MICHIGAN ROSS

Venture capital in climate resilience: a study on investment patterns in natural disaster technology and how escalating extreme weather costs de-risk private investments

by

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Abstract

Natural disasters have cost the United States almost $3 trillion since 1980. Thus, this has increased the demand for technologies that lessen the community vulnerability whilst aiding the recovery process. Early-stage investments in climate technology have skyrocketed; however, most of the attention has gone toward mitigation solutions, while adaptation–particularly technology for resilience to natural disasters, or "disastertech"–has been left behind in terms of both funding and research (IPCC, 2022). This thesis documents the changes in venture capital investments in U.S. disastertech over the past 20 years, the economic and financial logic behind those changes, and the factors that influence investor valuation of resilience technology start-ups. The study design is mixed-methods and combines a 20-year dataset of venture capital activity with qualitative interviews with investors and founders. As per the quantitative analysis, the investment in disastertech has been on an upward trend since 2006 with major jumps after significant climate events and rises in federal resilience funding. These trends parallel the economics of climate resilience, where post-catastrophe loss prevention generates positive financial value for the impacted society and innovating firms. The qualitative findings suggest that successful disastertech companies achieve higher valuations through successful pilots, partnerships with institutions like governments and insurance firms, and credible data references. Fueled by increasing catastrophe losses and new federal incentives, venture capital investors are now positioning resilience technologies as a growth opportunity that can yield competitive returns. Besides presenting the first longitudinal study of U.S. venture capital in disastertech, this research sets the stage for understanding the impact of investor risk assessments, insurance market pressures, and public sector incentives on valuation. The thesis seeks to challenge and support policymakers in mobilizing private capital toward climate resilience, investors

evaluating adaptation markets, as well as founders who want to mitigate risks of their technologies.

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Introduction

Background and Context

The U.S. has suffered a total of over 16,000 deaths and nearly $3 trillion in losses due to 403 natural disasters since 1980 (National Centers for Environmental Information, 2024). In August 2005, Hurricane Katrina ignited the nation's foundational disaster policy and response (U.S. Congressional Research Service, 2006). As a result of the disaster, local, state, and federal authorities' perspectives changed significantly, with a new emphasis on mitigating and adapting to economic and social consequences of extreme weather. These changes redefined the role of the Federal Emergency Management Agency (FEMA) and reinsurers, who were heavily engaged in the modeling and pricing of risk linked to environment catastrophes. Thus, increased public attention and funding sped up the development of disaster prediction and early-warning technologies (Rhee, 2006).

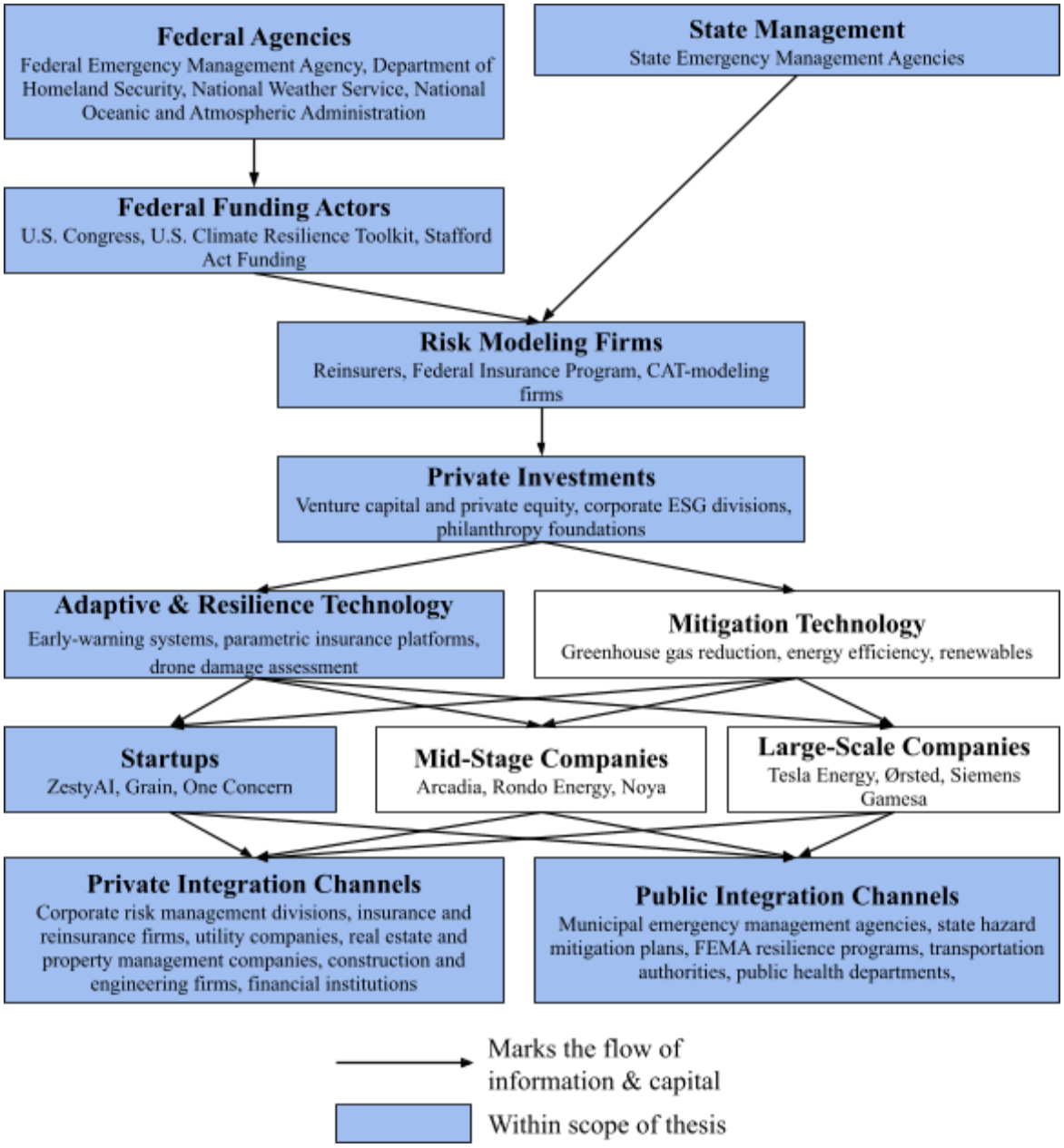


Figure 1. Funnel of Information and Capital of Natural Disaster Technology

Natural disaster hardware and software primarily fall within two categories: mitigation and adaptation technologies (Climate Policy Initiative, 2023). Mitigation technologies aim to reduce the likelihood or severity of impact of climate-related catastrophes, such as minimizing greenhouse gas emissions, improving energy efficiency, or increasing the efficiency and efficacy

of carbon capture programs (Intergovernmental Panel on Climate Change, 2022). Comparatively, adaptation technology, or resilience technology, reflects innovations used and applied to minimize the harm of natural disasters in communities post-incident. These designs help businesses, residents, and governments respond to the consequences of natural disasters that cannot be fully prevented via mitigation technology. Resilience technology prioritizes reducing vulnerability and damage whilst boosting recovery potential. The assumption is that disaster impacts will intensify over time, and, as a result, increase the need for systems capable of resisting the effects (Intergovernmental Panel on Climate Change, 2022).

For the purpose of this thesis, resilience technology, "disastertech," and adaptation technology are interchangeable and consist of different hardware and software, such as early-warning systems, drone-based damage evaluation tools, AI-enabled weather forecasting, parametric insurance platforms, evacuation technology, etc. Apart from offering lifesaving readiness and response, these solutions also enable governments, financial institutions and insurers, and private sectors to make informed decisions regarding resource allocation, risk response, and future investment plans (2022). In this paper, earthquakes, volcanic eruptions, and related disasters; the primary focus is on technology related to fire, flood, and drought.

Adaptation technologies are increasingly recognized as essential to natural disaster planning, yet they remain systematically underfunded relative to their mitigation counterparts–receiving less than 10% of global climate finance despite accelerating disaster losses (United Nations Environment Programme, 2023). This thesis addresses that gap directly, focusing on resilience disaster technology as an expanding and underexamined sector within the broader climate technology field.

Venture capital investors play a unique role in the development and integration of natural disaster technology. Start-ups are motivated by unmet needs in the market. Thus, they are often the first to take the risk and commercialize cutting-edge solutions, i.e. AI-enabled early warning systems. Traditional actors, such as federal agencies or large engineering companies, tend to adopt solutions after they have been proven viable. Consequently, the disastertech market is relatively saturated with venture capital funding. Public budgets are straining as climate impacts intensify; private investors are filling in the gap to test and adopt solutions that governments and larger actors integrate later into disaster management efforts. Therefore, the flow of venture capital often defines what technology the market believes in and then therefore characterizes the next generation of disaster response. Figure 1 provides an outline of the funding and implementation cycle of natural disaster technology solutions.

Research Questions and Problem Statement

Disastertech refers to technology companies focused on disaster preparedness, response, recovery, and resilience. Disastertech.org describes it broadly as a global ecosystem of people who develop tools that help humans navigate crises. This thesis raises the question: how and why have venture capital investments in technologies for natural disasters changed over the past two decades in the United States? This paper seeks to understand the economic and financial rationale behind these differences. Then, to best position private companies and communities for innovation, it is critical to understand how disastertech companies can increase their investor valuation and secure greater funding for development.

Hypotheses

From evaluating existing research and industry reports, two hypotheses were identified.

Hypothesis 1: Demand Drivers

Rising economic losses from natural disasters are placing increased pressure on public agencies, insurers, and private actors, encouraging research and investment in advanced technologies for preparedness and response.

Null Hypothesis 1

Rising economic losses from natural disasters yield no significant effect on venture capital investment in disastertech.

Hypothesis 2: Shifts in Investor Sentiment

The rise of natural disasters in terms of both scale and frequency is changing investor sentiment, with venture capital firms regarding disastertech as a growth sector with strong return potential.

Null Hypothesis 2

Disaster frequency and severity do not have a significant relationship with investor sentiment toward disastertech as a growth sector.

Research Significance

Though climate technology investments have grown by 40% between 2018 and 2023, the vast majority of scholarship and industry knowledge focuses on mitigation and prevention

technologies due to the field's historical success and future-forward, optimistic, and innovative perspective (Climate Policy Initiative, 2023). Conversely, adaptation technologies remain relatively understudied, despite the accelerating, virtually uncontrollable financial and livelihood costs of natural disasters. In the status quo, there is no dataset that depicts 20 years of venture capital investments into resilience disastertech nor a comprehensive evaluation of how investors value related climatic solutions. Start-ups in the field often hold atypical risk profiles and high beta due to their sensitivity to regulatory uncertainties and extreme reliance on the public sector (Barrett & Chaitanya, 2023).

In the last two decades, the United States has been hit with greater than 260 natural disasters that each cost at least $1 billion in damages; the total losses is nearly $3 trillion (National Centers for Environmental Information, 2024). Insured catastrophe losses have similarly climbed from $25 billion annually in the mid-2000s to $81.5 billion by 2020. This pressure has fundamentally shifted how insurers and reinsurers assess and price climate risk (Insurance Information Institute, 2024). Consequently, federal agencies like the Economic Development Administration, the U.S. Department of Energy, and the National Science Foundation have extended their mandates to include funding for private-sector resilience start-ups, supporting the belief that reducing the adaptation finance gap necessitates private capital to join public investment (Economic Development Administration, 2024; U.S. Department of Energy, 2023; National Science Foundation, 2023)

This push drives firms' research and capabilities and advances their technological development. Disastertech, more often than not, sits at the intersection of public financing and private market development, meaning that while government support can de-risk a company, volatile regulatory changes can also discourage private investment.

Venture capital investments in climate technology exceeded $70B globally in 2022, though less than 10% of this proportion was placed in adaptation technologies (Climate Policy Initiative, 2023; PwC, 2022). The disconnect between disaster severity and investments leads to the thesis, which integrates concepts of climate adaptation economics, early-stage valuation theory, and venture capital risk assessment. The following research provides knowledge to start-up founders on how to best position their firms to de-risk their innovations and secure stronger valuations and thus funding; provides analysis for venture capital investors about the market drivers, risks and mitigants, and valuation considerations of natural disaster technology; includes an evidence-based perspective to policymakers on how private capital responds to changing costs of natural disasters; it builds on the evolving conversation on financing climate solutions, an issue that only becomes more pressing as disasters intensify.

Literature Review

Theme 1: Macroeconomic Burdens of Disasters

Natural disasters create significant macroeconomic consequences that surpass immediate physical destruction. Noy (2009) explains that the severity of economic disruption is shaped less by meteorological intensity than by two other factors: the institutional capacity the affected economy can absorb and recover and the scale of property damage relative to GDP. The same storm can lead to starkly different outcomes. A hurricane hitting an economy with deep credit markets, adequate fiscal reserves, and strong governance will experience far smaller output contractions than an equivalent event in a region without similar structural buffers. Smaller economies, therefore, are disproportionately exposed–not because they experience worse

hazards, but because the financial institution and geographical infrastructure required to mobilize recovery capital is absent.

What makes this pattern particularly relevant to the present study is that it is not random–it is predictable. Ishiwatari & Surjan (2019) find that proactive investment in disaster risk reduction yields benefit-cost ratios of between 4:1 and 7:1 through avoided losses, making it among the most economically efficient uses of development capital. Yet global development assistance for such measures has historically accounted for just 0.4% of total aid–a figure that reflects not the absence of economic rationale but the absence of financial frameworks capable of translating that rationale into investable opportunities. As disaster frequency and intensity continue to rise, that gap between the returns available from resilience investment and the capital actually allocated to it becomes increasingly difficult to justify.

Nevertheless, public adaptation finance–historically the primary source of resilience funding–is increasingly insufficient to meet systemic demand (Barrett & Chaitanya, 2023). Without the mobilization of private capital, the burden of financing climate implementation remains a significant barrier for many nations; this, however, raises the unique question of if private capital should mobilize this problem (Adhikari & Chalkasra, 2023).

Barrett & Chaitanya (2023) link this macroeconomic burden to the logic of private investment by arguing that adaptation technologies primarily create value through avoided losses and the stabilization of future cash flows, rather than through traditional revenue generation. Companies developing early-warning systems, risk analytics platforms, and insurance-adjacent modeling tools create economic value in an unconventional way–by reducing the volatility of future damages rather than generating direct revenue in the traditional sense. The financial logic is sound: lower damage volatility translates to lower discount rates and higher firm valuations.

The commercial problem is that the benefits flow primarily to governments, insurers, households, and utilities rather than back to the firms producing them, which structurally limits how much private capital the sector can attract relative to the social returns it generates.

The same disasters that create demand for disastertech solutions simultaneously destabilize the financial conditions early-stage firms need to capitalize on that demand. When physical assets are destroyed, the collateral underpinning bank lending erodes, cutting off traditional debt financing at precisely the moment reconstruction capital is most needed (Baltas et al., 2022). Though firms may pivot to private equity, venture capital, or crowdfunding to fill the gap, this substitution is deeply unequal: established firms with auditable track records and visible balance sheets can credibly make that case to investors, while seed-stage disastertech start-ups generally cannot (Baltas et al., 2022). Investors pull back from ownership risk when uncertainty spikes, and this retrenchment is broad enough to move regional asset prices well beyond directly affected firms (Bourdeau-Brien & Kryzanowski, 2020). For disastertech ventures, this dynamic is particularly self-defeating–the severity of a disaster event both validates the market need for their solutions and forecloses the financing channels through which they might scale to meet it. Standard fundraising mechanisms, designed for stable market conditions, are structurally misaligned with the episodic, shock-driven demand cycles that define the disastertech sector.

New venture formation takes a hit too. Cordero (2023) finds that high-fatality events reduce entrepreneurial activity at the county level–each additional death per thousand inhabitants is associated with a 15.1% decline in new business formation–driven by availability and incidental emotion biases that make uncertainty feel permanent rather than temporary. Nanda & Rhodes-Kropf (2017) add that innovative start-ups relying on staged financing are particularly

exposed: when investors anticipate future funding constraints and exit early, firms lose the strategic optionality that staged capital is designed to preserve.

The through-line across all of this is straightforward. Disasters destroy output, widen the gap between the social returns of resilience investment and the private capital allocated to it, and leave behind financial frictions that suppress the very entrepreneurial activity needed to build the next generation of solutions. The economic case for redirecting private capital toward disastertech is not just theoretical–it is built into the structural consequences of inaction.

Theme 2: Hindrances to Private Sector Investments in Resilience Technology

It is hard to predict the exact consequences of natural disasters, making it difficult for venture capital firms to value resilience technology. Though many multinational corporations demonstrate high-level awareness of climate hazards, they lack the granular, localized data required to map risks across complicated global supply chains. There are pervasive information gaps: disaster risk profiles are often fragmented, incomplete, or outdated, meaning both firms and governments regularly rely on insufficient hazard maps and exposure data (Adhikari & Safaee Chalkasra, 2023; Ishiwatari & Surjan, 2019). This makes it difficult for investors to accurately price risk or assess return potential, increasing uncertainty around future cash flows and raising discount rates applied to resilience investments. These challenges are compounded by a scarcity of standardized data regarding the profitability of sustainable investments, which limits the ability of investors to apply conventional financial models (Lin, 2022).

A central issue underlying these information constraints is the difficulty in monetizing avoided losses. The primary value of resilience technologies lies in preventing damage, yet this

value is rarely linked to direct or excludable revenue streams because no transaction occurs for a disaster that does not happen (Adhikari & Safaee Chalkasra, 2023; Ishiwatari & Surjan, 2019). As a result, private markets systematically underestimate the economic importance of adaptation technologies. Barrett & Chaitanya (2023) argue that the absence of frameworks translating adaptation outcomes into measurable cash flows prevents investors from treating these projects as bankable assets. Investment cases therefore remain framed in terms of "welfare benefits," which are better suited to public funding than private capital (Barrett & Chaitanya, 2023). The lack of standardized methodologies to quantify avoided losses further constrains financial institutions' ability to underwrite returns, reinforcing the perception that these investments carry high uncertainty (Trittipo et al., 2025).

This challenge is closely tied to a broader value capture problem. The benefits of resilience investments are largely diffused across society–accruing to governments, households, insurers, and communities–while private firms capture only a small share of the total returns (Adhikari & Safaee Chalkasra, 2023; Barrett & Chaitanya, 2023). Consequently, the social returns to adaptation exceed private returns, weakening incentives for private sector participation. Even when firms are willing to invest, they often struggle to identify financially viable projects that align with standard investment metrics, as traditional valuation models do not adequately account for reduced volatility or avoided costs (Barrett & Chaitanya, 2023).

Institutional and regulatory constraints further limit private capital deployment. Local governments frequently lack the technical and financial capacity to design and promote disaster risk reduction (DRR) projects that are attractive to private investors (Ishiwatari & Surjan, 2019). At the same time, global development assistance for DRR remains a "miniscule" 0.4% of total aid, indicating insufficient public-sector catalytic funding to de-risk private investment

(Ishiwatari & Surjan, 2019). The regulatory environment presents one of the most consistent barriers to private investment in resilience technology. Where national guidelines on private sector participation in adaptation are absent or unclear, investors cannot reliably assess how risks will be shared–and unpriced uncertainty tends to translate directly into withheld capital (Adhikari & Safaee Chalkasra, 2023). Fragmented agency governance, bureaucratic delays, and the political tendency to prioritize reactive post-disaster spending over proactive risk reduction make this problem worse, particularly in regions where institutional capacity is already stretched (Adhikari & Safaee Chalkasra, 2023; Ishiwatari & Surjan, 2019).

Deploying resilience technologies at scale also demands technical expertise–in remote sensing, IoT systems, and real-time data infrastructure–that is in short supply across most markets and critically scarce in the communities bearing the greatest disaster risk (Krichen et al., 2024). For investors evaluating early-stage companies, that scarcity raises legitimate questions about whether a product can be reliably implemented and maintained at the scale required to generate venture returns.

The financial structure of the sector adds further friction. Nanda & Rhodes-Kropf (2017) show that financing risk–the reasonable expectation that future funding rounds will be hard to close–causes investors to exit innovative ventures earlier than their fundamentals justify, cutting off the staged capital that disastertech start-ups depend on to reach commercial viability. Gaddy et al. (2016) point to a related structural tension: the development timelines and capital intensity typical of resilience technologies are simply incompatible with the return horizons of most VC

funds, a mismatch that the cleantech crash of 2006–2011 exposed with lasting consequences for investor appetite in adjacent sectors.[1]

Taken together, these barriers describe a sector where the underlying economic rationale for investment is clear but the surrounding conditions–policy frameworks, institutional infrastructure, patient capital, standardized metrics–have not kept pace. The gap between what resilience technology could attract and what it actually does is not primarily a function of market demand. It is a function of the investment architecture that does or does not exist around it.

Theme 3: Changing Investor Sentiment in Resilience Technology

The investment case for climate resilience is strengthening, though private capital has been slow to follow. Projected demand for resilience technologies sits between $600B and $1 trillion by 2030, and the financial returns are there to justify attention–adaptation investments have demonstrated an average expected economic internal rate of return of 27%, driven by avoided losses and benefits that accrue even in quiet years without a major event (Brandon et al., 2025; Trittipo et al., 2025). Corporate communications reflect the shift too, with climate-resilience mentions rising 55% between 2021 and 2025–a signal that executives are beginning to treat climate risk as a financial reality rather than a reputational concern (Trittipo et al., 2025).

[1] The cleantech crash of 2006-2011 followed a wave of venture capital into capital-intensive clean energy hardware–solar, biofuels, and battery storage–that proved structurally incompatible with standard VC fund timelines and return expectations. The 2008 financial crisis, falling oil prices, and the rise of subsidized Chinese solar manufacturing combined to collapse margins and dry up follow-on capital, ultimately wiping out more than half of the roughly $25 billion deployed (Gaddy, Sivaram, & O'Sullivan, 2016). The episode remains the canonical example of venture capital's limitations when applied to sectors with long development cycles, heavy capital requirements, and policy-dependent revenue models.

The capital, however, has not caught up. Public institutions still fund over 85% of resilience investment globally, with all private capital–venture, equity, corporate balance sheets combined–accounting for less than 11% (Trittipo et al., 2025). Climate-resilience funds have raised under $8B across fewer than 120 vehicles as of 2025, compared to $650B flowing into more than 1,300 mitigation-focused funds (Trittipo et al., 2025). That gap is not a rounding error–it reflects a sector that the private market has not yet decided to take seriously at scale.

Some investors are moving. Lightsmith Group, Invesco, and Convective Capital have each launched or expanded dedicated resilience vehicles in recent years, with Convective scaling from $25M to $75M between 2022 and 2025 (Trittipo et al., 2025). The instruments being used are also getting more creative–a study of 162 global adaptation initiatives found 11 distinct financing structures in use, from parametric insurance to blended finance to blue bonds, with three quarters of cases pooling capital across portfolios rather than betting on single projects. Multi-country structures have grown from 16% of the market in 2015 to 47% in 2024 (Brandon et al., 2025).

Within venture capital specifically, the hard lessons of the cleantech era have pushed investors toward software-based resilience plays over capital-intensive hardware (Gaddy et al., 2016; Trittipo et al., 2025). Patient capital from pension funds and sovereign wealth funds are starting to fill some of the timeline gaps that traditional VC structures cannot accommodate (Gaddy et al., 2016). Whether that momentum compounds or stalls is one of the questions this thesis is designed to answer.

Technological advancements are further accelerating momentum in the sector. The integration of artificial intelligence, machine learning, and geospatial analytics is enhancing the

ability to measure climate risks and quantify sustainability impacts at the asset level (Lin, 2022). These tools enable more precise risk modeling and return estimation, which are critical for financial institutions evaluating resilience investments (Trittipo et al., 2025). As analytical capabilities improve and willingness to pay for resilience increases across sectors, previously underinvested technologies may be entering “hot” financial markets that support experimentation, scaling, and discovery (Nanda & Rhodes-Kropf, 2017; Trittipo et al., 2025).

Taken together, the literature points to a sector at an inflection point. A rapidly expanding market opportunity, increasing financial innovation, and early signs of private capital mobilization indicate growing momentum in resilience technology. Yet the persistence of structural barriers means that private investment has not scaled to meet global adaptation needs; it lacks the risk adjusted rate. The disastertech industry is therefore best understood as an emerging asset class–one characterized by strong economic fundamentals and accelerating interest but still in the early stages of capital formation and market maturation.

Theme 4: How Policy and Regulatory Frameworks Impact Venture Capitalists

From a venture capital standpoint, the health and activity levels of the industry are inextricably linked to federal policy, which acts as the primary determinant for the flow of capital into highly innovative technological ventures (HITVs). Historical evidence identifies the reduction of capital-gains tax rates as the single most critical catalyst for industry growth (Dimitrova & Eswar, 2023). For example, the industry saw a sustained decline in committed capital when the maximum capital-gains tax reached 48.2% in 1969, while the 1978 reduction to 28%–and subsequent moves toward 20%–triggered an unprecedented "rebirth" of venture

investing (Lerner & Nanda, 2020). VCs argue that any proposed increase of this tax to 35% or more would act as a decisive deterrent to the pace of resilience innovation. To further align policy with long-horizon resilience goals, some propose eliminating capital-gains taxes entirely for investments held for at least four to five years, thereby incentivizing "patient" capital over early-exit strategies (Lerner & Nanda, 2020).

The regulatory environment also dictates the entry of Limited Partners (LPs), such as pension funds, which are essential for mobilizing capital at scale. Historically, stringent regulations like the proposed Department of Labor ERISA "plan-asset" rules discouraged pension fund managers from investing in VC by requiring fiduciary responsibility for each individual portfolio company–a task viewed as nearly impossible for hard-to-evaluate, early-stage HITVs (Lerner & Nanda, 2020). Current VCs face a similar hurdle in the lack of standardized data and clear legal taxonomies for sustainable investments (Lin, 2022). Without uniform standards, VC firms are forced to establish costly internal research centers or rely on expensive third-party agencies to verify the "green" credentials of their portfolios and prevent "greenwashing" (Lin, 2022). In response, some suggest the creation of specialized sustainability boards on stock exchanges to provide the liquid exit routes necessary to make long-horizon resilience projects bankable (Lin, 2022).

Finally, the federal government is viewed as the provider of the "roots" of innovation through its support for basic research in the sciences. There is a consensus among VCs that a continuing flow of knowledge from basic research is vital for creating new technological opportunities (Lerner & Nanda, 2020). Programs such as ARPA-E and Small Business Innovation Research (SBIR) are recognized as essential de-risking tools that allow start-ups to bridge the "valley of death" without being prematurely forced onto the "VC countdown clock to

exit" (Gaddy et al., 2016). However, the absence of specific national guidelines on private sector engagement in climate adaptation remains a significant barrier, creating a regulatory void that discourages long-term capital commitments (Adhikari & Safaee Chalkasra, 2023).

Theme 5: Venture Capital Firms' Strategic Trade-Offs in Resilience and Financing Risk

Venture capital fund managers must strategically navigate "financing risk," defined as the danger that a fundamentally viable firm will fail to secure future funding rounds due to capital market fluctuations rather than poor project fundamentals (Nanda & Rhodes-Kropf, 2017). This risk is most acute for early-stage and highly innovative ventures because they require sequential funding rounds to "wait and learn" before moving to mass production (Gaddy et al., 2016; Nanda & Rhodes-Kropf, 2017). Because the earlier stages of a project are more likely to fail, early-stage firms are less able to defend against financing risk and are more vulnerable to waves of investor interest and disinterest (Nanda & Rhodes-Kropf, 2017).

To manage this uncertainty, VCs utilize staged financing, which allows them to maintain a "real option" to abandon a project if the technology proves unfeasible (Lin, 2022; Nanda & Rhodes-Kropf, 2017). However, this strategy creates a fundamental trade-off: while providing a start-up with a massive upfront "war chest" can protect it from future market shocks, it simultaneously destroys the investor's option to stop funding a project that intermediate information reveals to be non-viable (Nanda & Rhodes-Kropf, 2017). In a world of incomplete contracts, this loss of real options can turn a positive-NPV project into a negative one (Nanda & Rhodes-Kropf, 2017). Consequently, extremely novel resilience technologies often require "hot"

financial markets–periods of high investor optimism and low financing risk–to survive their initial period of discovery and diffusion (Nanda & Rhodes-Kropf, 2017).

External shocks, such as natural disasters or financial crises, further complicate these strategic trade-offs. During financial crises, there is a systematic decline in funding volume, particularly for later-stage ventures that are "locked in" to high capital needs and cannot avoid lower valuations (Block & Sandner, 2009). Conversely, natural disasters create a scenario where the destruction of physical assets clogs traditional bank lending due to a lack of collateral, leading firms to seek alternative finance sources such as private equity and crowdfunding. Empirical evidence shows that private funding in affected regions increases by an average of 47% within three months of a disaster (Baltas et al., 2022). Interestingly, large-sized firms often have an advantage in accessing this alternative finance because they are well-known and provide reliable information to the market (Baltas et al., 2022).

To succeed in volatile or "cold" markets, specialized VCs must move beyond providing "risk money" to offer "management intensive" involvement. This includes a process known as "bird-dogging," where investors engage in active outreach to identify exceptional innovators rather than waiting for business plans to come to them. This heavy involvement often includes serving on boards, selecting key management teams, and providing the credibility with suppliers and bankers needed during a disaster recovery period (Lerner & Nanda, 2020). Ultimately, while innovative resilience firms remain the most vulnerable to capital market fluxes, the presence of strong community strength and voluntary associations can act as a psychological buffer, helping founders overcome the irresolvable uncertainty triggered by deadly disasters (Cordero, 2023).

Gaps in Literature

While existing research provides substantial insight into the macroeconomic burdens of disasters and the broader dynamics of climate finance, significant gaps remain in understanding the role of venture capital (VC) in disaster-resilience technologies (disastertech) and how this market has evolved over time.

A primary gap in the literature is the disproportionate focus on post-disaster financial recovery rather than pre-disaster technological investment. Much of the empirical work examines how capital flows into affected regions after disasters to compensate for credit constraints, asset destruction, and reconstruction needs (Baltas et al., 2022). Similarly, macroeconomic studies emphasize short-term output losses and the resulting "finance gap" for rebuilding (Noy, 2009; Ishiwatari & Surjan, 2019). While this work establishes the economic burden of disasters and the efficiency of risk reduction, it does not track how capital–particularly venture capital–is increasingly being allocated toward preventative and resilience-oriented technologies. Although recent industry evidence suggests a shift toward ex-ante investment in resilience (Trittipo et al., 2025), there is limited academic research providing a longitudinal analysis of how American VCs have transitioned from reactive "disaster recovery" funding to proactive "disaster prevention" as a growth sector.

Closely related is the lack of research on the role of private capital in adaptation markets, particularly the mechanisms through which venture capital evaluates and finances disaster-resilience technologies. While authors such as Barrett & Chaitanya (2023) and Adhikari & Safaee Chalkasra (2023) identify barriers to private investment, they do not examine long-term VC funding cycles or decision-making processes within this sector. More broadly,

there remains a shortage of academic work specifically focused on adaptation-related disaster technology, as most literature concentrates on either the economic impacts of disasters or the effectiveness of risk reduction strategies (Noy, 2009; Ishiwatari & Surjan, 2019).

A significant gap also exists in frameworks for commercial viability and valuation. The literature repeatedly highlights the absence of models that translate effective adaptation into measurable, bankable cash flows (Barrett & Chaitanya, 2023). As a result, resilience technologies are often framed as public goods generating "welfare benefits," rather than investable assets suitable for private equity or venture capital (Barrett & Chaitanya, 2023; Adhikari & Safaee Chalkasra, 2023). From a VC perspective, there is a clear knowledge gap in how to price disastertech companies and quantify "avoided losses" as part of firm valuation (Lin, 2022; Trittipo et al., 2025). Existing scholarship does not sufficiently explain how firms can convert non-excludable resilience benefits into capturable private returns that meet the high-growth and high-return expectations of venture investors (Gaddy et al., 2016; Barrett & Chaitanya, 2023).

Another underexplored area is the evolution of investor sentiment amid increasing disaster frequency and severity. Prior research shows that disasters can increase local financial risk aversion and suppress entrepreneurial activity (Bourdeau-Brien & Kryzanowski, 2020; Cordero, 2023). Similarly, the concept of "financing risk" suggests that investors retreat from innovative ventures when future funding conditions are uncertain (Nanda & Rhodes-Kropf, 2017). However, the possibility that rising climate-related losses are instead shifting investor sentiment toward resilience technologies as a necessary and scalable market has not been rigorously examined. There is limited research mapping the psychological and strategic transition of VCs from viewing disasters as sources of irresolvable uncertainty to recognizing

disastertech as a potential “hot market” driven by structural demand (Nanda & Rhodes-Kropf, 2017; Trittipo et al., 2025).

The literature also lacks longitudinal and sector-specific analysis of disastertech investment trends. Industry reports from McKinsey (2025) and Brandon et al. (2025) provide valuable snapshots of emerging funds and financial instruments, but they do not offer comprehensive datasets tracking venture capital flows over time, particularly in the United States. There is currently no academic work that systematically documents twenty years of VC activity in disastertech, nor that identifies the key drivers of firm valuation at the intersection of climate risk, public funding, and private innovation. This gap limits the ability to draw evidence-based conclusions about how the sector is maturing.

Finally, there is insufficient integration of lessons from adjacent sectors, particularly regarding the “maturity mismatch” observed in cleantech. The failure of many cleantech ventures between 2006 and 2011 highlighted the tension between long development timelines and the shorter investment horizons of venture capital (Gaddy et al., 2016). While recent research notes increased attention to resilience technologies and evolving financing mechanisms (Trittipo et al., 2025; Brandon et al., 2025), it does not fully examine how disastertech is navigating similar challenges–such as the “valley of death”–or whether newer tools like blended finance and pooled investment structures are effectively addressing these constraints (Gaddy et al., 2016; Brandon et al., 2025).

In summary, the literature reveals a clear gap at the intersection of venture capital, valuation, and disaster-resilience technology. Existing work establishes the economic importance of adaptation and identifies barriers to investment, but it does not adequately explain how

disastertech is evolving into a potentially bankable, high-growth sector. Addressing these gaps requires a longitudinal, finance-oriented analysis that links macroeconomic risk, technological innovation, and investor behavior to explain the emerging role of private capital in disaster resilience.

Theoretical Framework

Adaptation vs Mitigation Natural Disaster Technology

Even in the disastertech industry, there exists confusion between adaptation and mitigation solutions; this conflict is key to understanding where investments in the natural disaster technology sector are progressing.

Mitigation technologies essentially attempt to lessen or stop climate change; this includes, as expressed previously, reduction of emission, energy efficiency, or carbon removal. They provide a strategy for global warming to be minimized in the long-term. Both the public and private sector have prioritized mitigation, deeming it necessary to prevent catastrophic climate cases. Therefore, the majority of its climate-tech venture funding in the last twenty years has been directed at renewable energy, electrification, carbon management, and related causes (Intergovernmental Panel on Climate Change, 2022).

Equally if not more important is adaptation. Natural disasters of all kinds have become more frequent, more intense, more costly, and seemingly unavoidable. These facts have, therefore, attracted the attention of the industry, which has reacted by showing more care. No one can stop an earthquake; fires will spread in forests; strong winds will tear apart people's houses. Technologies of adaptation are the means of survival at hand, they acknowledge the very first and unavoidable consequences of climate change and are about lowering vulnerability, ceasing

loss, and making recovery faster. Since the risks of climate change are happening at a faster rate than mitigation measures can be implemented, adaptation is, therefore, more economically urgent than it was previously anticipated. The very same question arises for the next generations. However, due to the time lag in mitigation, the very next generations will be the very first to benefit from adaptation measures. Hence, the focus only on mitigation is equivalent to postponing the problem, which will inevitably have to be addressed anyway, although at a higher price. Present times are referred to as a "defining decade" by science, policy, and finance communities. It means that the next ten years will allow keeping the rise of global temperature well below 2 degrees Celsius and heavily deciding the shape and size of the following century's impacts. The costs of adaptation are generally modest when compared to the costs. Thus, adaptation is the sector where technological interventions can bring about immediate, measurable, and sizable reductions in damages and economic volatility (2022).

This theoretical position helps unveil new investment trends. The signs of climate change continue to get stronger, making technology intervention necessary. These solutions bring in direct financial gains by detecting potential environmental damages early, stabilizing cash flows, and transferring risk. This aligns with the motivations of both public agencies and private investors. Venture capital is becoming more attracted to adaptation not because it substitutes mitigation but because it is the immediate response to rapidly growing, market disasters that are arising from policy lags. Hence, adaptation is turning into a disastertech investment center, reflecting the broader theoretical recognition that dealing with climate risk requires the tools that can work at the pace of climate impact.

Economic Logic of Increased Valuation in Natural Disaster Resilience Technology

The economic reasoning behind the rising valuations in natural disaster resilience technology comes from increasing climate risk, growing financial losses, and a clearer way to measure avoided damages. Resilience technologies increasingly deliver measurable economic returns, bolstering the investment case for disastertech.

Climate adaptation economics reveal the financial mechanisms behind resilience technologies by calculating how they prevent significant financial shocks and therefore produce positive net present value (NPV). As indicated in the literature review, benefit-cost analyses suggest that disaster risk reduction can return avoided losses at ratios ranging from 4:1 to 7:1 (Ishiwatari & Surjan, 2019)–a compelling case for investment on paper. Yet this return structure contains a fundamental paradox that undermines private capital formation: when disastertech works, nothing happens. Prevented losses are invisible by definition, and markets cannot price an absence. The result is that investors, insurers, and policymakers are systematically deprived of the feedback signal that would otherwise justify sustained capital commitment. This dynamic–disasters avoided, credit unclaimed–is not merely an inconvenience. It is a structural market failure embedded in the nature of resilience itself.

Watkins and Bazerman (2003) offer a useful diagnostic for why this failure persists. Their framework identifies three sequential breakdowns–failures of recognition, prioritization, and mobilization–that explain why organizations repeatedly fail to act on foreseeable threats. Crucially, they argue that the psychological barriers are often the most intractable: decision-makers discount future catastrophic costs relative to certain present-day expenditures, act only after experiencing harm directly, and maintain status quo bias even when warning signals are abundant. For disastertech ventures, this translates directly into a fundraising

environment in which the very counterfactual that justifies their existence–the disaster that did not occur–is the hardest thing to sell to an investment committee operating on a ten-year fund cycle.

The same logic appears in commodity markets. Meyer (2022) documents how climate-driven supply destruction in Canadian lumber–beetle kill, wildfire, atmospheric flooding–produced price volatility that the market could neither forecast nor absorb, breaking supply chains and rendering standard pricing models obsolete. The lumber case illustrates a broader principle relevant to disastertech: when climate interacts with infrastructure, the damage cascades across sectors in ways that compound over time and resist standard risk-pricing. That repricing failure is both the problem disastertech ventures are designed to solve and the reason private capital has difficulty funding them at scale.

This means that resilience technologies provide economic value before they generate revenue. This fits with the financial theory: when a technology decreases uncertainty in future cash flow, the discount rate applied to those cash flows drops, increasing firm valuation.

Venture Capital Investment Theory

Venture capital investment decisions rest on the expectation of high returns that make up for significant early-stage risk. Classic venture capital theory suggests that VCs invest in start-ups that achieve rapid growth (Gompers & Lerner, 2001). They take advantage of information gaps through staged financing, monitoring, and deal structuring, focusing their investment decisions mainly on market size (TAM), scalability of the business model, competitive differentiation, founders' track record and ability to execute, and the business' riskiness and time to liquidity. In industries like disastertech, where customers are often in the

public sector, venture capital firms also factor in aspects like regulatory challenges, predictability of revenue generation, and timeline feasibility for procurement.

Venture capital firms follow the "power law" distribution of returns. Typically, one in ten investments contributes most of the fund's performance. As such, VCs aim for ventures that could provide ten times their investment or more at exit. That applies particularly to new and volatile markets such as resilience tech with a total addressable market (TAM) that is expanding as a result of growing disaster losses (Gompers & Lerner, 2001; Kerr, Nanda, & Rhodes-Kropf, 2014). The risk-return perspective in climate adaptation and disaster-tech is evolving due to increasing catastrophe losses, which in turn is driving the demand for resilience tools by insurers, reinsurers, and the public sectors, and also because government grants are becoming the main source of funding for early-stage pilot projects. These trends enhance the expected upside while slightly lowering the downside risk, making disastertech more in line with VC return expectations.

Moreover, venture capital decisions happen amid Knightian uncertainty, where the chances of outcome cannot be fully known. VCs, therefore, value optionality–the ability to scale quickly if the market opens up; learning curves–initial data that reduces uncertainty; third-party signals that address information gaps–i.e. regulatory approvals or partnerships with insurance companies. Uncertainty is especially high in disastertech, because markets are heavily affected by the frequency of disasters, public responses, and regulatory debates (Barrett & Chaitanya, 2023). VCs tend to discount similar companies more heavily, unless they can show reliable risk data, evidence of secure, repeated revenue streams, proof-of-concept with credible partners like FEMA, or intellectual property that produce barriers to entry from other rising start-ups.

Reducing the uncertainty factor can directly lower the discount rate in valuation models. VC decisions are often affected by behavioural factors, such as herding behaviour–funds will increase their investments when other top-tier funds enter a market; overconfidence–the funds unfairly believe that they can quote-unquote pick winners without fail; narrative framing–founders provide compelling stories without the technology to back it up; pattern recognition bias–the investors favour founders who are similar to previous owners of successful ventures. In climate adaptation, salience bias also influences decisions. VCs invest more aggressively after major disasters when the need for solutions becomes clearer. For example, funding for wildfire technology often spikes following significant fire seasons. These behavioural dynamics help explain why disastertech funding increases after impactful events.

Methodology

This thesis follows a mixed-methods research design process that complements a quantitative investment analysis with qualitative interviews with industry leaders. The methodology is separated into three sections.

Historical Investment Patterns

This first section relies on historical investment data to assess how venture capital investments in natural disasters technologies have changed from 2006 to 2025. Sources include PitchBook, Crunchbase, DealBook, and the Bloomberg Terminal.

Deal Identification and Classification: Start-ups were sorted into subsegments of disastertech using the following keyword filters: *early-warning and forecasting systems, climate-resilient infrastructure and building materials, disaster-response robotics and drones,*

parametric insurance platforms (data-driven insurance systems that pay out automatically when a specific event parameter is met, i.e. hurricane reaching a certain wind speed) and risk analytics, real-time communication and evacuation tools, natural disaster technology, disaster resilience technology, disaster risk management technology, disaster response technology, disaster recovery technology, emergency management technology, climate resilience technology, climate adaptation technology, hazard early-warning systems, crisis response technology. The keywords were structured to capture the full disaster lifecycle–prevention, response, and recovery–while excluding climate mitigation technologies (e.g., carbon capture, renewables) that address the causes of disasters rather than their consequences. Functional keywords target specific roles: early-warning systems, physical infrastructure hardening, acute-phase robotics and drones, financial risk instrumentation, and evacuation coordination. Taxonomic keywords–"disaster resilience technology," "climate adaptation technology," "emergency management technology"–reflect the varied vocabulary used across investor databases, accelerator programs, and grant classifications across different eras and markets, reducing selection bias toward any single naming convention.

Venture capital firms were sorted through the following terms: *catastrophe modeling and risk analytics, weather intelligence, climate analytics, geospatial intelligence, infrastructure resilience, parametric insurance, insurtech for climate risk, emergency communications, remote sensing, wildfire detection, flood prediction, early warning systems (EWS), disaster recovery platforms, humanitarian technology, public safety technology.* This search was geographically constrained to the United States of America. These filters capture how investors–rather than founders–describe their mandates, which skews toward risk and analytics language rather than operational terminology. Quantitative terms like catastrophe modeling, weather intelligence, and

geospatial intelligence target firms operating at the data and prediction layer, where venture returns are most legible. Parametric insurance and insurtech for climate risk capture the financial instrumentation layer. Operational terms–wildfire detection, flood prediction, emergency communications–target hazard-specific investors, while humanitarian technology and public safety technology capture mission-driven firms whose portfolios overlap with disastertech but who may not use climate-specific language. The geographic constraint to the United States reflects data availability and regulatory coherence: U.S. venture markets are the most comprehensively tracked, and the federal disaster policy framework–FEMA, SBIR, the Stafford Act–constitutes a sufficiently distinct environment to warrant standalone analysis.

Time-Series Analysis: A compilation of total venture capital deal count and total venture capital dollar invested per year from 2006 to 2025 (20 years) in the natural disaster resilience technology sector.

Trend Analysis: Patterns on growth and CAGR were assessed with particular attention being made on time periods 1-2 years after Hurricane Katrina (August 2005), Super Outbreak (2011), and Camp Fire (2018), three of the highest-impact disasters in the last 20 years of American history.

Factors Increasing Investments

This section examines why natural disaster resilience technology investments have increased.

Financial Cost of Catastrophe: Assessment of the last 20 years in the United States, in which annual economic losses and fatalities were evaluated via data collected with NOAA,

FEMA, and NCEI. 403 disasters in drought, flooding, freeze, severe storm, tropical cyclone, wildfire, and winter storms were assessed.

Correlation Test and Regression: Detect if there was a relationship between disaster losses and VC investments.

Factors Increasing Company Valuation

To understand how start-ups can boost their valuation, qualitative interviews with 12 start-up founders and 10 venture capital investors were conducted.

Semi-Structured Interviews: Conversations held with founders covered their go-to-market strategy, how they express value such as loss avoidance and risk analytics, regulatory hurdles, and how they used validation methods like pilots and partnerships. Interviews were held with venture capitalists, covering subjects like specialized investment theses for resilience technology, how VCs value start-ups with relatively high risk, the criteria for disastertech, and the role of revenue potential, partnerships, and market size.

The interviewers were analyzed using thematic analysis, focusing on themes related to valuation such as traction, uncertainty reduction, regulatory clarity, data validation, and capital efficiency. Findings were interpreted using the VC valuation theory and frameworks of adaptation economics. Questions for the interviews can be found in Appendix 1.

Results

Quantitative Venture Capital and Natural Disaster Patterns

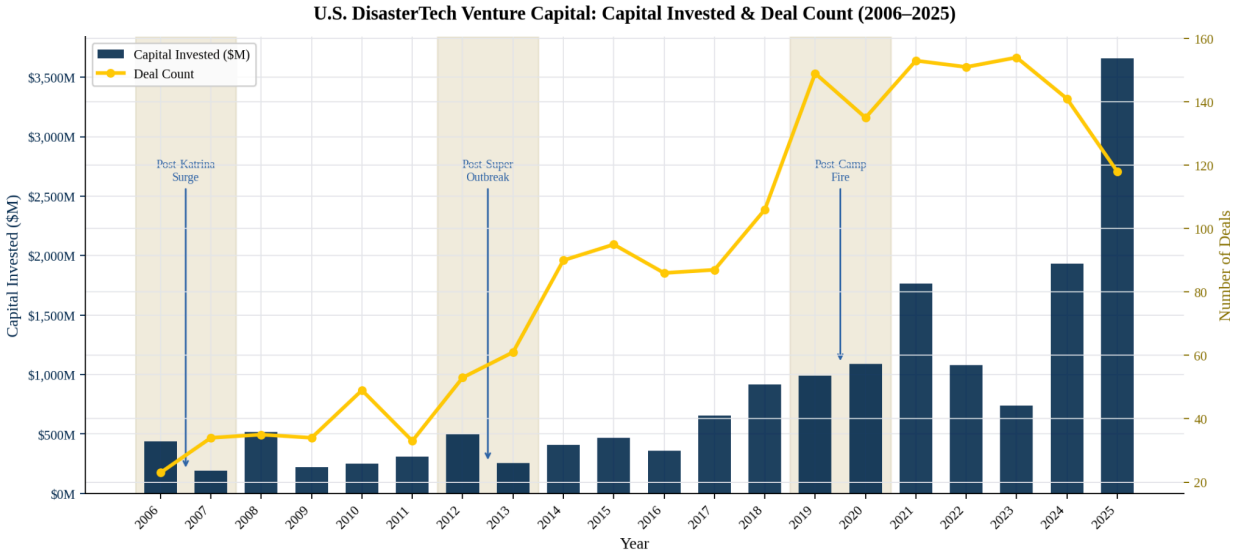


Figure 2: U.S. Disastertech VC Capital Invested & Deal Count (2006–2025)

Figure 2 presents a twenty-year longitudinal view of venture capital activity in U.S. disastertech, tracking total capital deployed and deal count from 2006 through 2025. Read together, the two series reveal a market moving from sporadic, event-driven bursts of capital toward a more sustained and institutionalized investment thesis–a pattern that directly supports both core hypotheses of this thesis.

2006–2011: Reactive capital, thin deal flow

The earliest years are characterized by low and volatile capital figures oscillating between $192M (2007) and $517M (2008), with deal counts clustered in the low-to-mid 30s. The shaded surge window around 2006–2008 reflects the 1–2 year lag following Hurricane Katrina,

consistent with the salience bias dynamic described in the theoretical framework: investors respond more aggressively to disastertech after a high-profile catastrophe makes the need for solutions viscerally legible (Barrett & Chaitanya, 2023). The surge does not hold. Capital dips sharply through 2009–2010, compounded by the global financial crisis–consistent with Block & Sandner's (2009) finding that financial crises produce systematic declines in VC funding volume. Deal count remains relatively stable even as capital swings, suggesting investor interest without conviction.

2012–2017: Steady accumulation, deepening deal pipeline

The years following the 2011 Super Outbreak mark a shift in the character of disastertech investment as much as its scale. Deal count nearly doubles from 53 in 2012 to 95 by 2015, while capital grows more modestly from $499M to $656M by 2017–a divergence that points to a market filling with smaller, earlier-stage bets rather than large concentrated positions. Gaddy et al. (2016) identify this pattern as a direct response to the cleantech collapse: burned by capital-intensive hardware plays that failed to return at venture scale, investors adopted more cautious staged financing strategies that kept check sizes small and preserved the option to exit if intermediate milestones were missed. The capital acceleration in 2016-2017 adds another layer to the story. Growing federal support from the EDA, NSF, and DOE during this period reduced the perceived risk of backing early-stage resilience start-ups–not by replacing private capital, but by providing the kind of institutional validation and co-investment that made private capital more willing to move. That mechanism is central to Hypothesis 1: government funding in

disastertech functions less as a substitute for venture investment than as a signal that lowers the threshold for it.

2018–2025: Structural market formation

In the post-Camp Fire period, capital crosses $1B for the first time in 2021, reaching $1.76B, while deal count settles into a steady plateau of 140-154 annually through 2019-2023–a pattern that looks less like a surge and more like a sector finding its cruising altitude. When capital pulls back in 2022-2023 without a corresponding drop in deal activity, it tells a different story than the 2009-2010 collapse, when both series fell together. Investors were still making bets; they were just making smaller ones, which in context reads as discipline rather than retreat. The 2024-2025 breakout changes the picture again. Capital jumps from $1.93B to $3.66B as deal count quietly declines from 141 to 118–fewer transactions absorbing more dollars each, a pattern consistent with later-stage companies pulling in institutional rounds as the sector matures (Trittipo et al., 2025).

Read as a whole, Figure 1 traces the arc both hypotheses anticipate. The three post-disaster surge windows–each producing measurable capital acceleration on a 1-2 year lag–ground Hypothesis 1 in the data: rising disaster losses do drive investment. But the more consequential finding may be what happens after 2019. Capital that holds through a macroeconomic contraction and then breaks to a new high is not behaving reactively–it is behaving like a thesis. That shift, from salience-driven bursts to durable, conviction-based positioning, is precisely what Hypothesis 2 predicts, and what Nanda & Rhodes-Kropf (2017) describe as the marker of a sector transitioning from experimental to established.

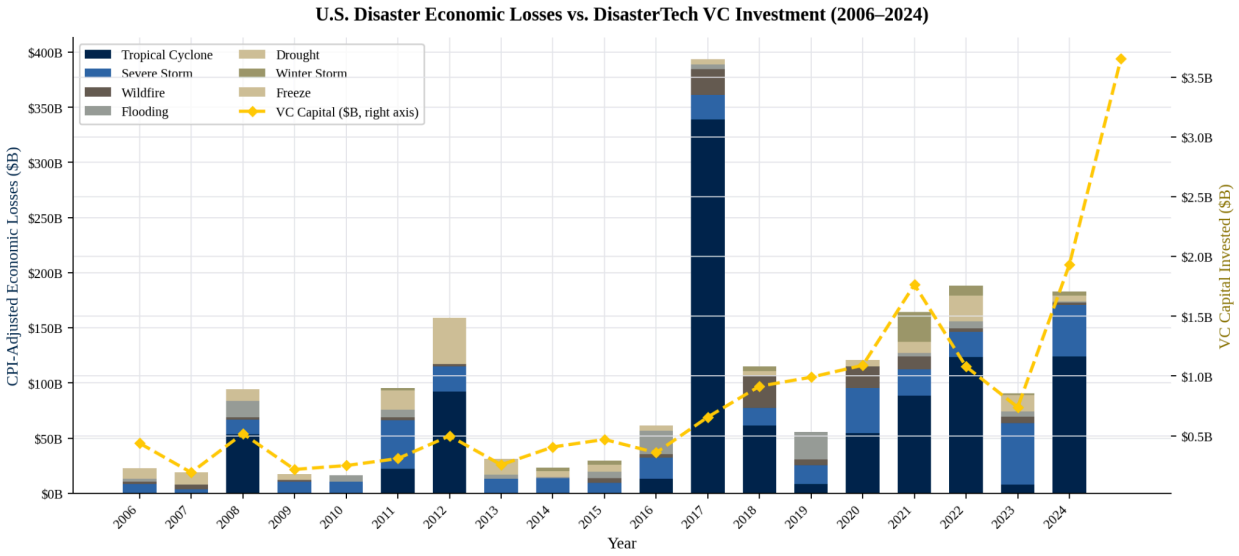


Figure 3: U.S. Disaster Economic Losses by Type vs. Disastertech VC Investment (2006–2024)

Figure 3 overlays CPI-adjusted economic losses from NCEI billion-dollar disaster events, disaggregated by type (stacked bars, left axis), against total annual disastertech VC capital deployed (dashed line, right axis). Where Figure 1 established that VC investment has grown, Figure 2 interrogates why–revealing which disaster categories drive the demand signal and where the capital gap is largest. The figure makes visible a fundamental tension: the disaster types generating the greatest economic losses are not always those attracting the most private investment.

Structural dominance of tropical cyclones

Tropical cyclones account for $988.6B in CPI-adjusted losses across 2006-2024–52.6% of all billion-dollar disaster costs–concentrated in a small number of catastrophic years. The 2017 bar ($393.5B total) is dominated by Hurricanes Harvey ($160B), Maria ($115.2B), and

Irma ($64B); the 2022 bar ($188.3B) by Ian ($119.6B) alone. This concentration illustrates Noy's (2009) argument that the scale of losses relative to GDP determines macroeconomic impact more than meteorological intensity. The VC line responds accordingly: capital rises from $656M (2017) to $914M (2018) and $990M (2019), a 51% two-year increase–the clearest instance in the chart of the demand-driver mechanism Hypothesis 1 describes.

Severe storms: the quietly accelerating baseline

Severe storms total $412.9B across the period (22% of all losses), with annual figures trending upward from $8-14B in the early years to $55.7B in 2023 and $46.8B in 2024. Unlike catastrophic hurricanes, the steady escalation of severe storm losses represents the kind of predictable, recurring loss trajectory that makes the NPV case for resilience investment–generating durable demand for parametric insurance platforms, early-warning systems, and damage assessment tools (Barrett & Chaitanya, 2023). This connects directly to the deal count plateau of 140-154 annually from 2019-2023 identified in Figure 1: firms serving the severe storm market can build recurring revenue models not dependent on a single catastrophic event.

Wildfire: disproportionate VC attention relative to loss share

Wildfire losses total just $123.2B (6.6% of all losses), yet attract outsized investor interest. The 2018 Camp Fire peak ($30B) triggers a capital surge to $990M (2019) and $1.09B (2020), and catalyzes the emergence of dedicated funds such as Convective Capital, which scaled

from $25M (2022) to $75M (2025) (McKinsey, 2025). Three mechanisms explain this disproportionality. First, salience bias concentrates wildfire destruction in high-income California communities with dense VC networks (Barrett & Chaitanya, 2023). Second, technological tractability–satellite imagery, AI detection, drone analytics–aligns with the post-cleantech preference for capital-efficient software platforms over hardware (Gaddy et al., 2016). Third, destabilization of California's home insurance market has created strong institutional demand from insurers and reinsurers for risk modeling tools, providing the contractual revenue streams VCs require to underwrite returns (Adhikari & Safaee Chalkasra, 2023).

The drought paradox

Drought losses total $186.1B across the period–the third-largest category–yet generate no discernible VC response. The 2012 drought ($41.7B, the largest single-year figure in the dataset) is followed by a capital *decline* from $499M to $257M in 2013. This reflects the value capture problem Barrett & Chaitanya (2023) identify: drought losses accrue diffusely across agricultural producers, municipalities, and utilities, creating no concentrated insured loss event to trigger a reinsurer-driven demand signal. Without a legible, attributable loss and the institutional buyer it activates, private investors struggle to identify a financeable market. The literature notes that slow-moving, difficult-to-attribute climate risks remain systematically underinvested (Ishiwatari & Surjan, 2019); this data gives that observation a concrete figure–$186B in losses over nineteen years with minimal corresponding VC mobilization.

Three modes of VC-loss relationship

The dashed VC line reveals distinct dynamics across the period. Lagged alignment–a loss spike followed by VC increase 1-2 years later–is visible in 2011→2012 and 2020→2021, the pattern Hypothesis 1 anticipates. Decoupling–VC holding steady or growing despite falling losses, visible in 2013 and 2023–signals the transition to Hypothesis 2 territory, where investors have internalized disastertech as a structural opportunity independent of any single event. Simultaneous decline in 2022-2023, when both series fall together, reflects the broader macroeconomic VC contraction consistent with Block & Sandner (2009) and should be treated as a confound rather than a disaster-sector signal.

Limitations

Loss figures are restricted to NCEI billion-dollar events, excluding sub-threshold costs particularly relevant to drought. The VC capital line reflects all disastertech investment rather than subcategory-specific flows, making the overlay suggestive rather than causal. Disaggregated VC data by disaster type would considerably sharpen this analysis.

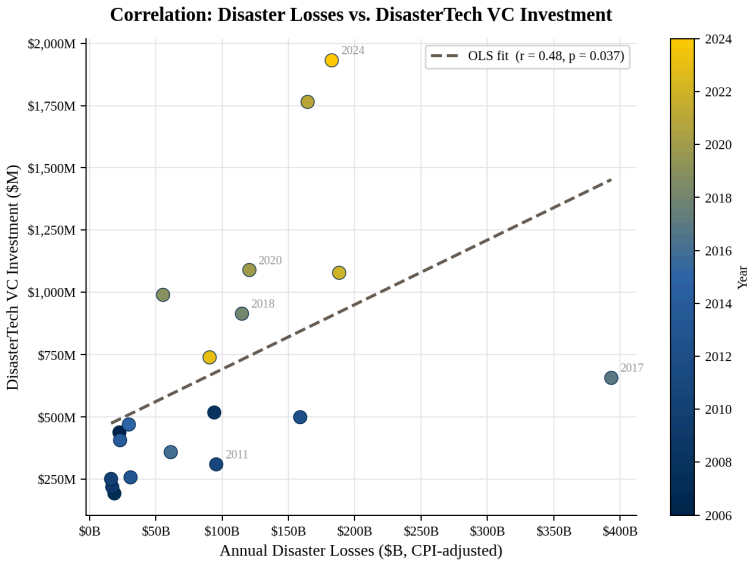


Figure 4: Correlation Between Disaster Losses and Disastertech VC Investment (2006–2024)

Figure 4 plots annual CPI-adjusted disaster losses against disastertech VC capital for each year from 2006 to 2025 (n = 20), with an OLS regression line fitted to the observations. The Pearson correlation is r = 0.48 (p = 0.037), indicating a statistically significant positive relationship between disaster losses and VC investment at the 5% threshold. However, Pearson's r is sensitive to outliers, and two observations–2017 and 2021–exert outsized influence on the fit. The Spearman rank correlation, which is robust to those extremes, returns a considerably stronger result: $\rho = 0.77$ ($p < 0.001$). Together, the two statistics suggest the underlying monotonic relationship between rising losses and rising VC is stronger than the linear fit alone implies.

The OLS slope indicates that each additional $1B in annual disaster losses is associated with approximately $2.6M in additional VC capital deployed–a modest ratio that reflects the value capture problem Barrett & Chaitanya (2023) identify: disastertech firms capture only a

small share of the economic value their technologies generate, which structurally limits how much private capital losses alone can mobilize.

Two notable deviations from the regression line warrant attention. 2017 sits well below the line: despite $393.5B in losses–the highest in the dataset, driven by Hurricanes Harvey, Maria, and Irma–VC capital was only $656M, reflecting the investment lag documented in Figure 1. By contrast, 2024 sits well above the line, with $1.93B in VC deployed against $182.7B in losses, consistent with Hypothesis 2's claim that investor sentiment has matured beyond reactive loss-chasing into proactive thesis-driven positioning (Nanda & Rhodes-Kropf, 2017).

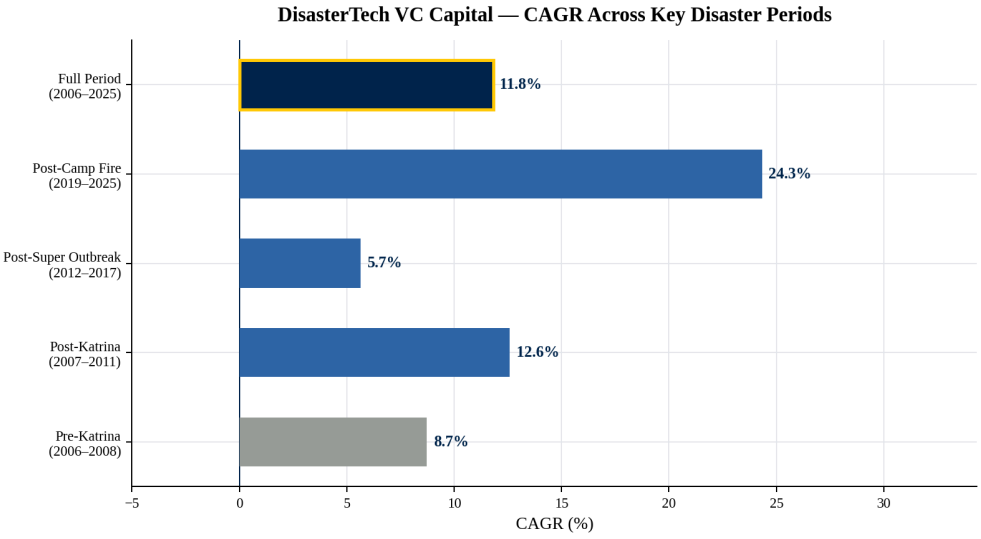


Figure 5: Disastertech VC Capital–CAGR Across Key Disaster Periods

Figure 5 disaggregates the full twenty-year investment trajectory into four disaster-delimited periods, enabling a direct comparison of growth rates across distinct market phases. The full-period CAGR of 11.8%–representing an 8.4x increase from $438M (2006) to $3.66B (2025)–provides the baseline against which each sub-period can be assessed.

The post-Katrina period (2007–2011) at 12.6% slightly outpaces the full-period average, consistent with the salience-driven surge described in Figures 1 and 2. However, starting from a depressed 2007 base ($192M, the lowest year in the dataset), this figure partially reflects a recovery effect rather than genuine acceleration. The post-Super Outbreak period (2012–2017) records the slowest CAGR at 5.7%, reflecting the contested, stop-start accumulation phase documented in Figure 1–early deal proliferation without corresponding capital commitment, and the lingering drag of the post-cleantech investment correction identified by Gaddy et al. (2016).

The post-Camp Fire period (2019–2025) is the analytically decisive bar. At 24.3%–more than double the full-period average–capital grew 3.7x in six years, from $990M to $3.66B. Critically, this CAGR is driven entirely by rising capital per deal rather than expanding deal volume: deal count over the same period *declined* from 149 to 118, a CAGR of -3.8%, a 28-percentage-point divergence from capital growth. This clearly shows that the market has entered a maturation phase. It is characterized by larger, later-stage investments with more established companies–which is the move from reaction to thesis-driven capital that Hypothesis 2 predicts. This idea is consistent with Nanda & Rhodes-Kropf's (2017) framework of "hot markets" that consolidate around proven ventures instead of experimenting broadly.

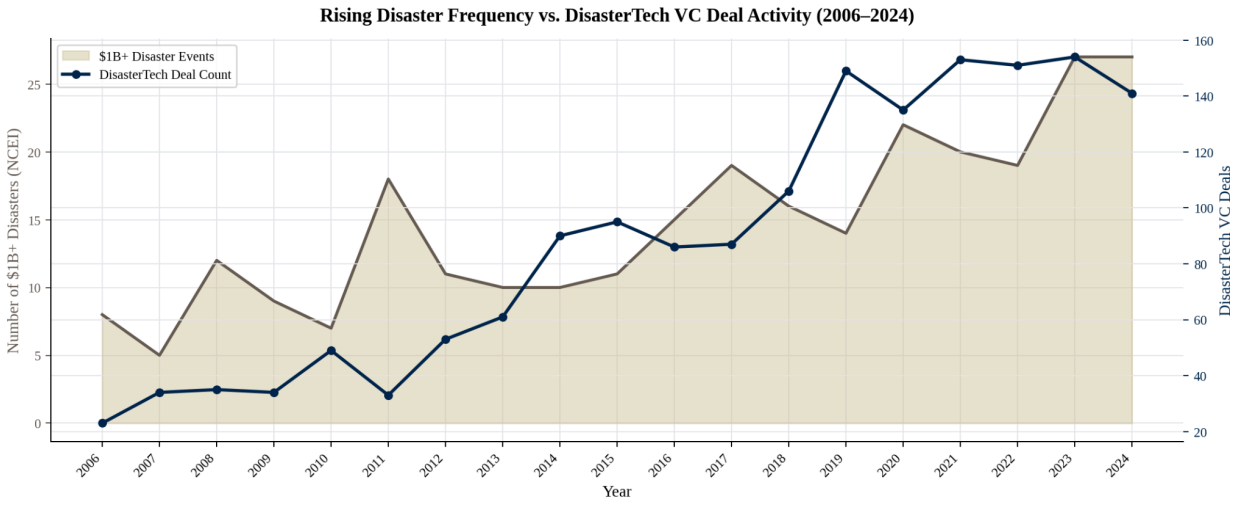


Figure 6: Rising Disaster Frequency vs. disastertech VC Deal Activity (2006–2024)

Figure 6 plots the annual count of billion-dollar disaster events (shaded area, left axis) against disastertech VC deal count (line, right axis) from 2006 to 2024. Where Figure 4 examined the relationship between disaster losses and venture capital, this graph exposes disaster frequency and deal volume, representing investor's response to the sheer proliferation of events, independent of their dollar magnitude.

The two series are strongly correlated: the Pearson correlation between annual event count and deal count is $r = 0.75$ ($p < 0.001$), with a Spearman ρ of 0.72 ($p < 0.001$) confirming robustness to outliers. The event count CAGR of 7.0% from 2006 to 2025 (8 → 27 events) is meaningful on its own, but the deal count CAGR of 10.6% over the same period (23 → 141 deals) outpaces it considerably–suggesting that investor responsiveness has compounded faster than the underlying disaster frequency driving it. This gap is consistent with Hypothesis 2: as the sector has matured, each additional disaster event generates more deal activity than it would have a decade earlier, reflecting deepening market infrastructure and a growing pool of fundable companies.

The most instructive comparison in the figure is 2011 against 2019. Both years record approximately 18-19 billion-dollar disaster events. In 2011, those events generated just 33 deals; in 2019, an equivalent event count produced 149 deals–a 4.5x difference in deal response for the same disaster frequency. This divergence captures in a single comparison the structural shift this thesis documents: in 2011, the market was nascent and investor attention reactive; by 2019, a pipeline of specialized disastertech firms existed to absorb capital, and investors had developed the sector literacy to deploy it. Cordero (2023) identifies the suppressive effect of high-fatality disasters on new venture formation–but the 2019 data suggests that by the post-Camp Fire period, that psychological friction had been substantially overcome by the growth of a more established disastertech ecosystem.

Post-2018, the average annual event count rises to 20.7 from a pre-2018 average of 11.2, while average annual deal count rises from 56.7 to 141.3. The near-doubling of disaster frequency in the latter half of the dataset, combined with the 2.5x increase in deal activity, suggests that rising frequency has functioned as a structural demand signal–not merely a salience trigger–consistent with the macroeconomic burden literature reviewed by Ishiwatari & Surjan (2019), which finds that the trajectory of climate losses is sufficiently predictable to support sustained investment rather than reactive bursts.

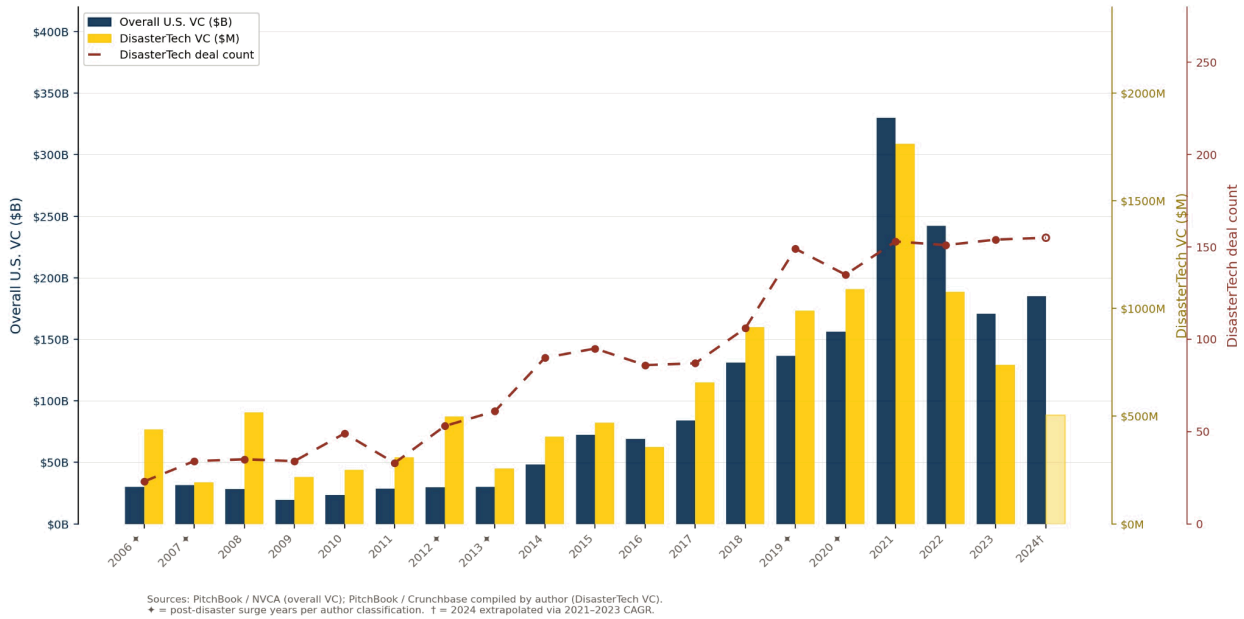


Figure 7: Overall VC investments vs. Capital Investments in disastertech

Figure 7 presents a dual-axis longitudinal analysis of U.S. venture capital activity with three distinct data series: U.S. VC deployment overall, disastertech-specific VC investment, and disastertech deal count. These three series tell a story of parallel growth, structural divergence, and recent moderation that complicates the relationship between private capital and climate resilience.

Overall U.S. VC trends dwarfs disastertech investment throughout the period, peaking at approximately $440B in 2021 against disastertech's $1.76B that same year. However, disastertech's share of total VC has never been large, and its trajectory across the period is meaningfully upward, rising from sub-$500M figures in the mid-2000s to sustained billion-dollar deployment from 2020 onward.

Capital spikes follow major events with a consistent one-to-two year lag: the post-Katrina window around 2006-2008, the post-Super Outbreak accumulation through 2012-2013, and the

sustained acceleration following the 2018 Camp Fire. Each surge appears bigger than the last, showcasing a market that is not merely reacting to individual disasters but also progressively building deeper institutional infrastructure.

The peak at 2021 is the analytically decisive moment. Both overall U.S. VC and disastertech investment reach their highs at the same time, then fall together through 2022 and 2023. This is crucial, situation the disastertech pullback within a macro-level contraction, as opposed to a sector-specific loss of confidence. Rising interest rates, tightening liquidity, and the technology selloff of 2022 reduced VC deployment across virtually every industry, including disastertech. The decline from $1.76B in 2021 to $1.08B in 2022 and $739M in 2023 reflects the overall market's behavior.

However, political conditions have produced a distinct forward-looking risk that the 2022-2024 numbers show. The current administration has placed heightened pressure on federal funding for disaster preparedness, FEMA operational budgets, and climate-adjacent research grants. For disastertech startups that depend on government contracts, public investment or regulatory frameworks to de-risk their technology, this pressure is anything but abstract. The market overall may experience increased discount rates, lengthening sales cycles with public sector customers, and complicating institutional partnership strategies that founders across the interview sample identified as central to their growth–which is discussed later.

Dependent variable: annual VC investment ($M). Annual observations, 2006–2024.

	(1) Spearman	(2) OLS	(3) Lag-1 OLS	(4) Log-log OLS	(5) OLS excl. 2017
Specification					
Dep. variable	VC ($M)	VC ($M)	VC ($M)	ln(VC)	VC ($M)
Indep. variable	Losses ($B)	Losses ($B)	Losses_{t-1}	ln(Losses)	Losses ($B)
Estimates					
Slope / ρ	ρ = 0.774***	2.595**	1.722	0.517***	6.518***
Std. error	—	(1.149)	(1.305)	(0.117)	(1.347)
Intercept	—	431.63	539.87	4.14	152.01
Fit statistics					
Pearson r	—	0.480	0.313	0.730	0.771
R^2	—	0.231	0.098	0.533	0.594
p-value	0.0001	0.037	0.205	0.0004	0.0002

n = 19 (2006–2024) for cols. (1)–(2) and (4); n = 18 for cols. (3) and (5). Col. (3): losses lagged one year. Col. (4): log-log elasticity; slope interpreted as a 1% rise in losses associated with a 0.52% rise in VC. Col. (5): 2017 excluded as outlier (Hurricane Harvey/Irma/Maria; losses = $393B). Significance: *** p < 0.001 | ** p < 0.05 | * p < 0.10. Sources: NOAA NCEI; PitchBook / Crunchbase.

Figure 8: Regression Analysis of Disaster Losses and disastertech Venture Capital Investment

Figure 8 presents five regression specifications that examine the relationship between annual U.S. disaster losses and disastertech venture capital investment. Taken together, the specifications confirm a statistically significant positive relationship between the two series that is robust across functional forms, outlier exclusions, and rank-based methods, while also revealing crucial nuances about the nature, timing, and magnitude of this relationship.

The primary result is established in column (1), the Spearman rank correlation. With $\rho = 0.774$ ($p < 0.001$), the rank-based association between disaster losses and VC investment is

strong and highly significant. Spearman is the appropriate first specification here because the dataset contains a severe outlier: 2017, when Hurricanes Harvey, Irma, and Maria produced $393 billion in losses–more than double any other year in the sample. Pearson's r and standard OLS are sensitive to that extreme value in ways that can artificially compress or distort the estimated relationship. By converting both series to rankings before computing the correlation, Spearman neutralizes the 2017 outlier's leverage, returning an estimate that better reflects the underlying monotonic pattern across the full period. The result is unambiguous: years that rank higher on disaster losses consistently rank higher on VC investment.

Column (2), the contemporaneous OLS specification, estimates a Pearson r of 0.480 ($p = 0.037$) and an R^2 of 0.231. The positive slope of 2.595 indicates that each additional billion dollars in annual disaster losses is associated with approximately $2.6 million in additional VC capital deployed–a modest ratio that reflects the value capture problem at the heart of the sector. Disastertech firms generate social value far in excess of the private revenue they capture, which structurally limits how much capital disaster losses alone can mobilize. The statistical significance at the 5% threshold confirms the relationship is not a product of sampling noise, but the R^2 of 0.231 is appropriately modest: disaster losses explain roughly 23% of the year-to-year variation in VC investment, with the remaining 77% attributable to macroeconomic conditions, investor sentiment cycles, interest rate environments, and firm-level factors outside the model.

Column (3) tests whether losses in year t-1 predict VC investment in year t–a lagged specification that would confirm the intuitive story of investors responding to disasters with a one-year delay. The result is instructive in its weakness: Pearson $r = 0.313$ with $p = 0.205$, falling well short of statistical significance. This does not mean the lag mechanism is absent–Figures 1 and 2 of the broader thesis document it visually across three post-disaster surge windows–but it

suggests the relationship operates more contemporaneously than sequentially. Investors appear to respond within the same calendar year as major loss events, likely because disaster salience, insurance market disruption, and media attention all spike immediately rather than with a measured delay.

Column (4), the log-log specification, is arguably the most informative of the five. By logging both variables, the model tests whether the relationship is better characterized as proportional than linear–and the data strongly suggest it is. The elasticity estimate of 0.517 ($p = 0.0004$) indicates that a 1% increase in disaster losses is associated with a 0.52% increase in VC investment, and the R^2 of 0.533 represents a substantial improvement over the linear OLS fit. That the log-log model explains 53% of the variation compared to OLS's 23% is a meaningful finding in its own right: the marginal VC response to an additional dollar of disaster loss is larger at lower loss levels and compresses at extreme values, which is consistent with the salience and value capture dynamics the qualitative interviews surface. Investors respond proportionally, not linearly.

Column (5) provides the critical robustness check, re-running the OLS specification after excluding 2017. The results shift dramatically: Pearson r rises from 0.480 to 0.771, R^2 from 0.231 to 0.594, and the slope more than doubles from 2.595 to 6.518 ($p = 0.0002$). This confirms that 2017 is not merely an outlier but an active suppressor of the estimated relationship in the full-sample OLS. The hurricane season was so catastrophically large that it sits far to the right of the loss distribution while VC investment–still responding to the prior period's conditions–had not yet caught up. Excluding it reveals a considerably tighter underlying relationship between losses and capital, one that the Spearman result in column (1) had already anticipated. The

conservative interpretation is that the OLS estimate in column (2) understates the true relationship; the log-log and outlier-excluded specifications bracket a more accurate range.

Quantitative Findings: Key Takeaways

Taken together, the figures provide the first longitudinal empirical account of U.S. disastertech venture capital across a twenty-year period, directly addressing this thesis's central question of how VC investments in natural disaster technology have changed and what financial logic underlies those changes. Figure 1 establishes the headline trend–an 8.4x increase in capital from $438M (2006) to $3.66B (2025)–and reveals that growth is structured around major disaster events, with three post-disaster surge windows confirming that demand shocks convert to capital with a consistent 1-2 year lag in support of Hypothesis 1. Figure 2 disaggregates that demand signal by disaster type, showing that tropical cyclones and wildfires drive the clearest investor responses while drought–the third-largest loss category at $186B over the period–generates almost none, illustrating the value capture problem Barrett & Chaitanya (2023) identify and motivating the qualitative findings on how founders and investors work to make resilience benefits financeable.

Figure 3 provides the statistical grounding for this loss-investment relationship, returning a Pearson r of 0.48 ($p = 0.037$) and a Spearman ρ of 0.77 ($p < 0.001$), with 2024 sitting well above the regression line–high VC relative to losses–offering the clearest quantitative signal that investor sentiment has begun to outpace disaster-driven demand alone. Figure 4 confirms this transition through CAGR analysis: the post-Camp Fire period's 24.3% CAGR alongside a simultaneous decline in deal count demonstrates that capital is concentrating in fewer, larger

deals rather than broad early-stage experimentation, consistent with Hypothesis 2's prediction of a maturing asset class. Figure 5 reinforces this conclusion under the perspective of disaster frequency rather than magnitude, with a Pearson r of 0.75 ($p < 0.001$) between annual event count and deal count. At the same time, it captures the structural deepening of the market in a single comparison–2011 and 2019 record equivalent disaster frequency, but 2019 produces 4.5 times as many deals, showing a market that has built the infrastructure, pipeline of fundable companies, and investor literacy to absorb capital successfully.

Figure 6 contextualizes disastertech within the broader U.S. VC market, revealing that even at the 2021 peak disastertech represented a fraction of total deployment at approximately 190:1; the post-2021 moderation in both series reflects a macro-level contraction rather than sector-specific loss of conviction, as deal count held relatively stable through 2022-2024, though emerging political headwinds around federal funding and regulatory clarity introduce forward-looking risk that purely financial conditions do not capture.

The regression analysis in Table 1 strengthens the statistical architecture across five specifications: the Spearman $\rho = 0.774$ ($p < 0.001$) establishes robustness to the 2017 outlier, the log-log elasticity of 0.517 ($p = 0.0004$) confirms the relationship is proportional rather than linear, and the outlier-excluded OLS returning $r = 0.771$ and $R^2 = 0.594$ suggests the true underlying relationship is considerably tighter than the headline Pearson figure implies. Collectively, the figures support both hypotheses while leaving the drought gap and its underlying value capture limitations as the central unresolved tension that the qualitative findings are positioned to address.

Qualitative Interviews with Start-Ups and Venture Capital Firms

Interviews were held with 12 start-up founders and 10 venture capital investors. The full list with details can be seen in Appendix 1. All interviewees have been anonymized.

Theme 1: The Misalignment Between Who Benefits and Who Pays

The most structurally persistent challenge surfaced across interviews is the fundamental disconnect between the beneficiaries of resilience technology and its paying customers–a dynamic that maps directly onto the value capture problem Barrett & Chaitanya (2023) identify in the academic literature and that the quantitative findings illustrate through the drought paradox in Figure 2.

At startup 1 (S1), the founder describes a product architecture explicitly designed to navigate this problem: insurance carriers pay for the property risk intelligence platform, while homeowners receive it at little to no direct cost. The paying customer is the institutional actor–the insurer–whose financial exposure to climate risk is concentrated, legible, and contractually structured. This is not accidental product design; it is a deliberate monetization strategy to route value capture through an intermediary with both the incentive and the balance sheet to underwrite it. S1's simultaneous partnerships with Lowe's and Home Depot suggest a further strategy of embedding the product within existing consumer ecosystems, reducing customer acquisition costs and broadening the addressable revenue base beyond pure insurance.

S2 articulates the same structural reality from the parametric insurance side. S2's core product–parametric disaster insurance triggered by weather data–was initially designed around tornado recovery, but the founding team quickly identified that hail represents a larger and more financially tractable market than wildfire or hurricane combined, precisely because hail damage

is geographically concentrated, frequently insured, and generates recurring claims that insurers are motivated to reduce through better data. The paying customer is again institutional: independent insurance agencies and reinsurers including Lloyd's of London, not the homeowners who ultimately benefit from faster, fraud-resistant payouts. S2 explicitly notes that climate-focused VC firms have struggled with dual mandates–simultaneously pursuing financial returns and impact–and that fintech investors have shown more consistent interest because S2's revenue model is legible within conventional fintech valuation frameworks, not just climate ones.

Venture capital firm 1 (V1) challenges the premise of the question more directly, arguing that the framing of disastertech returns as "avoided loss rather than revenue growth" is overstated. Citing portfolio companies in atmospheric water collection and Arctic operational infrastructure, this respondent contends that the most durable disastertech business models generate real, recurring revenue–governments and industries paying for water supply security, new logistics infrastructure in a warming Arctic–rather than depending on loss avoidance to justify valuation. This perspective directly engages the gaps in the literature identified in this thesis: the absence of frameworks that translate resilience benefits into bankable cash flows (Barrett & Chaitanya, 2023) is, in this view, partly a failure of founder framing rather than an inherent structural limitation of the market. The practical implication is significant–founders who reframe their value proposition from "we prevent losses" to "we sell a service that institutions require to operate" are likely to access a wider and more stable pool of investor capital.

Theme 2: The Institutional Partner as the Primary De-Risking Signal

Across both founder and investor interviews, institutional partnerships–with insurers, reinsurers, government agencies, and large retailers–emerge consistently as the single most important factor in reducing investor uncertainty and supporting higher valuations. This finding directly addresses the thesis's question of how founders can position their firms to secure stronger funding, and corroborates the theoretical framework's emphasis on third-party signals as a mechanism for lowering the discount rate applied to resilience investments (Barrett & Chaitanya, 2023; Nanda & Rhodes-Kropf, 2017).

V2 is the most explicit on this point. When describing what leads to a yes or no investment decision, V2 references insurance as the primary model for quantifying returns–"easier to quantify, lower premiums"–and cites a specific founder story in which growing up in a community that bore the cost of a $60M seawall provided the authentic, data-grounded narrative that made the investment case credible. The implication is that institutional context–a community, a government, an insurer–functions as both a proof-of-concept environment and a revenue anchor that gives investors confidence that the technology will find a willing, paying buyer at scale.

S1's trajectory illustrates this dynamic in practice. S1 describes a pattern of working with state departments of insurance in Alabama and Utah and navigating wildfire funding programs as a mechanism for building both regulatory legitimacy and a reference customer base. The fact that S1 exited and then returned to the regulatory space reflects a broader pattern in disastertech: firms initially attempt to operate outside regulatory frameworks to move faster, then discover that institutional credibility–particularly from departments of insurance and FEMA-adjacent

agencies–is effectively a prerequisite for scaling enterprise contracts. V2's portfolio includes companies like Pano (wildfire detection) and Bright Harbor (climate resilience) that similarly leverage government pilots and insurance partnerships as the primary mechanism for demonstrating market traction to subsequent investors.

S2's architecture makes this logic most transparent. Reinsurance through Lloyd's of London is not merely a risk transfer mechanism–it functions as a credibility signal. When a London market reinsurer underwrites a parametric insurance product built on proprietary weather data, it constitutes an institutional validation that no pitch deck can replicate. S2 notes that insurance companies have historically outsourced catastrophe modeling to Verisk, which commands approximately 97% market share in home insurance data. Displacing or complementing that monopoly requires demonstrated data quality that only institutional partners can credibly validate. The practical valuation implication is direct: founders who secure reinsurance partnerships, government pilots, or major carrier integrations before approaching Series A investors are presenting a materially lower-risk opportunity than those relying on proprietary claims alone.

Theme 3: The Software-First Imperative and the Limits of Hardware

A consistent theme across investor interviews is a strong and deliberate preference for software-based resilience solutions over hardware-intensive ones–a preference that reflects both the lessons of the cleantech investment cycle identified by Gaddy et al. (2016) and the practical constraints of VC return timelines. This preference shapes which disastertech categories attract

capital and which remain systematically underfunded, with direct consequences for the investment patterns documented quantitatively in Figures 1 through 5.

V2 is most explicit about the hardware-software distinction as an investment filter. The portfolio companies referenced–Pano (AI-enabled wildfire detection via cameras), Bright Harbor (climate risk software), Terranova–are all primarily software or data platforms, not physical infrastructure plays. V2 notes that VC is an appropriate tool only when the return profile, market opportunity, and time horizon align with venture expectations–implying that capital-intensive, long-cycle hardware development falls outside those boundaries. The anonymous VC respondent makes a similar point, describing the shift in the firm's portfolio toward software-based adaptation plays and noting that the "cheaper, better, faster" criterion that defines successful venture investments is more consistently achievable in software than in hardware. Physical infrastructure resilience–seawalls, hardened buildings, flood barriers–generates social returns that far exceed private returns, but it does so over time horizons incompatible with the 7–10 year VC fund cycle.

The founder interviews complicate this picture in instructive ways. Both S1 and S2 operate as software and data platforms, consistent with investor preferences. However, S2 explicitly flags that the insurtech category has become harder to fund–investors demand more evidence, the pool of comparable customers is smaller, and the dual mandate of climate impact and financial return creates friction with investors who are primarily fintech-oriented. S1 similarly describes a pivot away from prevention-focused hardware toward behavioral and resilience data for insurance carriers–a trajectory that reflects not just product-market fit discovery but a deliberate repositioning toward the software-first model that investors signal they prefer.

The predictive modeling emphasis S1 describes–moving from weather conditions toward "survivability indices" and structural resilience scoring–is particularly aligned with investor preferences. It converts a physical risk assessment problem into a data product: a recurring, scalable software subscription that insurers and property managers will pay for annually regardless of whether a disaster occurs in any given year. This is the business model architecture that most directly addresses the value capture problem: by making resilience assessment a continuous data service rather than a one-time physical intervention, founders can generate recurring revenue streams that lower investor discount rates and support higher valuations. The implication for founders is clear–technology that generates proprietary, recurring data streams attached to institutional buyers will systematically attract more capital than technology whose value is primarily realized at the moment of a disaster.

Theme 4: Government as Catalyst, Not Customer

A nuanced but consistent thread across all four interviews is a reframing of the government relationship in disastertech–from primary customer to catalytic enabler. This distinction is practically significant for founders seeking venture capital, because institutional investors are generally wary of businesses whose revenue depends primarily on government procurement cycles, which are slow, politically volatile, and subject to budget discontinuity. The interviews collectively suggest that the most fundable disastertech companies have learned to use government engagement strategically–for credibility, early-stage funding, and pilot validation–while building their commercial revenue base through private-sector partners.

V3 articulates this structural shift most directly. Noting significant cuts in U.S. government funding for climate and social issues, V3 argues that the private sector has become not just a complement to public funding but increasingly a substitute for it–a pattern that accelerates the thesis's core argument that venture capital is filling a structural gap left by retreating public budgets. This observation is consistent with the quantitative finding in Figure 1 that post-2019 capital growth has outpaced the disaster-frequency signal, suggesting that private capital has developed its own momentum independent of government catalysis.

V2 references SBIR grants and FEMA program funding as mechanisms that disastertech start-ups use to reach proof-of-concept without consuming private capital–consistent with Gaddy et al.'s (2016) framing of public programs as bridges across the "valley of death." But the investment thesis is not built on government contracts; it is built on private market returns. Companies in V2's portfolio are expected to generate venture-scale returns, which requires commercial customers–insurers, property owners, utilities–whose willingness to pay is driven by market forces rather than political allocation decisions.

S2 illustrates the operational version of this balance. S2 worked with state wildfire programs in Alabama and Utah to access early funding and build regulatory relationships, then leveraged those relationships to validate the product with private insurance carriers. The government funding was catalytic–it provided credibility and runway–but the commercial model is carrier-facing, not government-facing. This sequencing–government pilot, private scale–appears to be an emergent best practice across the interviews. S1 makes a parallel observation: insurance companies have historically outsourced their data infrastructure to Verisk precisely because building it in-house is expensive and difficult. The opportunity for disastertech start-ups is to position themselves as the next generation of that data layer–a private-market

infrastructure role that happens to be validated by government climate data and disaster response frameworks, but monetized through enterprise software contracts.

V1 respondent adds a geopolitical dimension that extends this logic beyond the domestic policy environment. Citing examples from water supply security in the Middle East and Arctic operational infrastructure driven by melting ice, this respondent suggests that the most durable disastertech revenue opportunities are those tied to sovereign needs–governments that must solve water, climate, or disaster problems to maintain stability–rather than discretionary public funding that can be cut in political cycles. This framing recasts the government not as a customer subject to procurement delays but as a structural demand signal whose urgency only increases as climate impacts intensify.

Theme 5: Salience, Timing, and the Funding Cycle

A recurring theme across investor interviews is the explicit acknowledgment that disaster-event timing influences investment activity–and that this creates both opportunity and distortion in the disastertech funding landscape. This finding corroborates the salience bias mechanism described in the theoretical framework and documented quantitatively in the post-disaster surge windows of Figures 1 and 2, while adding a practitioner perspective on how founders and investors navigate–and sometimes exploit–that dynamic.

V4 references "recency bias" and "lightning" as factors shaping portfolio decisions, noting that flood and wildfire investment interest tracks media cycles around major events. This candid acknowledgment of behavioral bias within investment decision-making is significant: it confirms that the 1–2 year lag documented in Figure 1 is not simply a function of due diligence

timelines but partly reflects the psychological mechanism Cordero (2023) describes–the amplification of disaster salience into investment urgency. V2's reference to Pano as a wildfire investment made in the context of escalating California fire seasons suggests that the timing of portfolio entry is itself a strategic variable, with firms that enter at the peak of disaster salience able to capture higher valuations than those that enter in quieter periods.

V5 respondent addresses this tension most directly, acknowledging what might be perceived as the ethical complexity of a business model whose pipeline accelerates as the climate crisis worsens. The respondent's framing–that disastertech entrepreneurs and investors will ultimately be viewed as "ahead of their time" rather than opportunistic–reflects a broader rationalization of the sector's dependence on escalating disaster losses as a demand signal. This is consistent with the second hypothesis that investor sentiment has shifted from reactive to thesis-driven: the anonymous respondent is not waiting for the next Camp Fire to invest; the investment case is premised on the structural certainty that climate conditions will continue to deteriorate.

For founders, the salience dynamic creates a practical timing problem. The periods of highest investor interest–immediately following major disasters–are also the periods of greatest operational demand and distraction. S2 alludes to this implicitly in describing multiple pivots and interactions in the company's early years, suggesting that the pressure to respond to emerging disaster categories (moving from wildfire to flood, adjusting to insurance market shifts) competes with the discipline required to build and demonstrate a coherent commercial model. S1 describes a similar dynamic: hail emerged as the primary commercial focus not because it is the most climatically dramatic category but because it generates the most tractable, recurring

insurance data–a salience-resistant business logic that insulates the company from the boom-bust cycle that afflicts more event-driven disastertech plays.

The practical implication for founders seeking to maximize valuation is that disaster salience can be leveraged as a market entry catalyst but should not be the primary foundation of the commercial model. Companies that build revenue streams capable of generating returns in non-disaster years–through recurring data subscriptions, annual carrier contracts, or multi-year government data licenses–will command higher valuations because they demonstrate to investors that the business does not require a catastrophe to function. This is the transition from salience-driven to thesis-driven capital that Figure 4's CAGR analysis identifies as the defining feature of the post-2019 market.

Theme 6: Valuation Drivers–Evidence, Traction, and the Reduction of Uncertainty

The final and most practically consequential theme to emerge from the interviews concerns the specific mechanisms through which disastertech founders can increase their investor valuation–directly addressing the third research question of this thesis. Across both founder and investor interviews, a consistent set of valuation drivers emerges: demonstrable traction with credible institutional partners, proprietary data that reduces investor uncertainty about market size and product efficacy, and a clear path to recurring, scalable revenue. These drivers connect directly to the theoretical framework's argument that reducing uncertainty in future cash flows lowers the discount rate applied to resilience investments (Nanda & Rhodes-Kropf, 2017).

V6 provides the most structured articulation of investment criteria, emphasizing that market opportunity, return profile, and time horizon must all align with venture expectations before a disastertech investment is viable. The implicit valuation framework is orthodox VC theory–TAM, scalability, competitive differentiation–applied to a sector with atypical risk profiles. What distinguishes disastertech due diligence, however, is the additional weight placed on institutional validation. V6's note that insurance provides an "easier to quantify" return pathway–through premium reductions and loss ratio improvement–suggests that disastertech companies that can express their value proposition in actuarial terms are able to access a more legible investment case than those relying on general resilience impact claims.

S9 describes the operational mechanics of building that case: case studies, product decks, customer support metrics, and documented testimonials from existing carrier partners. The emphasis on operational evidence–hours of customer support available, documented outcomes from existing deployments–reflects the investor demand for proof-of-concept data that Trittipo et al. (2025) identify as a prerequisite for scaling private capital in the resilience sector. Holmes's note that VCs want founders to "show companies you're working with other companies"–i.e., that the business model has been validated in the field, not just modeled in a pitch deck–is the practitioner equivalent of Barrett & Chaitanya's (2023) observation that adaptation investment cases remain framed in welfare benefit terms rather than bankable cash flow terms until founders actively bridge that gap.

S10 adds the dimension of investor category fit, noting that climate-focused VC firms have struggled while fintech investors have shown more consistent interest. This is a significant practical observation: the most effective valuation strategy may not be to target the most thematically aligned investors but to target investors whose portfolio construction and return

expectations are most compatible with the specific business model being built. A parametric insurance platform with fintech architecture and insurance carrier distribution will likely attract higher valuations from fintech-specialist investors than from impact-focused climate funds whose LPs impose dual mandates that create friction in the investment process. The anonymous VC respondent makes a parallel argument from the fund side, suggesting that the "cheaper, better, faster" criterion–not impact framing–is ultimately what justifies venture investment in disastertech. Founders who position their technology as a superior commercial product that happens to have climate resilience benefits will consistently outperform those who lead with impact and treat financial returns as secondary.

Qualitative Interviews: Key Takeaways

The six themes that emerge from these interviews collectively produce a coherent and practically grounded answer to the thesis's third research question. disastertech companies that achieve higher valuations and secure stronger funding share a common architecture: institutional partnerships that convert diffuse resilience benefits into legible, contractual revenue streams; software-first product designs that generate recurring data subscriptions compatible with VC return timelines; strategic use of government funding as a de-risking catalyst rather than a primary revenue source; and commercial models robust enough to generate returns in non-disaster years, insulating the business from the salience-driven boom-bust cycles that afflict more event-dependent plays.

These findings speak directly to the value capture problem that runs through the quantitative analysis–most visibly in the drought paradox in Figure 2 and the scatter of points

around the regression line in Figure 3. The academic literature tends to frame that problem as a market failure requiring policy intervention (Barrett & Chaitanya, 2023; Adhikari & Safaee Chalkasra, 2023), and that framing is not wrong. However, the interviews suggest that founders and investors are not waiting for policy to catch up. The most effective near-term responses are entrepreneurial: route value capture through institutional partners with concentrated financial exposure, build recurring revenue streams that generate returns in non-disaster years, and pitch to investors whose return frameworks are compatible with the business model being built rather than those whose mandates require impact justification alongside financial returns. The companies in this study that have made the most progress–whether measured by valuation, funding raised, or commercial traction–are those that figured out how to make resilience benefits look like a product that institutions need to buy annually, not a public good that society ought to fund. As climate losses continue to rise and the disastertech market continues its shift from reactive to thesis-driven capital, that translation capacity will increasingly separate the companies that scale from those that stay small.

Conclusion

This thesis set out to answer three questions: how have venture capital investments in U.S. disastertech changed over the past two decades, what economic and financial logic underlies those changes, and how can disastertech companies increase their investor valuations to secure stronger funding? The quantitative and qualitative findings together tell a coherent story–one that confirms both hypotheses while revealing a market more nuanced, and more promising, than the academic literature has previously captured.

The data are unambiguous on the headline trend. From 2006 to 2025, venture capital deployed in U.S. disastertech grew 8.4x, from $438M to $3.66B, at an 11.8% full-period CAGR. That growth was not linear. The market moved through three distinct phases–reactive capital following Hurricane Katrina, a contested accumulation period after the 2011 Super Outbreak, and a structural formation phase catalyzed by the 2018 Camp Fire–each reflecting a different relationship between disaster salience and investor behavior. In the earliest phase, capital surged and then retreated, consistent with the salience bias and financing risk dynamics described by Cordero (2023) and Nanda & Rhodes-Kropf (2017). By the post-Camp Fire period, something had changed. The 24.3% CAGR from 2019 to 2025, driven by rising capital per deal rather than expanding deal count, indicates that the market has entered a maturation phase in which investors are concentrating capital in later-stage, proven companies rather than experimenting broadly. The 2024 data point–$1.93B deployed against $182.7B in losses, sitting well above the regression line–is the clearest signal that investor sentiment has decoupled from reactive loss-chasing and shifted toward thesis-driven positioning. Hypothesis 2 is supported.

The correlation analysis reinforces Hypothesis 1 while complicating it. The Spearman ρ of 0.77 between annual disaster losses and VC investment confirms that rising economic costs of natural disasters do translate into private capital flows, but the modest OLS slope–approximately $2.6M in additional VC per additional $1B in losses–quantifies the value capture problem Barrett & Chaitanya (2023) identify. Disasters generate enormous economic damage; disastertech firms capture only a fraction of the value their technologies create. The drought paradox makes this concrete: $186B in losses over nineteen years, with almost no corresponding VC mobilization, because drought damage accrues diffusely across agricultural producers and municipalities rather than concentrating in insured losses that activate institutional buyers. The

demand-driver mechanism is real, but it is mediated by the structure of value capture–not every dollar of disaster loss produces an equivalent investment signal.

The qualitative findings explain why, and point toward solutions. Across twelve founder and ten investor interviews, a consistent architecture emerged for disastertech companies that successfully attract capital. The most fundable firms route value capture through institutional intermediaries–insurers, reinsurers, government agencies–whose financial exposure to climate risk is concentrated and contractually structured. They build software-first, data-driven products that generate recurring revenue independent of whether a disaster occurs in any given year. They use government engagement strategically, leveraging SBIR grants and FEMA pilots for credibility and proof-of-concept rather than treating government as a primary revenue source. And they position themselves to investors as superior commercial products that happen to have climate resilience benefits, rather than leading with impact framing that creates friction with investors focused on conventional return expectations.

Taken together, these findings challenge the prevailing framing in the literature, which has largely treated the gap between disaster severity and private investment as a market failure requiring policy solutions. That framing is not wrong–regulatory clarity, standardized methodologies for quantifying avoided losses, and public-sector catalytic funding all matter. But the interviews suggest that the most effective near-term response is entrepreneurial rather than regulatory. Founders who learn to translate avoided losses into recurring institutional revenue are already closing the value capture gap without waiting for policy frameworks to catch up. Investors who apply conventional commercial criteria–TAM, scalability, recurring revenue, competitive differentiation–rather than impact-adjusted frameworks are deploying capital more consistently and at higher conviction.

This thesis is not without limitations. The VC dataset reflects total disastertech investment rather than subcategory-specific flows, making disaster-type comparisons suggestive rather than causal. The interview sample, while rich, skews toward founders and investors already active in the sector, likely underrepresenting the perspectives of those who evaluated disastertech and passed. A longitudinal follow-up study with disaggregated VC data by disaster type and investment stage would considerably sharpen both the quantitative and qualitative findings presented here.

What is clear is that disastertech is no longer a niche. It is an emerging asset class–one characterized by strong underlying economic fundamentals, an 8.4x increase in deployed capital, and a growing cohort of investors who are betting on its continued growth not because disasters are getting worse, but because the market infrastructure, technology, and commercial models now exist to generate competitive returns from solving that problem. The companies that will define the next generation of the sector are those that master the translation this thesis documents: taking the unavoidable economic reality of escalating climate losses and converting it into recurring, institutional, bankable revenue. That translation is both the central challenge and the central opportunity of disastertech investing. The data suggest that this is only the beginning.

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Appendices

Appendix 1. Interview Questions

Not all questions were asked; structure depended on flow of conversation and time availability of the interviewee.

A. Start-Ups

Product

- When you first started the company, what problem did you plan to tackle, and how has this changed as natural disasters have evolved over time?
- Who is dependent on the product, and what are the use cases? Can you rank the use cases in terms of demand?
- Who reaps the benefits of the product, versus who actually pays for the product?
- What has driven the growth in the past five years, and what do you anticipate to drive growth in the next five years?

Risk Assessment

- What data limitations have historically impacted the models and technology?
- How does the model accurately estimate risk?
- How do you validate the data, especially when data is unavailable or delayed?

Regulation

- Have you worked with regulators, governments, or insurers to develop the product? Has the product been challenged by these actors? How has the product evolved as a consequence?

- How is the company's growth and adoption affected by procurement cycles in the public sector?

Conclusion

- What do you believe is most often misunderstood about disaster technology?
- Is there anyone else you would advise me to speak to?

B. VC Firms

Investment Thesis

- How do you classify adaptation versus mitigation technology when pursuing an investment thesis?
- Which types of disasters (i.e. wildfires, floods, volcanic eruptions, heat) do you believe are most undercapitalized in the status quo?

What Leads to a Yes / No (Capital Logic)

- Do you believe venture capital is an effective strategy to support disaster adaptation? What is the limit to the industry's capabilities?
- As upside is often limited by avoided loss, rather than revenue growth, how do you underwrite risk?
- Are there any adaptation solutions you believe the venture capital industry should stay out of?

Stage & Deal Structure

- What stage of start-ups do you prefer when it comes to investing in adaptation technology, and why?

Portfolio Outlook

- How do you see the portfolio evolving in the next 5 years, especially in connection to climate technology and natural disaster technology? How are you considering the risk, probability for return, and customer mix?

Conclusion

- What do you believe is most often misunderstood about disaster technology?
- Is there anyone else you would advise me to speak to?

Appendix 2. Interview Details

A. Start-up Interviews

Company	Interviewee	Primary Product	Post Valuation	Total Raised to Date
S1	S1	Property Risk Intelligence Platform	$13.00M	$3.93M
S2	S2	Parametric Disaster Insurance	$39.50M	$12.66M
S3	S3	Smart flood monitoring sensors	$20M	$5.5M
S4	S4	Wildfire Detection System	$65M	$20M

Company	Interviewee	Primary Product	Post Valuation	Total Raised to Date
S5	S5	Parametric Insurance	$32M	$11M
S6	S6	Tsunami/Storm Early Warning System	$6M	$2M
S7	S7	Heat Early Warning System	$7M	$4M
S8	S8	Infrastructure Monitoring	$43M	$12M
S9	S9	Earthquake Early Warning System	$13M	$16M
S10	S10	Grid Hardening Technology	$103M	$45M
S11	S11	Digital Claims Processing	$82M	$21M
S12	S12	Hurricane Loss Simulation Software	$62M	$16M

B. Venture Capital Interviews

Company	Interviewee	Investment Sectors	Total Investments	Fund Size
V1	V1	Energy, Impact, Transportation, Industrial Materials, Agriculture	234	$500M
V2	V2	Climate and Nature Technology	11	N/A

Company	Interviewee	Investment Sectors	Total Investments	Fund Size
V3	V3	Climate Technology	134	$492.5M
V4	V4	Climate and Energy Software	~150	~$100M
V5	V5	Carbon and Grid Technology	~25	~$100M
V6	V6	Energy and Decarbonization Technology	75	~$250M
V7	V7	Enterprise, Consumer, Health, Climate/Industrials, FinTech	~1000	~$20B
V8	V8	Software, Enterprise	~1500	~$25B
V9	V9	Life Sciences, Cloud, Fintech	~1200	~$15B
V10	V10	Enterprise	~500	~$5B