

CLIMATE ACTION AND WASTE REDUCTION

Compound climate extremes could triple under the current high-emission scenario. Are businesses prepared?

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The 2022 floods in Pakistan caused between 1,700 and 2,000 deaths and affected an estimated 33 million people. (Source: *Encyclopædia Britannica*)

- **Compound climate extremes will increase 2–3 times over most global land masses under current trajectories, yet most business risk models assess these threats separately.**
- **Wet–hot events will affect 30–40% larger areas than previously expected, threatening manufacturing clusters, agricultural zones, and infrastructure networks across Asia, North America, and Africa.**
- **Businesses that integrate compound risk assessment into their climate strategies can generate returns of \$2–19 for every dollar invested in resilience.**

The catastrophic floods that occurred in 2022 in Pakistan were not caused by rain alone. The deluge arrived weeks after record-breaking heat had baked the Earth solid, reducing its capacity to

absorb water. The result: widespread human displacement, \$30 billion in damages, and global supply chains severed for months.

This was not an isolated disaster – it was a compound climate extreme. New research published in *Earth's Future* shows these events will become 2–3 times more frequent under the current high-emission scenario. For businesses still assessing climate risks in isolation, the implications are stark. Conventional risk models are systematically underestimating exposure.

The business case: why compound risks matter

Climate disruption to global supply chains could cost \$3.75–24.7 trillion by 2060. Climate-driven fixed asset losses are projected to reduce average company earnings by 6.6–7.3% by 2035, accelerating to 9.9–12.8% by 2055. According to recent analysis, these losses could exceed 20% of annual earnings for the most exposed companies, particularly in utilities, telecommunications, and travel sectors.

Yet most corporate climate risk assessments still treat hazards separately – evaluating flood risk independently from heat risk, for instance. This single-hazard approach fails to capture actual exposure because it ignores how hazards interact with each other.

The financial community is increasingly recognizing this reality. "Climate risk is investment risk," wrote Larry Fink, CEO of BlackRock, the world's largest asset manager, in his 2021 letter to corporate leaders. "No issue ranks higher than climate change on our clients' lists of priorities. They ask us about it nearly every day."

However, most climate risk assessments that inform these investment decisions still evaluate hazards in isolation – precisely the gap that the research published in *Earth's Future* exposed.

The research provides one of the first comprehensive global quantifications of how compound climate extremes will evolve. The findings challenge conventional risk management and reveal where businesses must redirect climate adaptation investments.

What the science reveals

Recent climate science is beginning to quantify how these compound risks evolve. The research examined two critical combinations: dry–hot events (extreme heat with severe drought) and wet–hot events (extreme heat with intense precipitation).

Under current emissions trajectories:

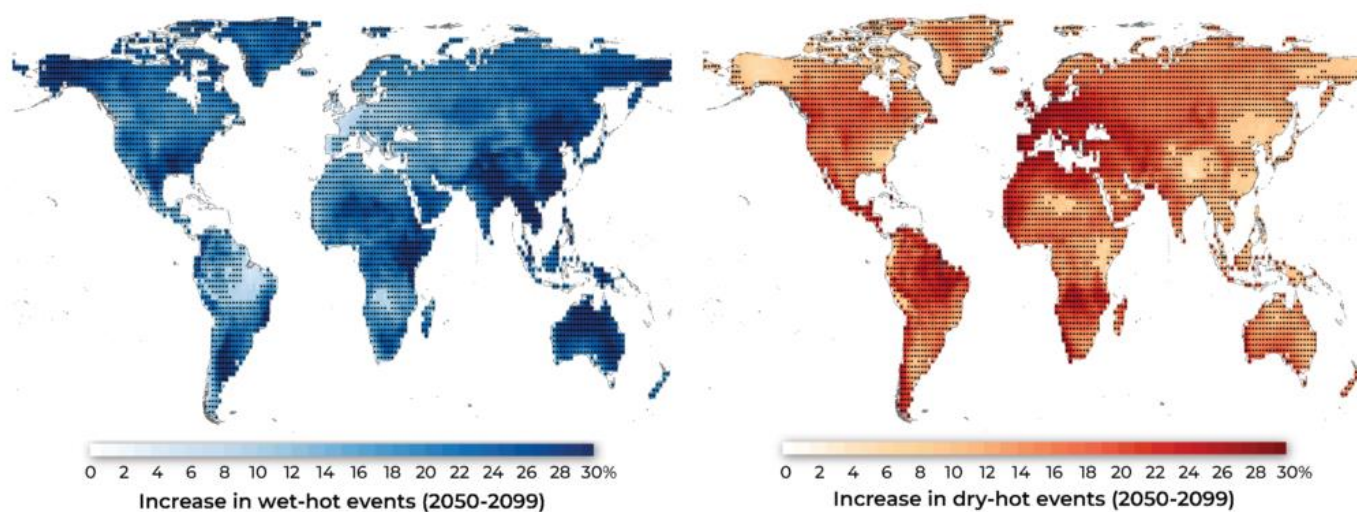
- Compound extreme frequency will increase 2–3 times relative to historical baselines
- Affected areas will expand by approximately 50%
- Peak temperatures during wet–hot events will rise 2–3°C beyond historical extremes

Together, these shifts alter how and where climate risks materialize for businesses.

Additionally, even though wet–hot events will expand across areas 30–40% larger than dry–hot extremes, corporate climate strategies have focused predominantly on drought-heatwave combinations. The mismatch means many businesses are adapting to the wrong risks.

The physical mechanism is well-established. Warmer air holds approximately 7% more moisture per degree Celsius of warming. When precipitation occurs during hot periods, it arrives with

greater intensity, increasing the likelihood that extreme heat and heavy rainfall strike simultaneously.



Wet—hot extremes will cover a greater area and be more severe than dry—hot extremes. (Source: American Geophysical Union)

Operational impacts across business sectors

The regions most exposed to wet—hot extremes, including eastern Asia, eastern North America, Australia, and central Africa, host critical manufacturing clusters, agricultural production zones, and infrastructure networks that drive global supply chains.

The physical sequence creates cascading operational disruptions. Extended heat hardens soil and increases evaporation. When intense rainfall follows, the compacted ground cannot absorb water, triggering flash floods and landslides.

These compound extremes affect industries in distinct but interconnected ways, creating sector-specific vulnerabilities that reinforce one another across the economy.

- **Manufacturing:** Heat-induced equipment stress followed immediately by flood damage to electrical systems. Facilities face simultaneous threats to production capacity and physical infrastructure.
- **Agriculture:** Heat-stressed crops become more vulnerable when waterlogging follows. Sequential stresses can compound damage beyond what either hazard would cause alone, amplifying losses across growing seasons.
- **Energy:** Peak demand during heatwaves strains generation capacity. Substations, cooling systems, and transmission infrastructure already operating under thermal stress are especially vulnerable when flooding follows.
- **Supply chains:** When multiple nodes face simultaneous compound shocks, redundancy fails. A supplier diversification strategy built on geographic spread offers no protection if all locations face the same hazard combination.

Consider what happens when factories lose their water supply, data centers struggle to cool, offices are submerged by floods, or fields are hit by drought. These disruptions show up on

balance sheets as costs rise through additional repairs, unfulfilled orders, and reduced worker productivity.

Importantly, these risks do not scale proportionally with warming. Between 1.5°C and 2°C, compound climate extremes accelerate sharply, with direct implications for infrastructure specifications and insurance premiums.

What this means for business leaders

The research findings point to three immediate priorities for corporate climate strategy.

First, risk models need updating. Most corporate climate assessments evaluate hazards in isolation. The single-hazard models are systematically underestimating exposure. Companies should ask not just “what is our flood risk?” but “how would flooding affect operations already stressed by extreme heat?”

Second, geographic diversification requires rethinking. Supply chain strategies built on spreading suppliers across regions assume those regions face independent risks. But compound extremes often strike multiple locations simultaneously. Effective resilience requires understanding where compound risks are correlated, not just where they exist.

Third, infrastructure investments must account for sequential stresses. Facilities hardened against flooding but not heat – or vice versa – remain vulnerable when both arrive together. Investment in compound-aware climate resilience generates returns of \$2–19 for every dollar invested through avoided losses, maintained operations, and reduced insurance costs.

The bottom line

Compound climate extremes, particularly wet–hot events, will increase 2–3 times under high-emission scenarios, yet most corporate risk models assess hazards in isolation. As compound extremes become more frequent and severe, businesses that integrate these interdependencies into strategic planning will be better positioned to protect operations, supply chains, and shareholder value.

Resilience investments depreciate slowly while compound climate extremes multiply rapidly. The cost of acting now is a fraction of the cost of repeated disruption.