were killing in the dozens or low hundreds. The change was not in the weather but in the capacity, and it was built from both engines at once: infrastructure in the form of thousands of raised cyclone shelters and coastal embankments, and institutions in the form of the Cyclone Preparedness Programme — a standing network of tens of thousands of trained volunteers who carry warnings the last mile and manage evacuations. Neither engine would have sufficed alone: shelters without a warning-and-evacuation system would have stood empty, and warnings without shelters would have had nowhere to send people. Together they turned a mass-casualty hazard into a survivable one.

Kenya illustrates the institutional engine, and specifically adaptive social protection fused with digital infrastructure. The Hunger Safety Net Programme maintains a registry of vulnerable households in the country's arid north and can scale cash payments to them on a drought trigger, reaching people before a poor rains becomes a famine. Its power depends on infrastructure the country built for other reasons — the near-ubiquitous M-Pesa mobile-money system, which makes it possible to disburse funds to remote households in hours rather than weeks. The combination is a template for the emerging world: a standing institution (the scalable safety net) riding on a piece of digital infrastructure (mobile payments), each amplifying the other, delivering anticipation and absorption at once.

Morocco and Vietnam show the infrastructure engine building capacity through the energy system. Morocco, importing the overwhelming majority of its energy, treated renewable power — the Noor solar complex, large-scale wind — as an act of national security as much as decarbonisation, severing the imported-fuel channel through which a distant price shock becomes a domestic fiscal crisis. Vietnam's rapid solar scale-up served a similar double purpose alongside the resilience of its exposed river deltas. In both cases clean infrastructure did double duty: meeting a development need while strengthening the fiscal institution against an external shock — an illustration of the double-duty investments Section 8 identified as the highest-value use of scarce capital.

Barbados and Rwanda round out the set on the institutional side. Barbados, through the Bridgetown Initiative, pioneered the climate-resilient debt clause — an institutional innovation that pauses debt service after a qualifying disaster, holding fiscal space open exactly when a shock would otherwise close it — and has pushed the reform into the wider financial architecture. Rwanda built its coordinating institution in advance: FONERWA, its national environment and climate fund, channels and coordinates resilience finance across ministries, an example of the anticipatory, cross-silo governance that interconnected risk demands. Table 3 summarises the cases against the framework, and the pattern across them is consistent: capacity was built, deliberately and in advance, from both engines together, and it paid off when the shock arrived.

**Table 3. Country experience against the two-engine framework. In each case, adaptive capacity was built from infrastructure and institutions together, ahead of the shock.**

| Country | Principal shock | Infrastructure + institution combination | Outcome |
|---|---|---|---|
| Bangladesh | Tropical cyclones | Cyclone shelters and embankments + Cyclone Preparedness Programme volunteer warning network | Cyclone mortality cut from ~300,000 (1970) to dozens–hundreds |
| Kenya | Drought | M-Pesa mobile-money rails + Hunger Safety Net Programme scalable cash transfers | Households reached before drought becomes famine |
| Morocco | Energy-price / import shock | Noor solar and wind capacity + energy-security strategy severing the fuel-import channel | Reduced fiscal exposure to imported-fuel price shocks |
| Vietnam | Energy & delta flooding | Rapid solar scale-up + delta water-management and planning institutions | Diversified supply; managed exposure of exposed deltas |
| Barbados | Hurricanes / debt | Resilient public assets + climate-resilient debt clauses (Bridgetown Initiative) | Fiscal space preserved through disaster; reform diffused globally |
| Rwanda | Multiple / climate | Resilience investments + FONERWA national climate fund coordinating across ministries | Cross-silo coordination built ahead of shocks |

# 13. Conclusion: An Agenda for Building Adaptive Capacity Before 2050

> *The report's argument can be put in a sentence: in a world of interconnected shocks, the decisive development variable is adaptive capacity, and adaptive capacity is built by advancing infrastructure and institutions together, before the shocks arrive, in the window that closes at mid-century.*

The case rests on a chain of claims the report has tried to establish. Risk has become interconnected, so that shocks cascade across systems and the quality that determines outcomes is a society's general capacity to meet whatever arrives rather than its defences against any particular hazard. The emerging world holds too little of that capacity, combining high vulnerability with low readiness, thin fiscal buffers, and a punishing cost of capital. Adaptive capacity is produced by two engines — physical infrastructure and organisational institutions — that are complements, so that building one without the other yields brittle or hollow systems and only building both together yields genuine capacity. The returns to building it are exceptional but diffuse, deferred, and hard to see, which is why it is under-provided even where it would pay for itself many times over. And the quarter-century to 2050 is the window in which the emerging world's capacity for the century will very largely be set, because that is when its infrastructure and institutions will actually be built.

From this, an agenda follows. Build both engines together: fund the operations, maintenance, and institutions alongside every asset, and treat a resilience investment as unfinished until both are in place. Prioritise the double-duty investments — digital public infrastructure, distributed clean energy, adaptive social protection — that strengthen infrastructure and institutions with a single outlay and climb the diagonal toward the adaptive corner directly. Fix the financing: buy down the cost-of-capital penalty with concessional and blended finance, guarantees, and local-currency lending; rebuild fiscal space through debt relief and instruments that hold buffers on countries' behalf; and reform the multilateral banks to lend more, and more cheaply, for capacity. Change the accounting: value capacity investments at their full risk-reduction return across the whole portfolio of shocks they mitigate, so that their exceptional worth is visible to the budgets that must approve them. And design for equity and against maladaptation, targeting the most exposed and appraising every investment against the whole system rather than one hazard at a time.

Move early. The single most important message of the report is about timing. Adaptive capacity built in advance pays off at every shock in the years that follow; capacity deferred is absent for all of them, and the infrastructure built wrong in the meantime locks in vulnerability for decades. The cost of delay is not a postponement of benefits but a permanent forfeiture, compounding shock after shock for the life of the assets. The window to build cheaply is open now, while the emerging world is still deciding what to construct, and it narrows with every year of business-as-usual.

The report closes where it began, with the nature of the risk. The dangers facing the emerging world are increasingly interconnected, and no wall, forecast, or reserve built for a single hazard will hold against a cascade. What holds is capacity — the standing, general ability to anticipate, absorb, adapt, and transform — and that capacity is not given by geography or fixed by fate. It is built, from infrastructure and institutions, by choice, in time. Building it across the emerging world before 2050 is the most consequential investment in human security available this century, and the accounting, the finance, and the design to make it are within reach. What remains is to build both engines, and to begin while the window is open.

# References and Further Reading

### Adaptive capacity, resilience, and risk framing

Intergovernmental Panel on Climate Change (2022), Sixth Assessment Report, Working Group II: Impacts, Adaptation and Vulnerability — hazard × exposure × vulnerability; adaptive capacity; soft and hard limits to adaptation.

C.S. Holling and the socio-ecological resilience tradition; Carl Folke and colleagues on resilience, adaptability, and transformability in social-ecological systems, Stockholm Resilience Centre.

World Economic Forum, Global Risks Report — the interconnection of global risks.

Notre Dame Global Adaptation Initiative, ND-GAIN Country Index — vulnerability and readiness.

### The hazard record and the value of early action

World Meteorological Organization (2021), Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2021) — disasters up ~5x, losses up ~7x (US$4.3tn), deaths down through early warning.

World Meteorological Organization and partners, Early Warnings for All — universal early-warning coverage by 2027.

### The returns to adaptation and resilient infrastructure

Global Commission on Adaptation (2019), Adapt Now: A Global Call for Leadership on Climate Resilience — US$1.8tn → US$7.1tn net benefits; benefit-cost ratios of 2:1 to 10:1.

World Bank (2019), Lifelines: The Resilient Infrastructure Opportunity — roughly US$4 of benefit per US$1 of resilient-infrastructure investment.

World Bank, Adaptive Social Protection: Building Resilience to Shocks.

### Finance, debt, and the financing gap

UN Environment Programme (2024), Adaptation Gap Report 2024: Come Hell and High Water — needs of ~US$215–387bn/yr against flows of ~US$28bn (2022).

UNCTAD (2025), A World of Debt — US$11.4tn developing-country external debt; US$921bn net interest (2024); 3.4bn people.

International Monetary Fund, Resilience and Sustainability Trust.

The Bridgetown Initiative and climate-resilient debt clauses; UNFCCC, Fund for responding to Loss and Damage.

International Energy Agency (2025), World Energy Investment 2025 — clean investment ~2x fossil, concentrated in advanced economies and China.

### Infrastructure, energy access, and the build-out

IEA, IRENA, UNSD, World Bank, WHO (2025), Tracking SDG 7: The Energy Progress Report.

World Bank and African Development Bank, Mission 300: Energizing Africa — electricity access for 300 million Africans by 2030.

World Bank, Digital Public Infrastructure — identity, payments, and data-exchange layers as adaptive-capacity multipliers.

### A note on figures and estimates

Figures 1, 2, and 5 are conceptual schematics that render the report's framework rather than plot data. Figure 3's regional positions are stylised for exposition after the ND-GAIN framework, not precise index values. Figure 8's trajectories are illustrative of the lock-in and cost-of-delay argument, not forecasts. Figures 4, 6, and 7 present values reported by the cited primary sources — the UNEP Adaptation Gap Report 2024, estimates of the emerging-market cost-of-capital premium, and the benefit-cost ratios compiled by the Global Commission on Adaptation and the World Bank. Benefit-cost ranges are indicative and vary widely by context. Every quantitative claim in the text is attributed inline to a primary or authoritative secondary source. The report is analytical rather than predictive.