

H HEURISTICS

Navigating a Changing World

The Cascading Risk Atlas

Mapping How Local Shocks Become Global Crises

Nodes, channels, amplifiers and circuit-breakers, with the 2026 Strait of Hormuz crisis as a live case

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Abstract

A local shock becomes a global crisis when it reaches a concentrated dependency, travels through channels that are coupled to one another, and meets buffers that are too thin to absorb it. The war that began on 28 February 2026 is the clearest live demonstration since the pandemic. Daily transits of the Strait of Hormuz, through which about 20 million barrels of oil a day passed in 2025, fell from 68 in January and February to 3.6 in September. Brent crude rose from a monthly average of US\$71 in February to US\$120 in April, European gas more than doubled, and urea rose 82 per cent to its April peak. The International Energy Agency describes the disruption as the largest in the history of the oil market.

This report proposes a five-stage grammar for cascades, covering trigger, node, channel, amplifier and manifestation, and uses it to build an atlas. The atlas has a gazetteer of ten global nodes, a taxonomy of seven transmission channels and twelve historical plates, from the Suez blockage of 2021 and the Thai floods of 2011 to the 2008 financial crisis, COVID-19 and the 2024 software outage. A stylised network model, with results labelled as illustrative, shows that the severity of a cascade is governed by buffers and structure and not by the size of the initial shock. In the model, a change in tolerance from 0.25 to 0.35 moves the failed share of a network from 100 per cent to under 1 per cent, hub-and-spoke networks need larger buffers than random ones, and a moderate degree of cross-sector coupling is the most dangerous.

The evidence from 2026 shows cascades running at different speeds. Oil and gas moved in days; fertiliser, jet fuel and aluminium in weeks; food, growth and debt over months. After the 2022 invasion of Ukraine the FAO Food Price Index jumped 13 per cent in a month and then fell. After the Hormuz war it rose 8 per cent in seven months and is at its highest since November 2022. The burden falls unevenly: the IMF estimates that emerging markets outside China lose 1.3 percentage points of 2026 growth in its adverse scenario against 0.6 for advanced economies, and developing countries paid out US\$741 billion more on external debt than they received in new financing in 2022 to 2024.

The report ends with ten pathways to the next cascade, a four-part circuit-breaker design covering prevention, containment, absorption and recovery, a division of tasks among governments, firms, financial institutions and multilateral bodies, and a ten-indicator dashboard. The task is to map the nodes, size buffers to the node and not the average, and agree the rules before the trigger.

Keywords: cascading risk; systemic risk; supply chains; chokepoints; Strait of Hormuz; network contagion; resilience; polycrisis; critical minerals; food security; sovereign debt

JEL classification: D85, F51, F60, G01, Q34, Q41; network formation and analysis; international conflicts; globalization; financial crises; resource and energy markets

Data and method: This report synthesises institutional and peer-reviewed research available to 19 October 2026. Series are drawn from IMF PortWatch (daily chokepoint transits to 11 October 2026), the World Bank Pink Sheet (monthly prices to September 2026), the FAO Food Price Index, the New York Fed Global Supply Chain Pressure Index and World Bank World Development Indicators, all accessed 19 October 2026. Several 2026 figures are preliminary. Figures 3 and 4 are outputs of a stylised model, and Figures 7 and 15 and the alert levels in Table 8 are H Heuristics judgement. They are not estimates.

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Key Findings

A local shock becomes a global crisis when it reaches a concentrated dependency, travels through channels that are coupled to one another, and meets buffers that are too thin to absorb it. The 2026 Hormuz crisis is the clearest live demonstration of that sequence since the pandemic.

- **Cascades have a repeatable grammar.** Every case in this atlas follows five stages: a trigger, a node where dependence is concentrated, one or more transmission channels, amplifiers that magnify the signal, and a global manifestation. Mapping a risk to these stages is more useful than ranking triggers by size.
- **Concentration at the node matters more than the size of the trigger.** About 20 million barrels of oil a day, roughly a quarter of seaborne oil trade, passed through the Strait of Hormuz before the war that began on 28 February 2026. [Daily vessel transits](#) fell from 68 in January and February to 3.6 in September. The [IEA](#) calls it the largest oil supply disruption on record.
- **Buffers decide whether a shock stays local.** In the H Heuristics stylised model, a change in node tolerance from 0.25 to 0.35 moved the failed share of the network from 100 per cent to under 1 per cent in a random network. In a hub-and-spoke network the same loss of the three largest suppliers still failed 57 per cent of nodes at 0.35, and needed a buffer near 0.40 to be contained.
- **Intermediate coupling is the most dangerous.** When the model's modules shared 20 per cent of supply links, a shock confined to one module brought down 83 per cent of the rest of the network at a moderate buffer. At 0 per cent coupling the shock stayed contained, and at 50 per cent it fell to 21 per cent because supply was diversified.
- **Cascades run at different speeds, and the slow ones reach the poor.** Brent crude rose from a monthly average of US\$71 in February 2026 to US\$120 in April. The FAO Food Price Index, by contrast, rose only 8 per cent in the seven months to September, but in a [steady climb](#) that had taken it to its highest level since November 2022. After Russia's 2022 invasion of Ukraine the index jumped 13 per cent in a month and then fell back.
- **The people least able to absorb a cascade absorb the most of it.** The [IMF](#) estimated that, in its adverse scenario, emerging markets outside China lose 1.3 percentage points of 2026 growth against 0.6 for advanced economies. Developing countries paid out [US\\$741 billion](#) more on external debt than they received in new financing in 2022-24.
- **Circuit-breakers work, and they are cheap relative to the harm.** The IEA's 400-million-barrel stock release, agreed within two weeks, together with rerouting, demand cuts and non-Gulf supply, offset a large part of the lost flow. Where buffers existed they were used. Where they did not, as with diesel, jet fuel and fertiliser, the cascade went on.
- **The next plates are already visible.** China's expanded rare earth export controls are suspended only until November 2026. The Panama Canal has again tightened draft limits as El Niño develops. The IMF names an artificial intelligence valuation correction as a downside risk. Section 12 maps ten pathways, four of them with potential to cascade globally, and Sections 13 and 14 set out circuit-breakers, a division of tasks and a ten-indicator dashboard.

1. Introduction: A Strait and a System

On 27 February 2026, 64 vessels crossed the Strait of Hormuz. On 2 March, four did. Within weeks the loss had reached gas markets in Europe and Asia, fertiliser markets in every farming region, aluminium smelters, jet fuel buyers and finance ministries that had never planned for it. This report maps how a local shock becomes a global one, and what can be done to interrupt the journey.

The war that began on 28 February 2026 is, at the time of writing, the largest live test of the modern global economy's capacity to absorb a shock at a chokepoint. According to the [International Energy Agency](#), an average of 20 million barrels a day of crude oil and products transited the strait in 2025, about a quarter of world seaborne oil trade, and export volumes had fallen below 10 per cent of their pre-conflict level by 11 March. The agency later described the disruption as the largest in the history of the oil market and put [cumulative lost supply](#) at more than 1.3 billion barrels by late June. The [World Bank's commodity price data](#) show the consequences travelling outward: Brent crude averaged US\$71 a barrel in February, US\$120 in April and US\$117 in September; European gas more than doubled between February and September; urea rose 82 per cent to its April peak.

The same data also show something less obvious. Urea has since fallen back to about 14 per cent below its February price. Food prices have risen slowly rather than spiked. Container freight rates, according to [Drewry](#), had been falling for thirteen consecutive weeks on Asia-Europe routes before they ticked up in mid-October. A cascade is not a single wave. It is a set of waves moving at different speeds through different channels, some of which have already crested while others have barely begun. Understanding why requires a map.

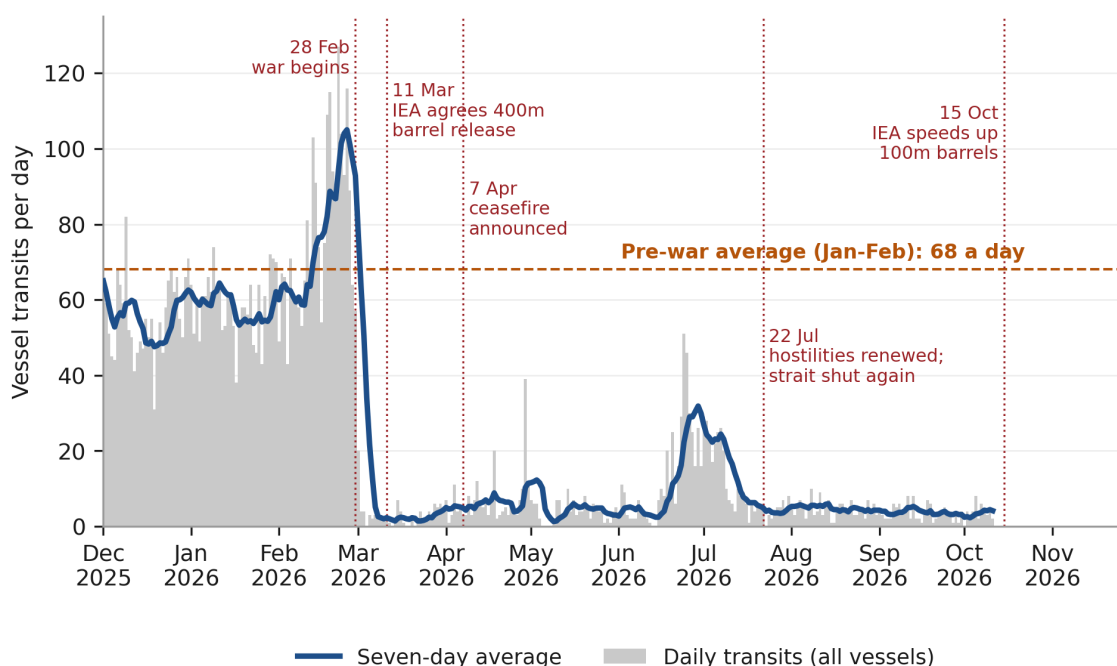


Figure 1. Daily vessel transits of the Strait of Hormuz, December 2025 to 11 October 2026.

Source: IMF PortWatch (accessed 19 October 2026), all vessel types; H Heuristics calculations. PortWatch counts vessels detected by satellite-linked tracking; ships that switch off transponders, which the IEA reports some Gulf exporters have done, are not captured. Event dates are from the IEA, Kpler and the sources cited in Section 6.

Hormuz is not an exception. In March 2021 a single grounded container ship blocked the Suez Canal for six days. In 2011 floods in Thailand disrupted the global supply of hard disk drives for the better part of a year. In 2024 a faulty software update crashed 8.5 million computers in a morning. The failure of one investment bank in 2008 was followed by a 12 per cent fall in world trade volume in 2009, and the spread of one virus by a 5 per cent fall in 2020. The details differ. The structure does not.

1.1 What this report argues

Four claims run through what follows. First, that cascades have a grammar: a trigger, a node, a channel, an amplifier and a manifestation. Describing a risk in those terms, rather than by the size or probability of its trigger, tells a decision-maker where to intervene. Second, that the severity of a cascade is governed more by the concentration of the node and the thickness of the buffers downstream than by the magnitude of the initial shock. Third, that cascades run at several speeds at once, and that the slowest, through food, debt and public finance, are the ones that reach the poorest households and countries. Fourth, that circuit-breakers exist, work, and cost little relative to the harm they prevent, but have to be in place before the trigger.

The report calls the resulting framework *the cascading risk atlas*. It is an atlas in the sense that it is a collection of maps: of nodes (Section 4), of channels (Section 5), of twelve historical cascades presented as plates (Sections 6 to 9), and of pathways that could become the next plate (Section 12). Like any atlas it simplifies. Its aim is to let a reader find their position on the map and see what lies upstream and downstream of it.

1.2 Scope, evidence and limits

The report synthesises institutional and peer-reviewed research available to 19 October 2026, drawing on the IEA, the U.S. Energy Information Administration, the World Bank, the International Monetary Fund, the Food and Agriculture Organization, UNCTAD, the WTO, the Federal Reserve Bank of New York, the Semiconductor Industry Association and industry data from Kpler, Synergy Research Group and the International Cable Protection Committee. Time series are drawn directly from public sources: daily chokepoint transits from [IMF PortWatch](#), monthly commodity prices from the World Bank's Pink Sheet (updated 2 October 2026), the [FAO Food Price Index](#), the New York Fed's [Global Supply Chain Pressure Index](#) and the World Bank's World Development Indicators.

Three cautions apply. First, the Hormuz crisis is unfinished and its reporting is moving: several 2026 figures are preliminary, sources sometimes conflict, and where they do the report says so. Second, two of the figures are products of H Heuristics modelling or judgement and are labelled as such: Figures 3 and 4 are outputs of a stylised network model, and Figures 7 and 15 place phenomena on axes by judgement. Third, the historical plates rest on published estimates whose methods vary, and several loss figures are gross values of goods delayed rather than measured economic losses. Section 15 returns to these limits.

1.3 How to read the atlas

Each plate follows the same layout: what triggered the cascade, which node it reached, which channels carried it, what amplified it, how it showed up globally, and what interrupted it, if anything did. Section 10 then compares the plates. Readers interested mainly in policy can move from Section 6 to Sections 13 and

14, which set out the circuit-breaker design and the division of tasks. Readers interested mainly in method will want Sections 2 and 3.

2. Anatomy of a Cascade

A cascade is not a large shock. It is a small or medium shock that finds a path along which each step triggers the next, so that the harm at the end of the chain is larger than, and far from, the event that started it.

2.1 Cascades, contagion and coincidence

Language in this field is loose, and the looseness causes errors in policy. Four phenomena are often conflated. A *cascade* is a sequence in which the failure or distress of one element causes the failure or distress of the next through a dependence between them. *Contagion* is the spread of behaviour, such as panic, imitation or loss of confidence, between elements that may not depend on one another materially. A *common-cause* shock hits many elements at once, as a heat wave does; the correlation in outcomes comes from the shared cause and not from dependence between the elements. A *compound* shock is the coincidence of independent shocks that happen to overlap in time. Real episodes mix all four. The 2026 Hormuz crisis contains cascades (lost Gulf output propagating to refiners and then fuel buyers), contagion (panic buying and precautionary hoarding), a common cause (the closure itself affecting oil, gas, sulphur and aluminium simultaneously) and compounding (an energy shock arriving at a time of high debt and stalled disinflation).

The distinction matters because the remedies differ. Cascades are interrupted by breaking the dependence: a substitute supplier, a stockpile, a firebreak. Contagion is interrupted by information and credible commitment, such as a central bank swap line. Common-cause shocks are managed by diversifying exposure across causes. Compound shocks are managed by keeping reserves large enough that no single shock uses them all. A strategy that treats a cascade as contagion, or the reverse, will spend its resources in the wrong place. The literature on the [causal mechanisms of crisis entanglement](#) by Lawrence, Homer-Dixon, Janzwood and colleagues makes the same point from the study of polycrises: crises are entangled through identifiable mechanisms, and naming those mechanisms is a precondition for acting on them.

2.2 Five stages

Every cascade in this atlas passes through five stages, shown in Figure 2.

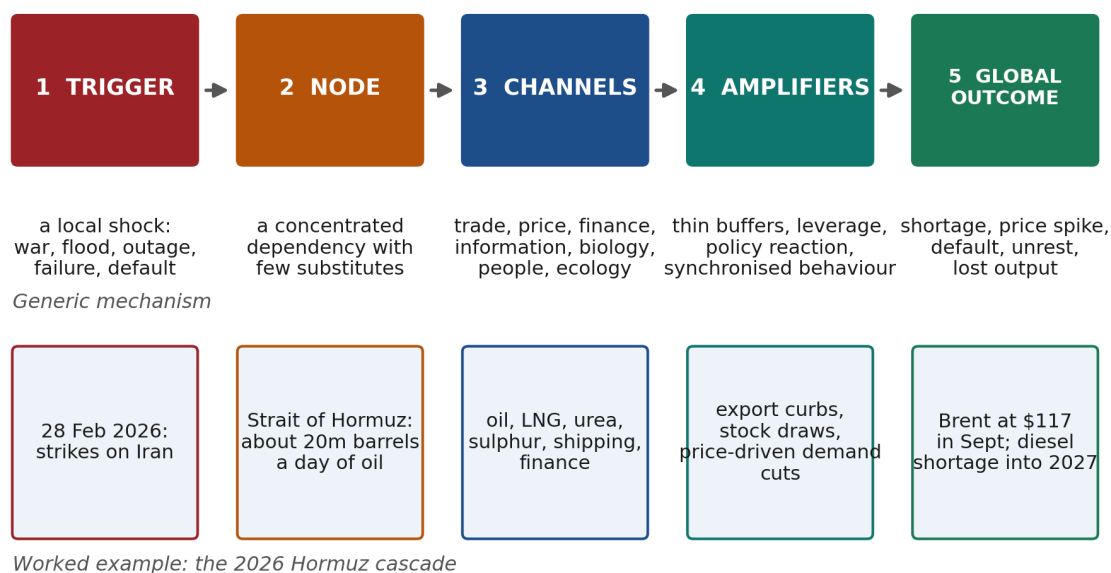


Figure 2. The five stages of a cascade, with the 2026 Hormuz crisis as a worked example.

Source: H Heuristics framework. Worked-example values: IEA (11 March and 22 June 2026), World Bank Pink Sheet (September 2026 Brent average of US\$116.8), IEA Oil Market Report via gCaptain (16 October 2026).

The *trigger* is the local event: a strike, a flood, a software update, a default. Triggers differ enormously in kind and the atlas does not rank them. The *node* is the point at which dependence is concentrated and substitutes are few: a strait, a plant, a protocol, a bank. A trigger that does not reach a node usually stays local. The *channels* are the routes along which the disturbance travels onward, and Section 5 identifies seven. The *amplifiers* are properties of the system that increase the magnitude or speed of the signal as it travels: thin buffers, leverage, policy reactions that spread rather than contain the shock, and the synchronised behaviour of many actors responding to the same signal. The *manifestation* is where harm becomes visible at global scale: a price spike, a shortage, a default, a recession, unrest.

A useful property of the five-stage view is that it separates what can be known in advance from what cannot. Nodes can be mapped before a trigger arrives; the Strait of Hormuz was a node long before 28 February 2026. Channels can be traced and buffers can be measured. What cannot be known is the identity and timing of the trigger. A risk strategy built on predicting triggers fails by construction. A strategy built on the nodes, channels and buffers does not need to.

2.3 Three shapes

Cascades take three recurring shapes. In a *chain*, harm passes from one element to the next in sequence: the fire at a single chip supplier halts an automaker's line, which halts its dealers' deliveries. In a *fan*, a single node feeds many others, and its failure strikes all of them at once: Hormuz supplies oil, gas, sulphur, aluminium and petrochemical feedstocks to dozens of downstream sectors. In a *loop*, the consequence feeds back into the cause: high energy prices raise inflation, which raises interest rates, which raises the cost of the debt used to import energy. Chains are the easiest to see and, usually, the easiest to interrupt. Fans are the most dangerous at the moment of impact. Loops are the hardest to stop once started, and the most likely to turn a recoverable shock into a lasting one.

Table 1. Vocabulary of the atlas.

Term	Meaning in this report	Example from the 2026 Hormuz plate
Trigger	The local event that starts the sequence	Strikes on Iran, 28 February 2026
Node	A point of concentrated dependence with few substitutes	The strait: about 20 million barrels a day of oil, about a fifth of world LNG trade
Channel	A route along which disturbance travels onward	Energy prices; fertiliser trade; shipping insurance; sovereign borrowing costs
Buffer	Stock, spare capacity, substitute or financing that absorbs a shock	IEA emergency stocks of more than 1.2 billion barrels; Saudi and UAE bypass pipelines
Amplifier	A property that magnifies the signal in transit	Thin diesel and jet fuel inventories; export restrictions; leverage in importing countries
Manifestation	The global symptom	Brent above US\$115 in September; food index at a near four-year high; downgraded growth

Source: H Heuristics. Example data: IEA, EIA, World Bank, FAO.

3. What Network Science Teaches

A body of research across physics, economics and finance reaches a consistent conclusion: whether a shock cascades depends less on how large it is than on how the system is wired, and how much slack it carries.

3.1 Five findings from the literature

The first finding is that cascades have thresholds. In his [model of global cascades on random networks](#), Duncan Watts showed that when each element fails once a fraction of its neighbours has failed, a system can be stable against almost every initial shock yet occasionally suffer a system-wide collapse from a trivial one, and that cascades occur only within a window of connectivity: too sparse and the shock cannot spread, too dense and each element is protected by the number of its neighbours. The second finding is that the target matters. [Motter and Lai](#) showed that networks with heterogeneous loads can be robust to random failures yet brought down by the removal of a small number of heavily loaded nodes, a property [Carlson and Doyle](#) called robust-yet-fragile. A world that has survived thousands of random disruptions can still be broken by one aimed at the right node, or by one that happens to land there.

The third finding is that interconnection is double-edged. [Acemoglu, Ozdaglar and Tahbaz-Salehi](#) showed that in financial networks, dense interconnection stabilises the system against small shocks, by spreading losses across many holders, but amplifies large ones, once spreading exceeds the capacity of the holders to absorb. [Haldane and May](#) drew an analogy with ecosystems and epidemics to argue that complexity and interconnection in banking had outrun the understanding needed to manage them. The fourth finding is that coupling between networks is more dangerous than connectivity within them. [Buldyrev and colleagues](#) showed that when two networks depend on each other, such as a power grid and its communications network, the coupled system collapses more readily and more abruptly than either alone, because failures can bounce between layers. [Helbing](#) applied the argument to global risk, warning that a hyperconnected world can generate cascading failures that no single actor controls.

The fifth finding is empirical. [Carvalho, Nirei, Saito and Tahbaz-Salehi](#) used the 2011 Great East Japan Earthquake to show that disruption propagated both upstream and downstream along Japanese supply chains, reaching the direct and indirect suppliers and customers of firms in the disaster area, and estimated that the earthquake and its aftermath reduced Japan's real GDP growth by 0.47 percentage points in the following year. [Barrot and Sauvagnat](#) found that natural disasters hitting suppliers of specific, hard-to-substitute inputs cut the sales of their customers, whereas disasters hitting suppliers of generic inputs did not. Taken together with the theory, the evidence says that the properties that matter are concentration, specificity and coupling. [Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi](#) show why such properties matter at the macro level: when a few suppliers dominate the network, shocks to individual firms do not average out and can drive aggregate fluctuations.

3.2 An atlas model

To make these ideas concrete, H Heuristics built two stylised experiments. They are illustrations of mechanism and are not estimates of any real system. Each uses a network of 1,500 nodes in which every node depends on three or more suppliers and fails when the share of its failed suppliers reaches its own

threshold. The threshold is the node's buffer: a higher value means the node tolerates more lost supply before failing. Thresholds vary randomly by plus or minus 0.1 around the value shown on each axis.

In the first experiment, three network structures are compared: a random network, a hub-and-spoke network in which half the links attach preferentially to already well-connected suppliers, and a modular network of ten loosely linked blocks. Two shocks are applied to each: the failure of one random node, and the simultaneous failure of the three largest suppliers. Results, averaged over 40 networks per structure, are in Figure 3.

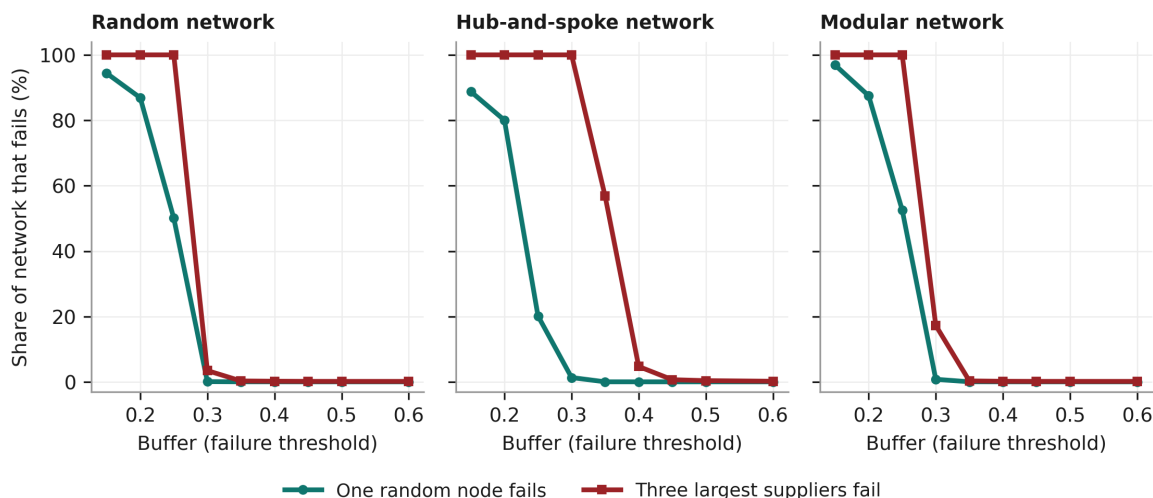


Figure 3. Share of the network that fails, by buffer, network structure and type of shock.

Source: H Heuristics stylised model (results.json, seed 20261019); 1,500 nodes, 40 networks per structure. Illustrative: not an estimate of any real system.

Three results stand out. First, the transition is sharp. In every structure, the failed share falls from near 100 per cent to near zero across a span of 0.05 to 0.10 in the buffer. In the random network, the loss of the three largest suppliers fails 100 per cent of nodes at a threshold of 0.25 and 3.5 per cent at 0.30. Small differences in tolerance therefore separate a contained shock from a total one. Second, hubs raise the buffer required. In the hub-and-spoke network, a random single failure is harmless above 0.30 (1.4 per cent at 0.30, 0.1 per cent beyond), but removing the three largest suppliers fails 100 per cent of nodes at 0.30, still 57 per cent at 0.35, and is not contained until about 0.40. A system that looks safe against ordinary failures can be fragile against a targeted or unlucky one. Third, modularity helps. In the modular network, the same targeted shock fails 17 per cent at 0.30, against 100 per cent in the hub network.

The second experiment asks how much cross-module linkage is dangerous. The network has ten modules, and a share q of each node's supply links cross module boundaries. The five largest suppliers of one module fail, and the figure records the share of nodes outside that module that fail.

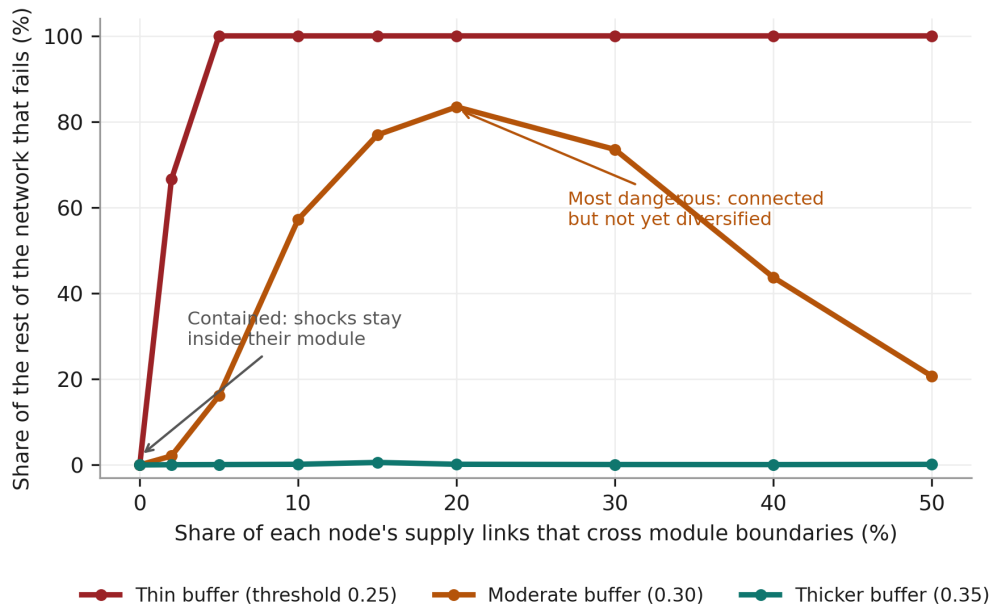


Figure 4. Spillover from a shock in one module to the rest of the network, by degree of cross-module linkage and buffer.

Source: H Heuristics stylised model (results.json, seed 20261019); ten modules of 150 nodes, 30 networks per point. Illustrative: not an estimate of any real system.

The relation is not monotonic. With no cross-module links, the shock stays in its module. As links are added, spillover rises sharply: at a buffer of 0.30, 2 per cent of the rest of the network fails at 2 per cent coupling, 57 per cent at 10 per cent coupling and a peak of 83 per cent at 20 per cent. Beyond that peak it falls, reaching 21 per cent at 50 per cent coupling, because by then each node draws on so many modules that the loss of one module's hubs no longer exceeds its tolerance. At a thinner buffer of 0.25 the spillover is 67 per cent at only 2 per cent coupling and complete from 5 per cent upward. At 0.35 there is no spillover at all. The result echoes the finding of Acemoglu and colleagues that dense interconnection can stabilise, while showing that the dangerous zone lies in the middle: systems that are linked enough to transmit a shock but not yet diversified enough to absorb it. Several real supply systems look like that zone, in which a few producers supply many users across many regions and the users have few alternatives.

3.3 What the models cannot say

The models are deliberately simple. They treat every dependence as equal, do not represent prices, inventories, policy responses or time, and impose thresholds that real systems do not have. They cannot say how close any actual network is to its critical buffer, and no number in Figures 3 and 4 should be applied to a real supply chain. What they do show is a pattern that the empirical literature supports: severity depends on structure and slack, the transition from contained to catastrophic can be abrupt, and the cheapest intervention is usually to add buffer where hubs sit or to reduce the dependence on them. The next sections map where the hubs are.

4. The Nodes: A Gazetteer of Global Chokepoints

A node is a place where much of the world's supply of something passes through a single point, and where the alternatives are few, slow or expensive. The first task of the atlas is to list them.

Nodes cluster into four families: physical lanes and facilities, industrial and material bottlenecks, digital infrastructure, and financial structures. Each has a different measure of concentration and a different time to substitute. Figure 5 sets out ten that matter for the cascades discussed in this report, using the most recent published measure for each.

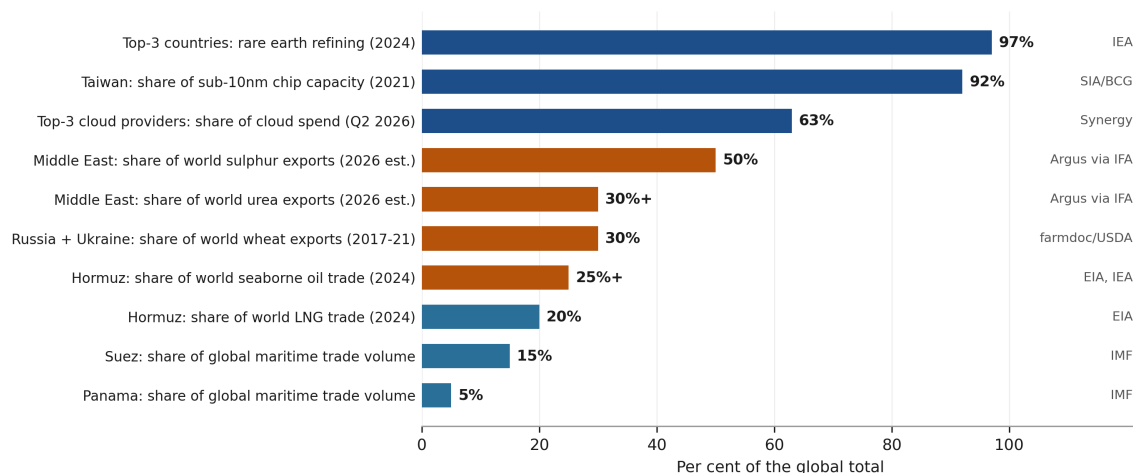


Figure 5. Concentration at ten global nodes: share of the global total held by the leading country, group or provider.

Sources: SIA/BCG (2021); IEA Rare Earth Elements 2025 (data for 2024); Synergy Research Group (Q2 2026); EIA (2024) and IEA (2025) for Hormuz; Argus Media as reported by the International Fertilizer Association (July 2026); farmdoc daily using USDA data (2017-21 averages); IMF (2023-24). Measures differ by node and are not strictly comparable. Hormuz oil and Middle East urea are lower bounds as reported.

4.1 Maritime chokepoints

Maritime chokepoints are the best documented nodes because their flows are observable. [IMF PortWatch](#) tracks nearly all global cargo and tanker movements through satellite-linked vessel data, and its daily counts for eight chokepoints are plotted in Figure 6. The [IMF estimates](#) that the Suez Canal normally carries about 15 per cent of global maritime trade volume and the Panama Canal about 5 per cent. According to the [EIA](#), oil flows through Hormuz averaged 20 million barrels a day in 2024, about a fifth of global petroleum liquids consumption, with around a fifth of global LNG trade; 84 per cent of Hormuz crude and condensate and 83 per cent of its LNG went to Asia.

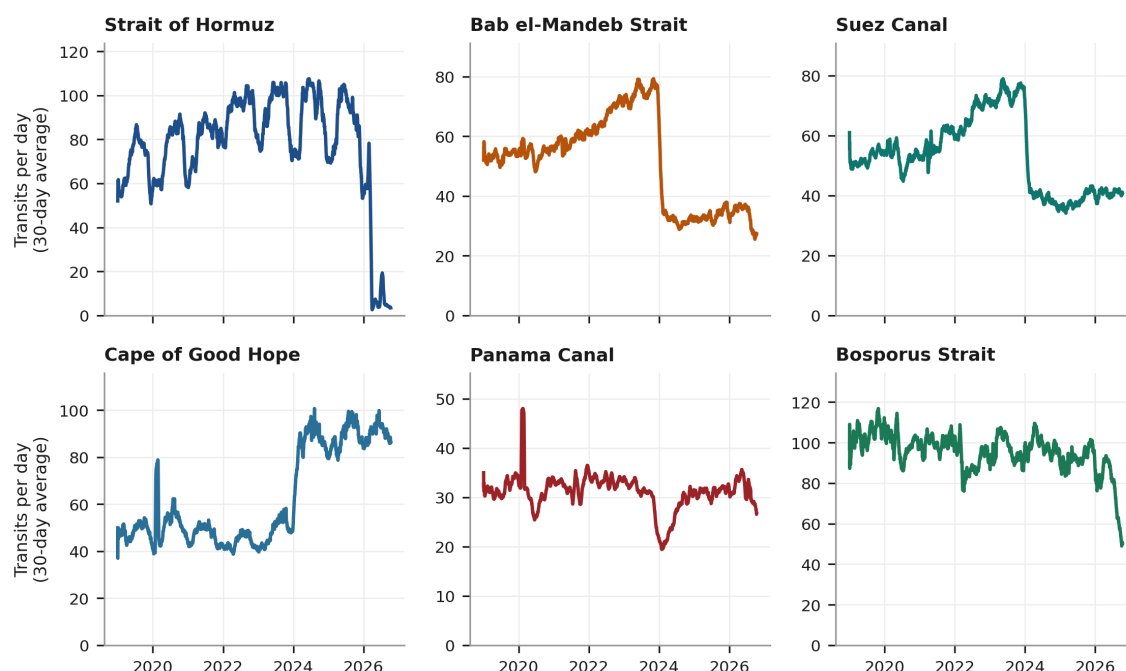


Figure 6. Daily vessel transits at six chokepoints, January 2019 to 11 October 2026 (30-day average).

Source: IMF PortWatch (accessed 19 October 2026); H Heuristics calculations. All vessel types. Series show shifts of level that correspond to the Red Sea crisis from late 2023, the Panama drought of 2023-24, and the Hormuz closure from 28 February 2026.

The data show three of the nodes in distress and three unchanged. Hormuz transits averaged 68 a day in January and February 2026 and 3.6 in September. At Bab el-Mandeb, daily transits fell from 74 in 2023 to 33 in 2024 and have not recovered; at Suez, from 74 to 40 and 39 in 2025, and about 40 to 44 in 2026. Transits around the Cape of Good Hope rose from 49 a day in 2023 to 87 in 2024 and 90 in 2025. The EIA recorded that oil flows through Bab el-Mandeb fell [by more than half](#) in the first eight months of 2024, while those around the Cape rose from 6.0 to 9.2 million barrels a day. At Panama, the drought of 2023-24 cut daily transits from about 30 to 22 in December 2023 and 20 in January 2024, before recovery. In contrast, the Malacca Strait, with about 220 to 240 transits a day, and the Taiwan Strait, with about 230, show no sign of disruption in the data. The Bosphorus, at the mouth of the Black Sea, has declined from 80 a day before the war to 51 in September 2026. The data do not say why, but the FAO's [October cereal brief](#) cites constrained Black Sea shipping routes among the reasons for a lower 2026/27 wheat export outlook.

4.2 Industrial and material nodes

The most cited industrial node is advanced semiconductor manufacturing. A [2021 study](#) by the Semiconductor Industry Association and the Boston Consulting Group found that all of the world's most advanced manufacturing capacity, below 10 nanometres, was in Taiwan (92 per cent) and South Korea (8 per cent), and that more than 50 points in the chip value chain had a single region with over 65 per cent of the global market. The data are five years old and the geography has begun to shift, but the concentration remains the defining feature of the node.

Critical minerals are the second. The [IEA's 2025 outlook](#) found that the average share of the top three refining countries across key energy minerals rose from about 82 per cent in 2020 to 86 per cent in 2024, and that China was the dominant refiner for 19 of 20 strategic minerals, with an average share of about 70

per cent. For [rare earths](#), the top three countries held 97 per cent of refining in 2024. The [2026 edition](#) records that China expanded its export controls in October 2025 to cover foreign-made products containing Chinese rare earths, that these measures are suspended for one year until November 2026, and that, if fully implemented, they would put about US\$6.5 trillion a year of downstream production outside China at risk.

Fertiliser inputs and food staples are the third. According to Argus Media figures reported by the [International Fertilizer Association](#), the Middle East accounts for roughly half of global sulphur exports and more than 30 per cent of urea exports. The [FAO](#) estimates that between 20 and 45 per cent of exports of key agrifood inputs rely on sea passage through Hormuz. On the food side, a [farmdoc daily analysis](#) of USDA data found that Russia and Ukraine together supplied nearly 30 per cent of world wheat exports on a 2017-21 average, and estimates for sunflower oil run higher still.

4.3 Digital and financial nodes

Digital nodes are less visible and, in some respects, more concentrated. [Synergy Research Group](#) reports that Amazon, Microsoft and Google together held 63 per cent of worldwide cloud infrastructure spending in the second quarter of 2026, with quarterly spending of US\$143 billion. The physical layer is more distributed than commonly believed: the [International Cable Protection Committee](#) counts about 500 systems and 1.8 million kilometres of submarine cable, with 150 to 200 faults a year, 70 to 80 per cent of them accidental, and reports that bandwidth through Hormuz is under 1 per cent of international bandwidth. A cable break, in short, is common and usually absorbed. A software update pushed to millions of machines at once is a different kind of node, and Section 8 shows what happens when it fails.

Financial nodes are the hardest to map from public data, because their concentration is in exposure and not in geography: a bank whose depositors are mostly uninsured and mostly in one industry, a lender whose borrowers are all exposed to the same price, a market where the same few firms are on both sides of every trade. The atlas treats them by function. Section 9 shows two cases, the 2008 and 2023 bank failures, and Section 11 shows how the same logic applies to sovereign borrowers.

Table 2. Gazetteer of ten nodes, with the latest observable status (October 2026).

Node	Concentration	Status in October 2026
Strait of Hormuz	About 20 million barrels a day of oil (EIA, 2024); about a fifth of LNG trade; about 30+ per cent of urea exports	Practically closed: 3.5 transits a day in 1-11 October against 68 before the war
Bab el-Mandeb and Suez	About 15 per cent of global maritime trade at Suez (IMF)	Suez about 44 a day in early October against 74 in 2023; Bab el-Mandeb 29 a day against 74
Panama Canal	About 5 per cent of global maritime trade (IMF)	26 a day in 1-11 October against 31 before the war; maximum draft cut in stages since July as El Niño develops
Malacca and Taiwan Straits	Malacca about 220-240 transits a day; Taiwan Strait about 230	No disruption visible in transit data
Advanced chips	92 per cent of sub-10nm capacity in Taiwan (2021)	Not tested in 2026; Taiwan Strait traffic normal
Refined critical minerals	Top-three share 86 per cent average (2024); 97 per cent for rare earths	Expanded Chinese controls suspended until November 2026
Gulf sulphur and urea	About 50 per cent of sulphur exports; over 30 per cent of urea exports	Urea price back below February level; phosphate fertiliser prices still rising
Black Sea grain	Russia and Ukraine near 30 per cent of world wheat exports	Bosporus transits at 51 a day against 80; FAO cites constrained routes
Public cloud	Top three hold 63 per cent of spending	No current outage; July 2024 precedent in Section 8
Subsea cables	About 500 systems; 150-200 faults a year	Faults routine; Hormuz bandwidth under 1 per cent of international total

Sources: IMF PortWatch (transit counts, 1-11 October 2026 against January-February 2026 or 2023 as stated); EIA; IMF; SIA/BCG; IEA; IFA/Argus; FAO; farmdoc daily; Synergy Research Group; ICPC.

5. The Channels: Seven Routes of Transmission

A node fails. What reaches the rest of the world, and how fast, depends on the channels that connect it. Seven recur across the cases in this atlas.

The channels differ in speed and persistence. Prices and information move in hours. Physical goods move in weeks. Debt, public finances and ecosystems move in years. Figure 7 places them on those two axes, by H Heuristics judgement, with bubble size showing breadth of reach.

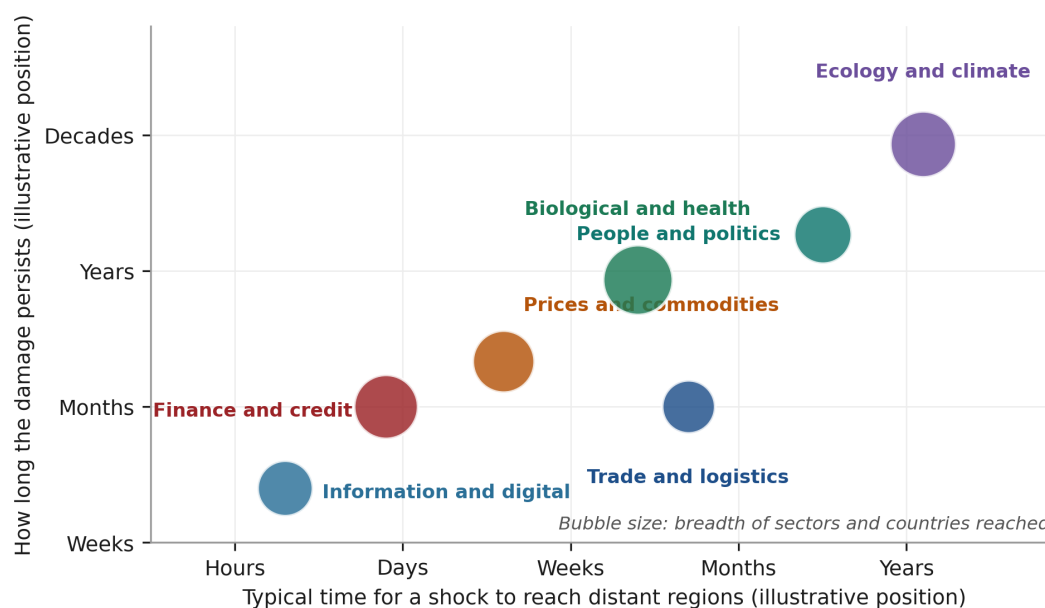


Figure 7. The seven channels: typical speed of transmission against persistence of damage.

Source: H Heuristics judgement, informed by the cases in Sections 6 to 9. Positions are illustrative, not measured.

5.1 Trade and logistics

Goods, vessels and inputs move along physical routes, and the route is the channel. When Houthi attacks diverted shipping from the Red Sea, the [IMF found](#) that Suez Canal trade volume dropped by 50 per cent year on year in the first two months of 2024, Cape of Good Hope transit surged by an estimated 74 per cent, and delivery times rose by ten days or more. The effect spread to ports: the IMF recorded falls of 5 to 7 per cent in port calls in sub-Saharan Africa, the European Union and the Middle East and Central Asia. [UNCTAD](#) reported that rerouting drove a record rise of nearly 6 per cent in ton-miles in 2024.

5.2 Prices and commodities

A price is a signal that travels faster than any ship. When the strait closed, the price of oil, gas and fertiliser moved within days. The FAO has noted that fertiliser and energy markets are inelastic, so that prices can rise much more than changes in traded volume imply, which is why the price channel often outruns the physical one. Price movements then act on third parties: a country that does not buy from the Gulf at all still pays more for fuel and, if it exports food or fertiliser, finds its own domestic prices bid up.

5.3 Finance and credit

Finance transmits distress through losses, through the cost and availability of credit, and through confidence. UNCTAD's [assessment of the Hormuz crisis](#) listed falling stock prices, weakening currencies and rising cost of external debt as the financial consequences for developing countries. The IMF found that emerging markets, especially commodity importers with prior vulnerabilities, were hit hardest by the tightening in financial conditions. The channel is fast, as the 2023 run on Silicon Valley Bank showed, and it leaves persistent damage through the debt that results.

5.4 Information and digital systems

Software, data and communications networks transmit failure at the speed of light and to every user of the same system at once. The distinguishing risk is not the speed but the simultaneity: one flawed update reaches every machine running the same software. Information is also a channel in the narrower sense that beliefs about scarcity can cause scarcity. Panic buying and precautionary stockpiling convert a forecast shortage into a real one.

5.5 Biological and health systems

Pathogens use the same networks as people and goods. The COVID-19 pandemic is the clearest case in this atlas of a biological trigger transmitted through the health system into trade, labour supply, logistics and finance. The [WTO](#) recorded a 5.3 per cent fall in world merchandise trade volume in 2020. The channel is also the least predictable in timing, but it has been the subject of more formal preparedness than any other.

5.6 People and politics

Governments and populations are channels as well as nodes. Export bans, tariffs, export controls and tolls transmit pressure deliberately. The FAO has urged that countries avoid export restrictions on energy and fertiliser, noting that trade restrictions worsened food price spikes in past crises. [Brookings](#) reported that Iran charged a toll of about US\$1 a barrel, around US\$2 million for a very large crude carrier, on the few ships that paid to pass, and warned that the practice could be copied at other chokepoints, naming Malacca, Gibraltar and the Danish Straits. Political reactions, including food riots, migration and changes in alliances, belong here, though they are slower and harder to attribute.

5.7 Ecology and climate

Weather and ecosystems are the channel that no policy controls and that is least well buffered. The IMF described the 2023 Panama Canal drought as the [worst in the canal's 143-year history](#), with passages set to halve to 18 ships a day from 36 in ordinary times. Floods in Thailand in 2011 and in Pakistan in 2022 disrupted manufacturing and agriculture respectively, with effects well beyond their borders. The channel interacts with the others in a particular way: the World Bank and the FAO have both flagged that a strong El Niño in 2026 would compound the Hormuz-driven pressure on food and inputs.

Table 3. The seven channels compared.

Channel	What moves	Typical speed	Example in this atlas	Principal buffer
Trade and logistics	Goods, vessels, inputs	Weeks	Red Sea diversion: Suez trade down by half in early 2024	Alternative routes; spare vessel capacity
Prices and commodities	Price signals	Hours to days	Brent from US\$71 to US\$120 in two months	Stocks; spare production
Finance and credit	Funds, collateral, confidence	Hours to months	SVB: US\$42 billion of withdrawals in one day	Liquidity lines; deposit guarantees
Information and digital	Data, software, beliefs	Minutes	8.5 million Windows devices in one update	Staged roll-outs; diversity of systems
Biological and health	Pathogens, labour	Weeks to months	COVID-19: world trade volume down 5.3 per cent in 2020	Surveillance; surge capacity
People and politics	Policy, tolls, controls, migration	Days to years	Hormuz tolls; Chinese export controls	Agreements; stock-sharing rules
Ecology and climate	Water, heat, floods, drought	Days to decades	Panama Canal drought, 2023-24	Infrastructure design; reservoirs; insurance

Sources as cited in the text. Speed is the typical time to first effect outside the source region.

6. Plate I: The Hormuz Cascade, 2026

The closure of the Strait of Hormuz has produced a first wave in oil and gas, a second in fertiliser, sulphur, metals and fuels, and a third in growth, inflation and debt. Each travelled at a different speed, and the system's buffers absorbed some waves far better than others.

6.1 Trigger and node

The trigger was the beginning, on 28 February 2026, of military strikes by the United States and Israel on Iran, followed by Iranian attacks on shipping. The node was the Strait of Hormuz. The [IEA](#) reported that an average of 20 million barrels a day of crude oil and products transited in 2025, about 25 per cent of world seaborne oil trade, and that bypass options were limited. The [EIA](#) put the LNG volume at more than 10 billion cubic feet a day, about 20 per cent of global LNG trade, mostly from Qatar. [PortWatch data](#) show how fast the node failed: 64 transits on 27 February, 20 on 1 March, 4 on 2 March, and none on 4 March.

The trajectory since is summarised in Table 4. After a ceasefire announced in early April and a US blockade of Iranian ports from 13 April, there was a partial resumption in late June, when the seven-day average of transits reached about 32 a day on 29 June, under half the pre-war level. By the week to 22 July, [Kpler](#) was describing the strait as closed once again after renewed hostilities. Transits averaged 3.6 a day in September. The [IEA's October report](#) put total oil flows through Hormuz at 10.9 million barrels a day in September, higher than the transit counts would suggest, which the agency attributed to more tanker movements and ship-to-ship transfers in the Gulf of Oman. The two measures differ in method and the gap is not reconciled here. A third count, by Windward and reported by [Al Jazeera](#), put pre-war traffic at about 130 vessels a day against PortWatch's 68, a reminder that vessel counts depend on what is counted.

Table 4. Hormuz timeline, 2026.

Date	Event	Source
28 Feb	US and Israeli strikes on Iran begin; Hormuz effectively closed	IEA; Brookings
4 Mar	QatarEnergy declares force majeure on LNG	EIA
11 Mar	IEA members agree a 400-million-barrel emergency stock release, the largest ever	IEA
Early Apr	Dated Brent reaches an all-time high of US\$144 a barrel; ceasefire announced about 7 April	IEA; World Bank
13 Apr	US blockade of Iranian ports begins	Brookings
Mid-Jun	A US-Iran agreement aimed at reopening the strait; transits recover to about 32 a day on 29 June	IEA; PortWatch
Week to 22 Jul	Hostilities renewed; strait described as closed again; TTF at its highest close since January 2023	Kpler
10 Aug	Windward counts 10 vessels crossing against about 130 a day before the war	Al Jazeera
Sep	IEA estimates oil flows of 10.9 million barrels a day, with ship-to-ship transfers; Brent monthly average US\$116.8	IEA via gCaptain; World Bank
14-16 Oct	IEA reports stocks 509 million barrels below pre-war; board agrees to speed release of about 100 million barrels	IEA via gCaptain

Sources as stated. Dates marked as approximate are as reported in secondary summaries of primary releases.

6.2 First wave: oil and gas

The first wave moved at the speed of price. The [World Bank](#) reported that Brent was US\$72 at the end of February and US\$118 at the end of March, a rise of 65 per cent, the largest monthly rise on record, and that Asian LNG prices rose 94 per cent and European gas 59 per cent in March. Figure 8 shows the monthly series. Brent peaked as a monthly average at US\$120 in April, fell to US\$85 in June during the partial resumption, and returned to US\$117 in September. European gas, far from retreating, has risen almost without pause to US\$25.4 per million British thermal units in September, 2.3 times its February level. The [EIA](#) found that European gas storage had ended the winter at 28 per cent full against a five-year average of 41 per cent, and that Asian buyers, who take more than 80 per cent of Qatari gas, were competing for spot cargoes. Kpler recorded Ras Laffan loading four cargoes in a week in July and shipments from the UAE's Das Island halted.

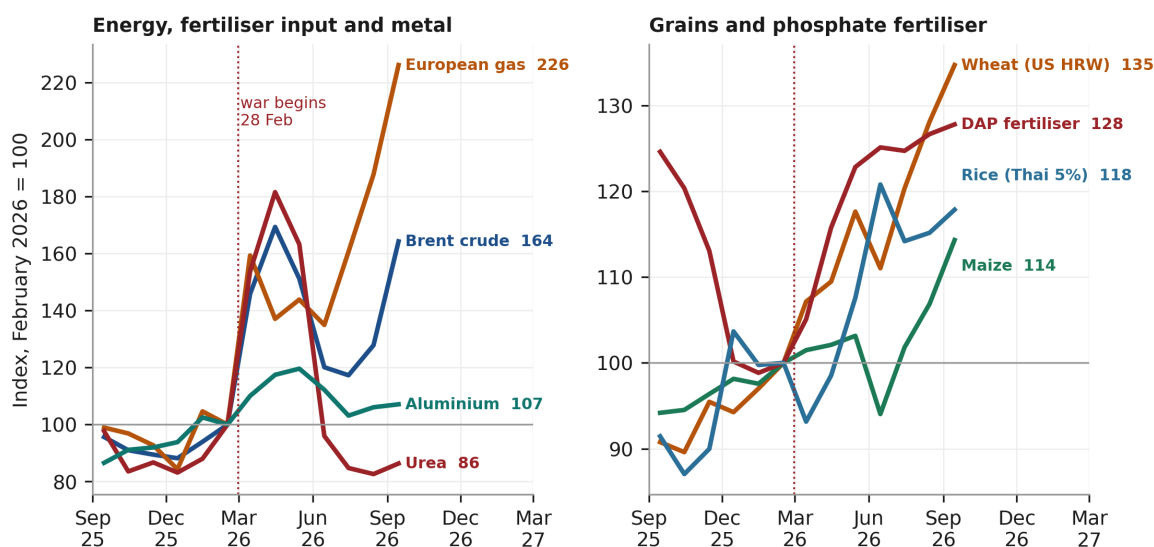


Figure 8. Commodity prices around the war, September 2025 to September 2026 (February 2026 = 100).

Source: World Bank Commodity Price Data (the Pink Sheet), monthly nominal US dollar prices, updated 2 October 2026; H Heuristics calculations. Gas is the European (TTF) series; wheat is US hard red winter; DAP is diammonium phosphate; rice is Thai 5 per cent. The vertical line marks 28 February.

The response was uneven by region. Henry Hub gas in the United States fell by 9 per cent after the closure, because the United States is a net LNG exporter whose export capacity is nearly full. Europe and Asia, importers who compete for Atlantic cargoes, rose. A node shock redistributes as well as raises: the same closure raised the price of a molecule in one place and lowered it in another.

6.3 Second wave: fertiliser, sulphur, metals and fuels

The second wave travelled through materials that most analysts had not listed as Hormuz-dependent. Middle East producers supply more than 30 per cent of urea exports and about half of sulphur exports. Urea rose from US\$472 a tonne in February to US\$857 in April, an increase of 82 per cent, then fell back to US\$408 in September. DAP, a phosphate fertiliser whose production depends on sulphur-derived acid, followed a slower path, rising from US\$627 to US\$801. Aluminium, which relies on Gulf smelters, reached

US\$3,600 in April, 17 per cent above February. The [World Bank projected](#) in April that the fertiliser index would rise by more than 30 per cent in 2026, that metals and minerals would reach a record high, and that aluminium would rise about 22 per cent.

Fuels were the most acute. The [IEA reported](#) that the Middle East was the world's largest source of internationally traded jet fuel in 2025, that Europe, which sourced most of its jet imports from the region, was the most affected, and that diesel and jet markets were tighter and more vulnerable than crude going into the war. By October the diesel problem had become structural: Middle East refined product shipments averaged 1.9 million barrels a day in September against 4.7 million before the war, and the IEA warned that the diesel shortage could persist well into 2027.

6.4 What the system absorbed

The cascade was large, and the system's response was also large. The IEA estimated that oil flows through the strait averaged 2.7 million barrels a day over March to May, a loss of about 17 million barrels a day from the 20 million barrels normal. Figure 9 compares that with the principal offsets the IEA identifies. Global inventories fell by an average of 3.8 million barrels a day. The agency's 400-million-barrel collective action was supplying about 2.5 million barrels a day in May. China cut crude imports by 40 per cent, or 4.6 million barrels a day, between February and May, through lower refinery runs and stock draws. Saudi exports from Yanbu on the Red Sea rose from 2 to over 5 million barrels a day, and UAE exports reached 4.3 million barrels a day in early June, from 1.9 in March. World oil demand fell by almost 5 million barrels a day year on year in the second quarter.

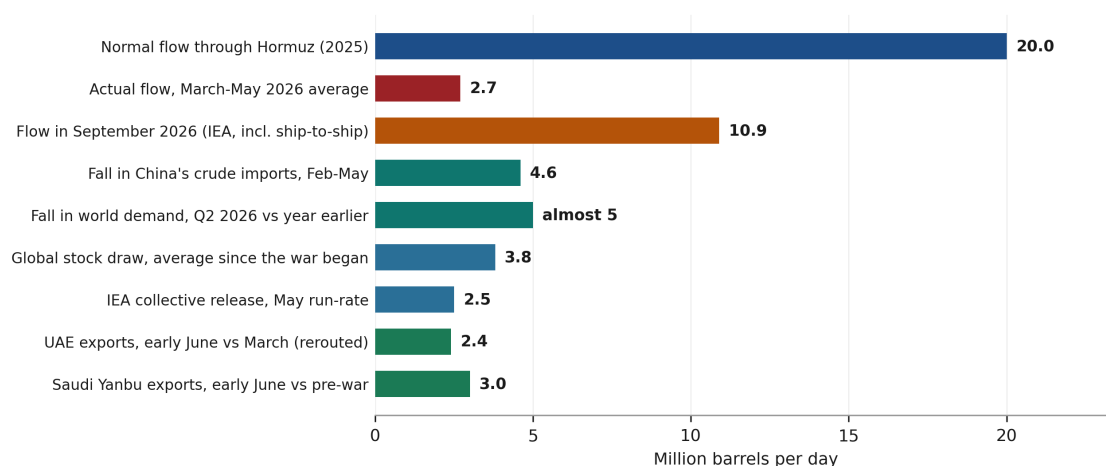


Figure 9. Scale of the Hormuz loss and of the principal offsets, million barrels a day.

Source: IEA commentary of 22 June 2026 and IEA October Oil Market Report as reported by gCaptain (16 October 2026). The bars are a comparison of scale, not a balance sheet: the measures cover different periods and overlap. Yanbu and UAE bars show increases against the pre-war level or March.

The pattern is informative. No single buffer was large enough alone, and several were used at once. Stocks bought time, rerouting restored a fraction of the flow, and demand destruction in the most exposed Asian economies closed much of the gap. The IEA noted that the demand declines were much smaller than the losses at Hormuz, and that without the other adjustments the demand impact would have been far more severe. But buffers are finite. The IEA reported in October that observed oil stocks were 509 million barrels

below their pre-war level and that its board was speeding the release of a further 100 million barrels, of which more than 20 million was diesel. A buffer used is a buffer that must be rebuilt.

6.5 Third wave: growth, inflation and debt

The third wave is in macroeconomic aggregates. The IMF's [April 2026 outlook](#) assumed a limited, short conflict and projected global growth of 3.1 per cent in 2026. It also set out adverse and severe scenarios: in the adverse case, with oil at about US\$100 a barrel, global growth falls to 2.5 per cent and inflation reaches 5.4 per cent; emerging markets outside China lose 1.3 percentage points of growth against 0.6 for advanced economies. The July update projected [3.0 per cent growth](#) in 2026, headline inflation revised up to 4.7 per cent, and stalled disinflation. The World Bank revised emerging and developing economy growth for 2026 from 4.0 to 3.6 per cent and their inflation from 4.1 to 5.1 per cent.

Both institutions' baselines assumed that the acute phase would end quickly. The World Bank's April outlook assumed it would end in May with shipping returning to near pre-war levels by October. The IMF's April outlook assumed Middle East exports normalising by mid-2026, and its July update assumed reopening from mid-July and normalisation by March 2027. The data through October show the strait still practically closed. A recurring weakness in cascade forecasting is visible: baselines place the node's recovery earlier than the evidence supports, which understates the later waves. Both institutions explicitly flagged the risks as tilted to the downside.

6.6 Food: a slow burn

The least expected feature of the plate is food. After Russia's invasion of Ukraine in February 2022, the FAO Food Price Index jumped 13 per cent in March and the cereals index 17 per cent, and both then fell back. After the Hormuz war began, the index rose far more slowly: 8 per cent in the seven months to September, with the cereals index up 13 per cent in a nearly continuous climb (Figure 10). The [World Bank](#) found that food prices rose 5 per cent in the two months after the conflict began against 15 per cent after the 2022 invasion, and gave three reasons for the muted response: record grain supplies, Northern Hemisphere farmers having bought fertiliser before the war, and a shock that works through input costs and not through lost food exports.

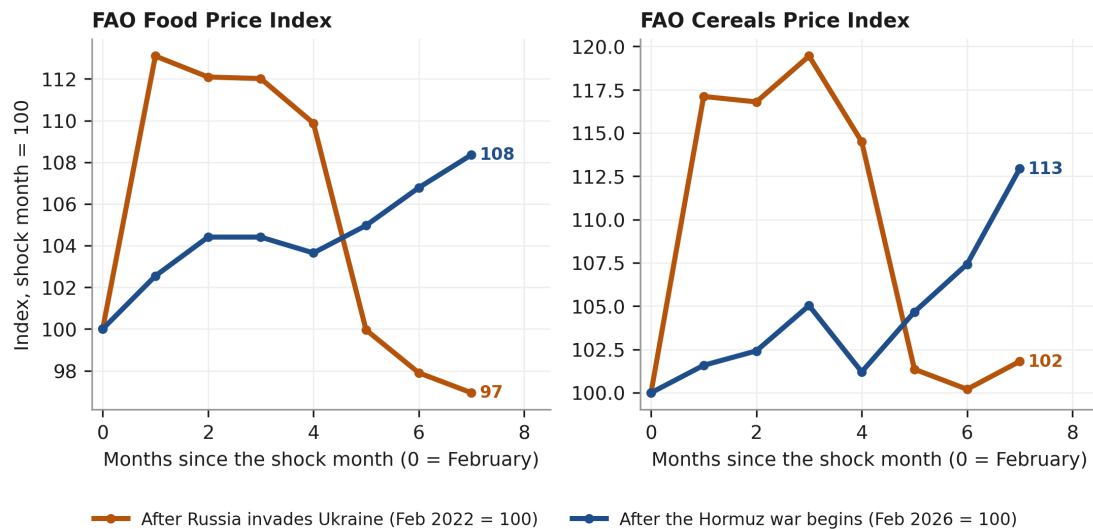


Figure 10. FAO food and cereals price indices after the 2022 and 2026 shocks (shock month = 100).

Source: FAO Food Price Index, revised series (accessed 19 October 2026); H Heuristics calculations. Month 0 is February of each year. The 2026 series ends in September (month 7).

The reasons are also reasons for caution. An input shock reaches food with a lag set by the crop calendar. The FAO warned in April that the risk was an ‘input crisis’ becoming a catastrophe, that lower fertiliser use would reduce yields later in 2026 and in 2027, and that farmers’ planting decisions in May would determine the outcome. The World Bank noted that the World Food Programme estimates up to 45 million additional people could face acute hunger in 2026 if disruptions last beyond mid-year and oil stays above US\$100. Because the window to prevent a food cascade closes with each planting season, the food wave is the one that remains most open to policy, and the one whose damage will be visible latest. The FAO index in September stood at 136.0, 5.8 per cent above a year earlier and the highest since November 2022.

6.7 Reading the plate

Five lessons follow. First, the node was well known, and the harm came from its size and the lack of substitutes, as the atlas predicts. Second, the cascade has run in three waves at three speeds, and each has had a different buffer: stocks and rerouting for oil, price adjustment for fertiliser, fiscal space and credit for growth. Third, the second-order dependencies, sulphur, jet fuel, aluminium and urea, were less visible than the first-order ones and were mapped by almost nobody beforehand. Fourth, buffers worked where they existed and were used up where they were thin. Fifth, forecasts that assumed quick resolution have repeatedly been overtaken, and the right planning assumption for a node failure is that it lasts longer than anyone hopes.

7. Plates II to IV: When Shipping Lanes Fail

Three episodes at three chokepoints show three kinds of failure: an accident that lasted six days, an attack whose effects are now in their third year, and a drought that cut a canal's capacity by a third.

7.1 Plate II: Ever Given at Suez, March 2021

Trigger. The container ship Ever Given ran aground in the Suez Canal on 23 March 2021 and was refloated six days later. *Node.* The canal, which the [IMF puts](#) at about 15 per cent of global maritime trade volume. *Channel.* Trade and logistics. *Amplifier.* Just-in-time schedules and the bunching of vessels at either end. *Manifestation.* [Lloyd's List estimated](#) that the blockage delayed goods worth about US\$400 million an hour, equal to some US\$9.6 billion a day, with [at least 369 ships queuing](#) by 28 March and the backlog cleared only on 3 April.

The case is the cleanest demonstration of the atlas's first claim. A trigger that no risk model would have rated as large, a ship blown off course, reached a node of high concentration and produced a global effect within days. The estimates are of goods delayed, not output lost, and the difference matters. Most of the delayed goods eventually arrived, and what was lost was time, schedule reliability and the cost of rerouting some vessels. The case is also a story of what interrupts a cascade: a physical removal of the trigger, achieved by tugs, dredgers and a spring tide.

7.2 Plate III: The Red Sea, 2023 to the present

Trigger. Houthi attacks on commercial shipping from November 2023. *Node.* The Bab el-Mandeb Strait and the Suez Canal beyond it. *Channel.* Trade and logistics, then prices. *Amplifier.* Insurance withdrawal and the avoidance of risk by vessel owners, which turn an attack on a few ships into a de facto closure for most. *Manifestation.* A permanent change in route. [PortWatch data](#) show Bab el-Mandeb transits falling from 74 a day in 2023 to 33 in 2024 and 27 to 29 in recent weeks, Suez transits from 74 to about 40, and Cape of Good Hope transits rising from 49 to about 90. The [EIA](#) found that oil flows through Bab el-Mandeb fell from 8.7 million barrels a day in 2023 to 4.0 in January to August 2024.

The [IMF's first estimate](#) found Suez trade volume down by half and delivery times up by ten days or more, with port calls falling in regions that had nothing to do with the dispute. [UNCTAD](#) reported that rerouting produced a record rise of nearly 6 per cent in ton-miles in 2024. Two years later, the Red Sea has not normalised. [Al Jazeera](#) reported in August 2026 that Yemen's government accused the Houthis of killing six people in missile attacks on a commercial vessel in Bab el-Mandeb. Drewry's October 2026 assessment refers to some vessels returning to Suez, and the transit counts show only a partial recovery.

The Red Sea plate shows that a chokepoint failure need not be a spike. It can be a step: a shift to a new and costlier equilibrium that persists for years and whose costs are absorbed so gradually that they cease to register as a crisis. It also shows how cascades overlap. The 2026 Hormuz closure arrived when the Red Sea route, the other maritime artery between Asia and Europe, was already running at about half of its former traffic.

7.3 Plate IV: The Panama Canal drought, 2023-24

Trigger. A drought that the [IMF described](#) as the worst in the canal's 143-year history. *Node.* The Panama Canal, carrying about 5 per cent of global maritime trade, whose locks run on fresh water from a reservoir. *Channel.* Ecology and climate, then logistics. *Amplifier.* A physical limit that cannot be exceeded by paying more. *Manifestation.* Restrictions that the IMF said would halve daily passages to 18 from 36 in ordinary times, adding about six days in transit, with ports in Panama, Nicaragua, Ecuador, Peru, El Salvador and Jamaica seeing 10 to 25 per cent of their maritime trade flows affected. PortWatch data show transits falling from about 31 a day in mid-2023 to 22 in December and 20 in January 2024, before recovering to 28 by June 2024 and about 30 through 2025.

The plate is a reminder that the ecology and climate channel acts on physical nodes with no commercial substitute. It is also a live one. NOAA has confirmed that El Niño has developed in 2026, and the canal authority has [lowered the maximum draft](#) for the largest vessels in stages since July. PortWatch data show 26 transits a day in the first eleven days of October, against 31 before the war. Unlike most triggers in this atlas, the drought risk can be monitored in advance, from rainfall and lake-level data, and the canal authority's staged draft cuts show the information being used.

8. Plates V to VII: Industrial and Digital Cascades

In industry and in software, nodes are less visible than straits. They are a factory, a vendor, a single product line. When they fail, the cascade follows the supply chain or the software dependency, and it can be fast, specific and hard to see coming.

8.1 Plate V: Japan and Thailand, 2011

Trigger. The Great East Japan Earthquake of March 2011, and floods in Thailand from late July. *Nodes.* Specialist suppliers in the disaster areas of both countries. *Channel.* Trade and logistics along supply chains. *Amplifier.* Input specificity: components that no other supplier could provide on short notice. *Manifestation.* In Japan, [Carvalho and colleagues](#) showed that the disruption propagated upstream and downstream to direct and indirect suppliers and customers, and estimated a 0.47 percentage point reduction in Japan's real GDP growth in the following year. In Thailand, the flooding ran from 25 July 2011 to 16 January 2012, killed 815 people and affected 13.6 million. The [World Bank estimated](#) economic losses of 1.425 trillion baht, about US\$46.5 billion, mostly in manufacturing, after seven major industrial estates were flooded to depths of up to three metres.

The global consequence was a shortage of hard disk drives that lasted through 2012. Estimates of Thailand's share of world output vary from about a quarter to a third. Shipments in the fourth quarter of 2011 were 124 million, down 26 per cent, and the average selling price rose [28 per cent](#) according to IHS. The New York Fed's supply chain index registered the combined effect with a reading of 1.55 standard deviations above its average in April 2011 (Figure 12). The episode is an early and well-studied case of a lesson that the later plates repeat: a local disaster in a place that supplies a narrow input reaches distant users at a size out of proportion to the local economy.

8.2 Plate VI: Texas, Renesas and the chip shortage, 2021

Triggers. A freeze in Texas from 13 to 17 February 2021, and a fire in March 2021 at a Japanese chip plant. *Nodes.* Grid and fabrication capacity in Texas; the plant's share of automotive microcontrollers. *Channels.* Trade and logistics; prices. *Amplifier.* Inventories cut to the bone during the pandemic, and a rapid rebound in demand that suppliers had not planned for. *Manifestation.* Car production cuts through 2021 and 2022.

The Texas power crisis left at least 4.5 million homes and businesses without power at the peak, ran the grid to within [4 minutes 37 seconds](#) of complete failure, and caused an official toll of 246 deaths according to the Texas Department of State Health Services. [Three semiconductor plants](#) in Austin, owned by Samsung, Infineon and NXP, were shut by the outage. The [chip shortage](#) that followed was expected to cost the global car industry about US\$210 billion in revenue in 2021 according to estimates cited by CNBC and Business Insider; Goldman Sachs found at least 169 industries affected; and Toyota announced a plan to cut worldwide production by 40 per cent in September 2021. A fire in March 2021 at a plant owned by Renesas, which supplies about 30 per cent of the automotive microcontroller market, took at least 100 days to recover from.

The plate is a compound cascade in which several shocks arrived at a node that was already under strain. The freeze was a common-cause shock to a region; the fire was a chain shock to a single product line; and the underlying demand shift was a system-wide stress that left no slack to absorb either. The shortage

subsided in 2023. It illustrates the atlas's second claim, that buffers decide the outcome: with normal inventories, none of the individual events would have mattered at global scale.

8.3 Plate VII: The July 2024 software outage

Trigger. A faulty update to a widely deployed endpoint security product, pushed on 19 July 2024. *Node.* The single vendor and the single operating system on which a large part of the world's business computing depends. *Channel.* Information and digital systems. *Amplifier.* Simultaneity: every affected machine received the same flaw at once, so there was no gradual spread to observe and interrupt. *Manifestation.* [Microsoft estimated](#) that 8.5 million Windows devices were affected. [Parametrix estimated](#) direct losses to Fortune 500 companies, excluding Microsoft, at about US\$5.4 billion, with healthcare the largest at US\$1.94 billion, banking US\$1.15 billion and airlines US\$860 million, and expected only 10 to 20 per cent of the cost to be recoverable through cyber insurance, implying insured losses of roughly US\$540 million to US\$1.08 billion.

The faulty update was [reported](#) to have been rolled back within 90 minutes, yet recovery took far longer because many machines reportedly needed individual repair. Strictly, the event is a common-mode failure and not a cascade, since the damage did not travel from one node to another but arrived at all of them together. It belongs in the atlas because its consequences did travel: an airline's grounded aircraft became a stranded passenger, a delayed shipment and a disrupted hospital appointment. And it demonstrates the digital version of node concentration, in which the dependence is not on a place but on a shared piece of code. The same logic applies to any widely adopted platform, including the cloud services of Section 4.

9. Plates VIII to XII: Financial, Health, Food and Climate Cascades

The last five plates run through the slower and larger channels: credit, disease, food and the weather. They are where cascades have done their most lasting damage.

9.1 Plates VIII and IX: Lehman and COVID-19, the two world trade collapses

Plate VIII. The failure of Lehman Brothers on [15 September 2008](#) was the trigger of a crisis whose node was the web of counterparty exposures among financial institutions. The finance channel carried the shock to trade. The [WTO recorded](#) a 12.2 per cent contraction in the volume of global merchandise trade in 2009, the largest since the Second World War. Exports of Japan fell 24.9 per cent, those of the European Union 14.8 per cent and those of the United States 13.9 per cent, while the oil-exporting regions of the Middle East, Africa and South and Central America fell least. World real GDP growth was negative, at –1.3 per cent, in the World Bank’s series (Figure 11). The work of [Haldane and May](#) and of [Acemoglu and colleagues](#) belongs to the literature that followed it.

Plate IX. The first reported cases of a novel coronavirus were the trigger of the pandemic, and the node was the global movement of people. The biological channel then carried the shock into trade, labour supply and logistics. The [WTO recorded](#) a fall of 5.3 per cent in world merchandise trade volume in 2020 and projected a rebound of 8.0 per cent in 2021. World real GDP fell by 2.9 per cent in 2020. The distinctive feature of the plate is its second wave: the New York Fed’s supply chain index peaked at 3.5 standard deviations above its average in April 2020, then, after a lull, at 4.4 in December 2021 (Figure 12), the highest in its history, as demand rebounded into constrained supply. The shock and its consequence were 20 months apart.

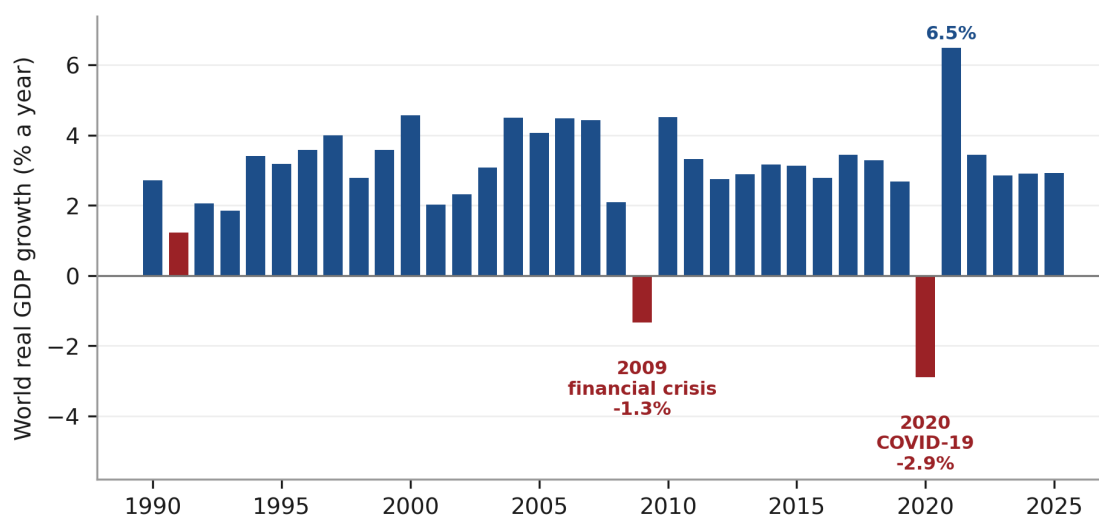


Figure 11. World real GDP growth, 1990 to 2025.

Source: World Bank, World Development Indicators, NY.GDP.MKTP.KD.ZG (accessed 19 October 2026). Years of growth below 1.5 per cent are shown in red.

9.2 Plate X: Silicon Valley Bank, March 2023

Trigger. In the second week of March 2023, depositors of Silicon Valley Bank, a bank with a concentrated depositor base in one industry, began to withdraw funds. *Node.* The bank itself: [94 per cent of its deposits](#) were uninsured, according to a Yale School of Management case study. *Channel.* Finance and information. *Amplifier.* Synchronised behaviour across a single network of depositors who could move money instantly. *Manifestation.* According to [testimony by the Federal Reserve’s Vice Chair for Supervision](#), customers withdrew US\$42 billion on 9 March and had scheduled a further US\$100 billion for 10 March, together about 81 per cent of the bank’s deposits at the end of the previous year. The plate shows a cascade whose speed was set by the information channel and whose containment depended on a single circuit-breaker, the public guarantee of deposits, applied within days.

9.3 Plate XI: Ukraine, 2022

Trigger. Russia’s invasion of Ukraine in February 2022. *Nodes.* The Black Sea’s grain and sunflower-oil exports, Russian and Belarusian fertiliser, and Russian gas. A [farmdoc daily analysis](#) of USDA data found Russia and Ukraine supplied nearly 30 per cent of world wheat exports in 2017-21 and over 75 per cent of sunflower oil exports. *Channels.* Prices and commodities, trade and logistics, and policy. *Manifestation.* The revised FAO Food Price Index rose from 141.7 in February to 160.2 in March 2022, with the cereals index up 17 per cent and the vegetable oils index up from 202 to 252. In the World Bank’s series, wheat rose from US\$391 to US\$522 a tonne by May, urea from US\$744 to US\$925 by April, and European gas from US\$27 to US\$59 per million British thermal units by September. The food index then fell back as supply adjusted, to 137 by September 2022.

The plate is the benchmark against which the 2026 food response should be read (Figure 10). The shock was a loss of exports, felt at once in price; the response was a rapid adjustment of planting and trade flows. It shows both the speed of the first wave and the speed with which a market can recover when the node’s output can be replaced from elsewhere. It also shows what the first wave did not: the effects on fertiliser, gas and sovereign debt lasted for years.

9.4 Plate XII: Pakistan, 2022, a cascade that stayed national

Not every cascade is global, and the atlas includes one that was not, because its distribution of harm is instructive. The 2022 floods in Pakistan, according to the World Bank-backed [post-disaster needs assessment](#), caused damage of more than US\$14.9 billion and economic losses of about US\$15.2 billion, affected 33 million people and killed more than 1,730, with Sindh province bearing close to 70 per cent of the total and reconstruction needs of at least US\$16.3 billion. The trigger was extreme monsoon rainfall; the channel was ecology and climate; the nodes were housing, agriculture and transport on a flood plain. The effects travelled through households and public finances, and not through global markets.

It belongs in the atlas for two reasons. First, the harm of roughly US\$30 billion in damage and losses fell on a lower-middle-income economy with limited buffers, which had to find reconstruction money of at least US\$16 billion. Second, it is a reminder that the same channels that carry a cascade from a node to the world also carry it from a node to a nation’s poorest, and that the people at the end of the chain are often not the ones with the shortest connection to the trigger. Section 11 returns to this.

10. Reading Across the Plates: Speed, Scale and Amplifiers

Twelve cascades, in different sectors and decades, share a small number of regularities. Reading them together shows where the leverage for intervention lies.

Table 5. The twelve plates compared.

Plate	Node	Main channels	Time to first global signal	Scale of effect
I. Hormuz, 2026	Strait; Gulf LNG, urea, sulphur	Prices, trade, finance	Days (price); months (food, debt)	Brent US\$71 to US\$120 in two months; IEA: largest oil supply loss on record
II. Ever Given, 2021	Suez Canal	Trade	Days	About US\$9.6bn a day of goods delayed
III. Red Sea, 2023-	Bab el-Mandeb, Suez	Trade, prices	Weeks	Suez trade down 50% in early 2024; ton-miles up nearly 6%
IV. Panama, 2023-24	Canal locks	Ecology, trade	Weeks	Transits down from about 31 to 20 a day
V. Japan and Thailand, 2011	Specialist suppliers	Trade	Weeks	Japan GDP growth lower by 0.47 points; Thai losses US\$46.5bn
VI. Texas and chips, 2021	Fabs; one microcontroller supplier	Trade, prices	Weeks to months	About US\$210bn of auto revenue at risk (estimate)
VII. Software outage, 2024	One vendor, one platform	Digital	Minutes	8.5 million devices; US\$5.4bn direct Fortune 500 losses
VIII. Lehman, 2008	Interbank counterparties	Finance, trade	Days (finance); months (trade)	World trade volume down 12.2% in 2009
IX. COVID-19, 2020	Movement of people	Health, trade	Weeks	Trade down 5.3%; GDP down 2.9% in 2020
X. SVB, 2023	One bank	Finance, information	Hours	US\$42bn withdrawn in a day
XI. Ukraine, 2022	Black Sea grain; fertiliser; gas	Prices, trade, policy	Days (price)	Food index up 13% in a month
XII. Pakistan, 2022	Flood plain	Ecology, people	Days (local)	About US\$30bn of damage and losses

Sources as cited in Sections 6 to 9. Scale measures differ by plate and are not comparable.

10.1 Five regularities

The trigger is rarely the story. A ship blown off course, a fire, a software update and a bank's depositors were not large events in themselves. The scale of the consequence was set by the node and the buffers. *The node is usually known.* Hormuz, Suez, Taiwan's fabs and Black Sea grain were identified as concentrated dependencies in published work years before they failed. *The second-order dependencies are not.* Sulphur, jet fuel, a single microcontroller supplier, the cooling water of a canal: these were the links that carried the surprising parts of the cascade. *Policy is part of the system.* Export restrictions, tolls and controls move shocks between countries; stock releases, swap lines and deposit guarantees stop them. *Speed varies by*

channel, and the slowest reach the poorest. Information moved in minutes and hours, prices in days, goods in weeks, and food, debt and growth in months and years.

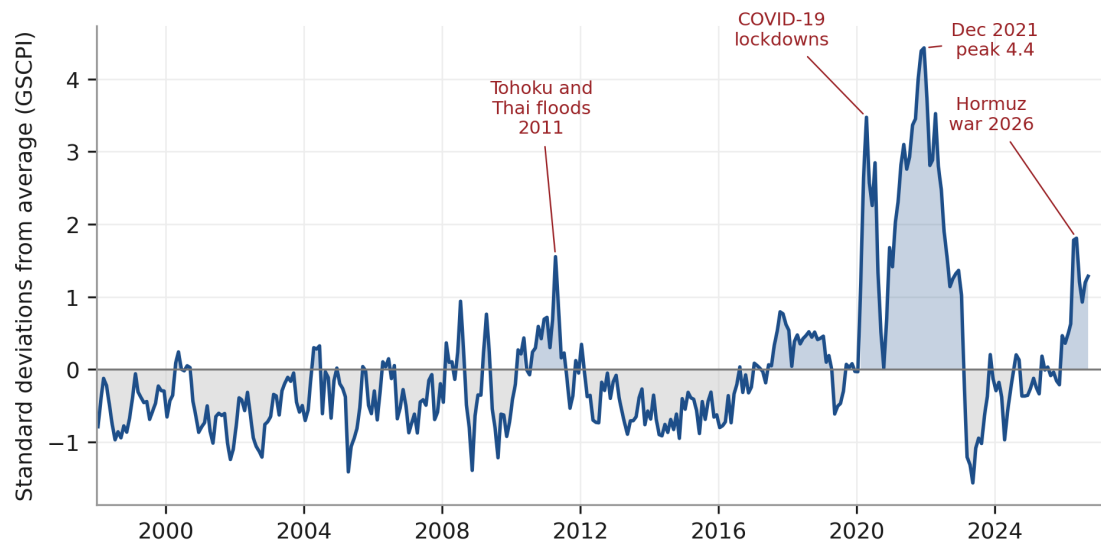


Figure 12. Global Supply Chain Pressure Index, January 1998 to September 2026.

Source: Federal Reserve Bank of New York, GSCPI (data to September 2026, accessed 19 October 2026). The index is standardised: zero is the historical average, and units are standard deviations.

Figure 12 shows the aggregate record. The pressure index shows three of the plates as distinct peaks, the 2011 episode at 1.55, the pandemic's two at 3.5 and 4.4, and the 2026 episode, which reached 1.8 in April and May and stood at 1.3 in September. It also shows that the Hormuz crisis, as a supply-chain stress, has been modest by the pandemic's standard. The reason is the nature of the shock: it falls on energy and a handful of inputs, and not on the movement of manufactured goods in general. A supply-chain index registers one kind of cascade and misses others, and the Hormuz crisis lies largely in prices, finance and food, where no equivalent single index exists.

10.2 Six amplifiers

Six properties recur as amplifiers. *Thin buffers*: diesel and jet fuel went into the Hormuz crisis with less slack than crude, and the shortage is expected to persist into 2027. *Specificity*: Renesas's share of automotive microcontrollers meant a fire at one plant could stop assembly lines on three continents. *Leverage*: Silicon Valley Bank's deposit base was almost entirely uninsured, and middle-income developing countries entered 2026 with external debt service of 13 to 15 per cent of exports (Section 11). *Simultaneity*: a single vendor's update reached every machine at once. *Policy reaction*: export controls, tolls and bans reallocate scarcity, and often worsen it for the countries with least bargaining power. *Synchronised behaviour*: panic purchases and precautionary stockpiling convert a forecast shortage into an actual one, and the FAO's warning that biofuel and export decisions would determine the outcome for food is an instance of this.

The six are not independent. A node with thin buffers is more likely to prompt a policy reaction. A policy reaction triggers synchronised behaviour. Leverage turns synchronised behaviour into insolvency. That

interaction is why cascades are non-linear and why the cheapest point at which to intervene is usually the amplifier nearest to the node.

11. Who Bears the Cascade

A cascade's damage is not distributed by distance from the trigger. It is distributed by the thickness of each country's and household's buffers, which is lowest where incomes are lowest.

11.1 Energy and food import exposure

Exposure begins with what a country must import. Figure 13 shows the share of merchandise imports taken by fuel and by food across income groups. Fuel is 26 per cent of imports of lower-middle-income countries against 9 per cent in high-income ones; in low-income countries it was 18 per cent in the latest year for which data are available, 2019. Food is 18 per cent of low-income imports against 8 to 9 per cent elsewhere. A shock to fuel or food prices is therefore a larger share of the import bill, and of the economy, for the countries least able to finance it.

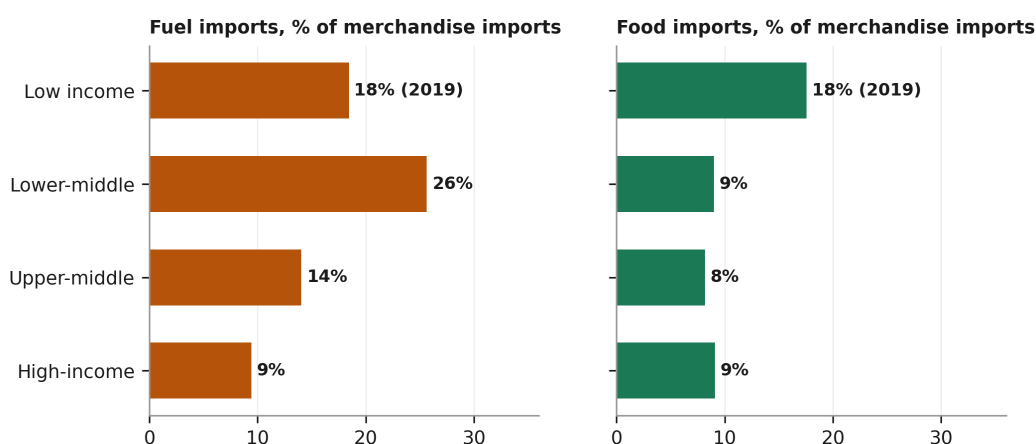


Figure 13. Fuel and food imports as a share of merchandise imports, by income group, latest year.

Source: World Bank, World Development Indicators, TM.VAL.FUEL.ZS.UN and TM.VAL.FOOD.ZS.UN (accessed 19 October 2026). Low-income data are for 2019, the latest available; other groups are for the latest year, 2024 or 2025.

The [IMF's April outlook](#) quantifies the asymmetry. In its adverse scenario, emerging markets outside China lose 1.3 percentage points of 2026 growth against 0.6 for advanced economies; in its severe scenario they lose 1.9, almost twice the advanced-economy loss. Cumulative growth in 2026 and 2027 is revised down by 0.5 percentage points for low-income net energy importers, against 0.2 for energy-importing advanced economies. Energy exporters are revised up or left unchanged. On food, the [World Bank noted](#) that the World Food Programme estimates up to 45 million more people could face acute hunger in 2026 if disruptions last beyond mid-year and oil stays above US\$100 for long, and that more than half of those would be in sub-Saharan Africa and in the Middle East, North Africa, Afghanistan and Pakistan region.

11.2 The debt loop

The third channel of exposure is credit, and it is a loop. High energy and food prices raise import bills; countries borrow, or draw down reserves, to pay them; borrowing costs rise as risk premia widen; and higher debt service reduces the capacity to buy the next shock's imports. Figure 14 shows the starting position. External debt service was 14.5 per cent of exports in lower-middle-income countries and 12.7 per cent in upper-middle-income countries in 2024, and 9.3 per cent in low-income countries, after a peak of

about 17.6 per cent in 2021. The [World Bank's 2025 International Debt Report](#) found that developing countries paid out US\$741 billion more in principal and interest on external debt than they received in new financing between 2022 and 2024, the largest gap in at least fifty years, and that interest rates on new bond financing hovered around 10 per cent, about double their level before 2020.

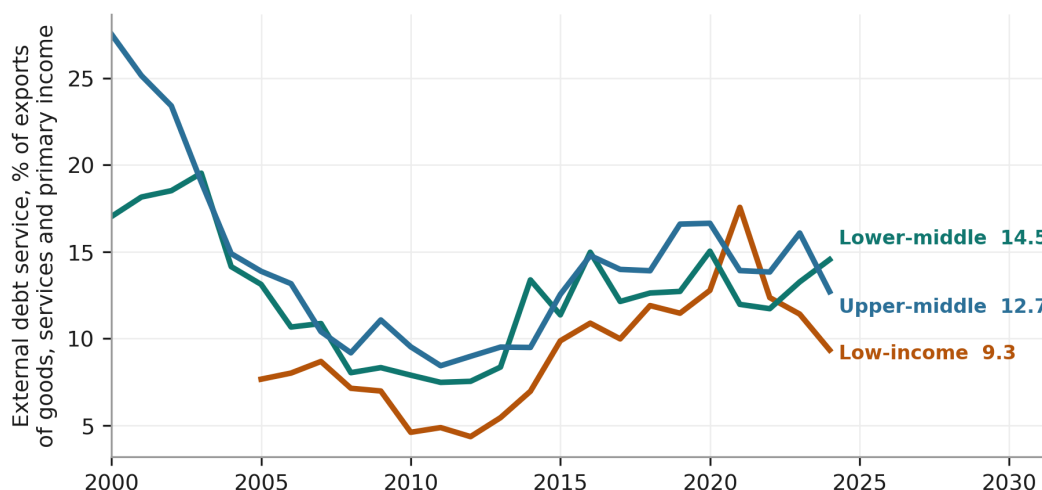


Figure 14. External debt service as a share of exports of goods, services and primary income, by income group, 2000 to 2024.

Source: World Bank, World Development Indicators, DT.TDS.DECT.EX.ZS (accessed 19 October 2026). Coverage is of low- and middle-income countries reporting to the World Bank's debt system.

[UNCTAD's A World of Debt](#) reports global public debt of US\$111 trillion in 2025, of which developing countries held US\$35 trillion; net interest payments by developing countries of about US\$995 billion; and 3.7 billion people living in countries that spend more on interest than on either education or health, 1.2 billion more than in 2010. In Africa, 24 per cent of the population lived in such countries in 2010 and 65 per cent in 2023. UNCTAD's own [assessment of the Hormuz shock](#) lists rising cost of external debt, weakening currencies and falling stock prices as the financial consequences for developing countries, and calls for emergency financing, debt relief and central bank swap lines to be available quickly. The IMF has, for its part, pointed to elevated public debt, refinancing risk and capital-flow reversals as risks, and to the need for concessional financing and debt resolution for high-debt low-income countries.

11.3 Why the poorest absorb more

Three asymmetries explain the pattern. *Buffers are unequal.* Advanced economies and a few large emerging ones hold strategic stocks, reserves and fiscal space. China, for example, holds nearly 1.4 billion barrels of strategic oil stocks, according to Brookings, and the IEA reports that it cut crude imports by 40 per cent between February and May through lower refinery runs and stock draws. Low-income economies rarely hold equivalent stocks of anything. *Bargaining power is unequal.* When cargoes are scarce, buyers compete, and in the Hormuz crisis Asian buyers who lost Qatari cargoes competed for Atlantic supply, as the EIA noted. A buyer with weaker credit and smaller volumes loses that competition. *Credit is unequal.* A rich country can borrow in its own currency to subsidise the shock. A poor one borrows in foreign currency, at about 10 per cent, or not at all. The Pakistan plate in Section 9 is the national version of the

same pattern. A risk map without a distributional layer therefore misleads: a cascade that costs the world 0.5 percentage points of growth can cost a low-income importer many times that.

12. Pathways Ahead: The Next Plates

The atlas's method can be run forward. For any node, ask what could trigger it, which channels it would use, how thick the buffers are, and who would bear it. Ten pathways merit attention.

The [World Economic Forum's Global Risks Report 2026](#), published in January, ranked geoeconomic confrontation first among the risks survey respondents thought most likely to trigger a material global crisis in 2026, selected by 18 per cent, followed by state-based armed conflict at 14 per cent, and found that half of respondents expected a turbulent or stormy outlook over two years, rising to 57 per cent over ten. The pathways below are consistent with that picture. Their placement in Figure 15 is an H Heuristics judgement of likelihood and of potential to cascade, informed by the evidence cited. It is not a forecast.

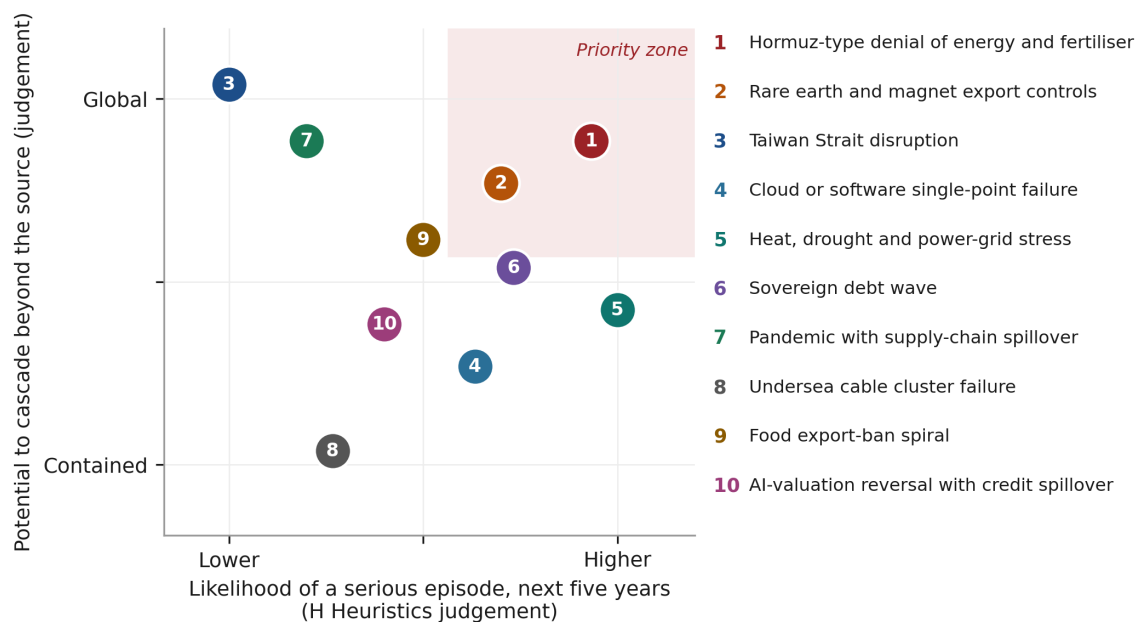


Figure 15. Ten pathways to the next cascade: likelihood against potential to spread beyond the source.

Source: H Heuristics judgement, informed by the evidence in Sections 4 to 11. Positions are ordinal and illustrative. The shaded zone marks pathways rated both reasonably likely and high-potential.

Table 6. Ten pathways, with the evidence behind each.

#	Pathway	Evidence and trigger to watch
1	Hormuz-type denial of energy and fertiliser	Strait practically closed in October; Kpler's base case is a prolonged crisis recovering through Q1 2027; IEA warns diesel shortage could last into 2027. Watch: transit counts, stock cover, Qatar's LNG trains.
2	Rare earth and magnet export controls	Expanded Chinese controls suspended until November 2026; IEA estimates US\$6.5 trillion a year of non-China production at risk if fully implemented; planned magnet capacity is about a third of expected 2035 mined supply. Watch: extension or lapse in November.
3	Taiwan Strait disruption	92 per cent of sub-10nm capacity in Taiwan (2021 data); transit counts normal. Likelihood is the hardest to judge; potential is the highest on the map.
4	Cloud or software single-point failure	Three providers hold 63 per cent of cloud spending; the July 2024 outage reached 8.5 million devices. Watch: update practices, vendor concentration.
5	Heat, drought and power-grid stress	El Niño developed in 2026; Panama Canal draft cut in stages since July; Texas 2021 precedent. The World Bank and FAO flag a strong El Niño as compounding.
6	Sovereign debt wave	US\$741 billion negative net transfers in 2022-24; 3.7 billion people in countries spending more on interest than on health or education; IMF flags refinancing risk.
7	Pandemic with supply-chain spillover	COVID-19 precedent: trade down 5.3 per cent in 2020 and supply pressure peaking 20 months after the first shock.
8	Undersea cable cluster failure	150-200 faults a year, mostly accidental and absorbed; a correlated multi-cable event is the tail case.
9	Food export-ban spiral	FAO index at its highest since November 2022; Black Sea shipping constrained; FAO has urged countries to avoid restrictions on energy and fertiliser.
10	AI-valuation reversal with credit spillover	IMF names an AI-profitability correction as a key downside risk and AI-driven demand as a support to growth in the technology value chain.

Sources as cited in earlier sections and: IMF July 2026 WEO Update remarks; World Economic Forum (2026).

Three observations follow. First, one pathway is already live, the Hormuz denial, and a second, the rare earth controls, has a decision date within weeks. The atlas therefore does not describe only hypothetical risks. Second, the pathways interact. A strong El Niño, a prolonged Hormuz closure and a food export-ban spiral are three parts of one scenario: the World Bank and the FAO have both described that combination, and the FAO has called conditions for a 'perfect storm' present if it materialises. Third, the pathways with the highest potential, a Taiwan Strait disruption and a pandemic, are those with the least observable lead indicators, which is the reason to invest in buffers and not in prediction.

13. Breaking Cascades: Design Principles for Circuit-Breakers

Circuit-breakers are interventions that interrupt a cascade between stages. They work, they are cheaper than the harm, and they have to exist before the trigger.

The five-stage view suggests four kinds of intervention, one aimed at each transition, shown in Figure 16. *Prevent* acts on the node and the trigger: diversify, reduce exposure, and where possible resolve the source. *Contain* acts on the channels, building firebreaks between sectors and regions. *Absorb* acts on the amplifiers, supplying buffers that take the shock. *Recover* acts on the manifestation, restoring capacity and relieving those most hurt.

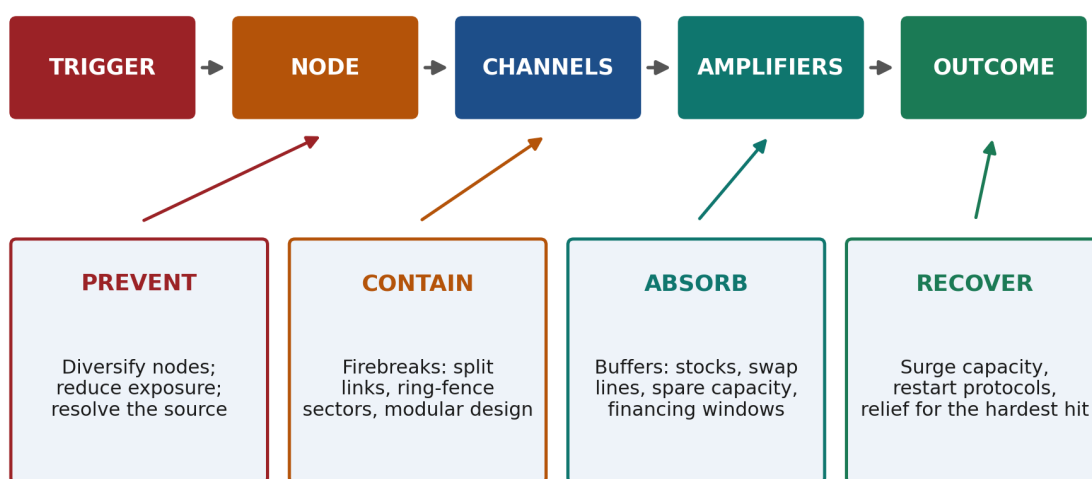


Figure 16. Four circuit-breakers mapped to the five stages of a cascade.

Source: H Heuristics framework.

13.1 Prevent

The most effective circuit-breaker for the Hormuz cascade is resolving the closure, as the IEA has said: the key fix is a full reopening, and stock releases are a short-term measure. That is a diplomatic and military matter outside the scope of an atlas. Where prevention is within reach, it takes the form of diversifying the node. The IEA's 2026 outlook finds that diversified rare earth refining capacity is about two-thirds of expected 2035 mined supply, but that planned magnet capacity is only about a third, a gap that investment can close. Prevention also means reducing the exposure of the node itself, by using staged roll-outs for software and by hardening and spreading physical sites.

13.2 Contain

Containment relies on firebreaks. The H Heuristics model illustrates why: in Figure 4, the shock stays inside its module when cross-module links are absent, and cascades most severely when linkage is moderate and undiversified. The practical lessons are to avoid creating the intermediate condition, to prefer either genuine modularity or genuine diversification, and, in a crisis, to refrain from measures that spread the shock. The

[FAO has urged](#) countries to avoid export restrictions on energy and fertiliser and to be cautious about biofuel mandates, because trade restrictions worsened price spikes in past crises. Brookings reached a similar conclusion on [fuel export bans and gas tax holidays](#), judging both likely to do more harm than good.

13.3 Absorb

Buffers are the circuit-breaker with the clearest evidence. The IEA's members hold more than 1.2 billion barrels of government emergency stocks and a further 600 million barrels of industry stocks under government obligation; they agreed unanimously on 11 March to release 400 million barrels, and by May the action was delivering 2.5 million barrels a day. Pipelines were buffers too: Saudi Arabia's East-West line and the UAE's Fujairah line gave bypass capacity that the [EIA had counted](#) in 2025 at about 2.6 million barrels a day, and exports through Yanbu rose from 2 to more than 5 million barrels a day. Financial buffers matter equally. UNCTAD recommends rapid access to emergency financing, central bank swap lines and debt relief; the FAO has proposed using IMF balance-of-payments facilities and a food shock window as an input-financing facility so that countries can buy fertiliser without triggering subsidy competition; and the IMF recommends fiscal support that is temporary and targeted, with sunset clauses.

13.4 Recover

A buffer used must be rebuilt, and rebuilding is part of the circuit. The IEA reported stocks 509 million barrels below pre-war levels in October. Recovery also means restart protocols, surge capacity and relief for those worst affected. Here the distributional point of Section 11 applies: restoring a country's reserves is not the same as relieving a household's hunger, and both belong in the design.

Table 7. Circuit-breakers compared.

Breaker	Stage	Evidence of effect	Limit
Emergency oil stocks	Absorb	400m-barrel release agreed on 11 March, 11 days after the war began; 2.5m barrels a day in May	Finite: stocks 509m barrels below pre-war in October; thin for diesel
Bypass pipelines	Absorb	Yanbu exports from 2 to over 5m barrels a day; UAE exports 4.3m in June	Capacity is fixed; EIA counted about 2.6m barrels a day of bypass capacity in 2025
Demand response	Absorb	World demand down almost 5m barrels a day in Q2; China imports down 40%	Costly and uneven across countries
Deposit guarantee	Contain	SVB run of US\$42bn in a day halted within days	Moral hazard; one-off
Export-restraint discipline	Contain	FAO and Brookings judge bans and tax holidays harmful	Hard to enforce without agreed rules
Staged software roll-out	Prevent	Fault rolled back in about 90 minutes in 2024; the harm came from simultaneity	Slows deployment
Financing windows and swap lines	Recover	Proposed by FAO and UNCTAD; not yet tested at scale	Needs pre-agreement to be fast
Refining and magnet diversification	Prevent	Diversified refining about two-thirds of 2035 mined supply	Planned magnet capacity only about a third

Sources as cited in Sections 6 to 13. Evidence is descriptive, not a controlled estimate of effect.

14. A Strategy: Who Does What

Circuit-breakers have owners. The task is to assign them, to agree rules before the next shock, and to watch a short list of indicators that would show a cascade starting.

14.1 Governments

Governments hold the largest buffers and the most levers. Five tasks follow from the atlas. *Map the nodes and publish the map.* The Hormuz plate showed that second-order dependencies were not mapped by almost anyone. *Review stock rules.* Diesel, jet fuel, fertiliser and sulphur were the thin links in 2026. Whether stock obligations are sized for the first two, and whether any collective stock exists for the last two, deserves review. *Commit to restraint.* Agree in advance that export bans on energy, fertiliser and food will not be used, or will be notified and time-limited. *Pre-arrange finance.* Standing swap lines and a financing window for essential imports are worth far more if agreed before a shock than negotiated during it. *Invest in diversification at the nodes that matter,* including magnet and refining capacity, alternative routes and storage.

14.2 Firms

Firms need to look two and three tiers upstream. The plates show that the cascade often runs through a supplier's supplier, as with Renesas or Gulf sulphur. They should identify single-source inputs, hold buffer stock for the specific ones, and qualify second sources. They should treat digital monocultures as nodes, with staged roll-outs and tested rollback. And they should size working-capital buffers to the speed of the slowest channel that affects them, not the fastest.

14.3 Financial institutions and regulators

Financial institutions should stress-test with cascade scenarios that follow dependence two steps beyond the first-order exposure, such as a sovereign's energy import bill or a borrower's fertiliser costs. Regulators should watch concentrated depositor bases and funding structures, as SVB showed, and sovereign exposures where debt service already takes a large share of exports. The distribution of harm in Section 11 argues for particular attention to the lenders and instruments that serve the lower-middle-income countries, where debt service is highest.

14.4 Multilateral institutions and the research community

Multilateral bodies can supply what no single country can: pre-agreed financing windows, shared data and rules of the road. The PortWatch and GSCPI series used in this report are public goods that anyone can check. They should be extended to the channels with no equivalent, such as fertiliser flows, jet and diesel stocks, and the distribution of sovereign debt service. Researchers can test the claims in Section 3 against more cascades and refine them, in particular the hypothesis that intermediate coupling is the most dangerous.

14.5 Three horizons

In the next twelve months the priorities are to rebuild stocks, especially of diesel and jet fuel, to finance fertiliser for the next planting season in the countries least able to pay, and to prepare for the November 2026 decision on rare earth controls. Over one to three years the priorities are diversification of refining and magnet capacity, review of stock rules, and firebreaks in the most concentrated supply chains. Over three to ten years the aim is a system built for modularity, with cascade-aware standards in financial and infrastructure regulation.

Table 8. A ten-indicator cascade dashboard, with current readings (October 2026).

Indicator	Source	Current reading	Alert level (H Heuristics judgement)
Hormuz transits per day	IMF PortWatch	3.5 (1-11 Oct), against 68 pre-war	Below half of pre-war: red
Suez and Bab el-Mandeb transits	IMF PortWatch	44 and 29 a day, against 74 in 2023	Below 60 per cent of 2023: amber
Panama Canal transits and draft	PortWatch; ACP notices	26 a day; draft cut in stages	Below 25 a day: red
Supply chain pressure	NY Fed GSCPI	1.28 (September)	Above 1.0: amber; above 2.0: red
FAO cereals price index	FAO	122.8 (September), up 13% since February	Up more than 10% in six months: amber
Urea and DAP prices	World Bank	Urea US\$408, DAP US\$801 (September)	Either 30% above 12-month average: red
European gas price	World Bank	US\$25.4 per mmBtu (September)	Above US\$20: amber
Oil stock gap	IEA	509m barrels below pre-war	Widening three months running: red
Developing-country debt service	World Bank	Lower-middle 14.5% of exports (2024)	Above 15%: amber
Rare earth control status	IEA; MOFCOM notices	Expanded controls suspended until November 2026	Lapse of suspension: red

Sources: as listed; readings from data accessed 19 October 2026. Alert levels are H Heuristics judgement, not official thresholds.

15. Limits and What Would Change the Argument

15.1 Limits

The report has several limits. The Hormuz plate describes an unfinished event, and some figures are preliminary or conflicting; where transit counts and flow estimates disagree, the report gives both and does not reconcile them. Several historical figures are gross values of goods delayed or revenue at risk, not measured losses, and some rest on secondary summaries of primary sources. The twelve plates are chosen from many possible cases, and a choice of famous cases risks hindsight bias, since a cascade is easier to recognise after the fact. The stylised model of Section 3 is a toy: it shows a pattern that the empirical literature supports but cannot say how close any real system is to a threshold. Figures 7 and 15 and the alert levels in Table 8 are judgement, offered for discussion. And the report is a synthesis, not a new empirical study; its originality lies in the framework and in assembling live data in one place.

15.2 What would change the argument

Four findings would change it. A systematic study of many cascades showing that the thickness of buffers explains little of their severity once node concentration is controlled for would weaken the second claim. A rapid, complete and lasting reopening of Hormuz with no further waves in food or debt would show the system to be more resilient than the plate implies, though it would not remove the concentration. Evidence that diversification of supply, in the real economy, increases correlated exposure by pulling suppliers towards the same few inputs would qualify the circuit-breaker design. And evidence that cascades through the slower channels are, on average, absorbed by markets without lasting damage to the poorest would weaken the third claim. Each is testable, and the dashboard in Table 8 is designed to help test them.

16. Conclusion: Mapping Before the Shock

The 2026 Hormuz crisis did not reveal a new kind of risk. It revealed, at scale and in real time, an old one: that a small place carrying a large share of something the world needs can, when it fails, produce harm in distant places and through channels that nobody listed. The grammar of the cascade, trigger, node, channel, amplifier and manifestation, is the same as in the plates from Thailand, Texas and Suez. What differs is the speed at which the waves arrive and the thickness of the buffers they meet.

Three conclusions follow for anyone responsible for resilience. First, map the nodes, two tiers deep, and treat the ones with few substitutes as the real risk register, whatever their probability. Second, size buffers to the node and not to the average, and rebuild them after use, since a buffer that has been spent is the next cascade's opening. Third, agree the rules, on stocks, on restraint, and on finance, before the trigger, because a rule negotiated during a crisis is slower and weaker than the same rule agreed in advance. The atlas cannot say where the next trigger will fall. It can say which nodes it would have to reach, and how much slack the system will have when it does.

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