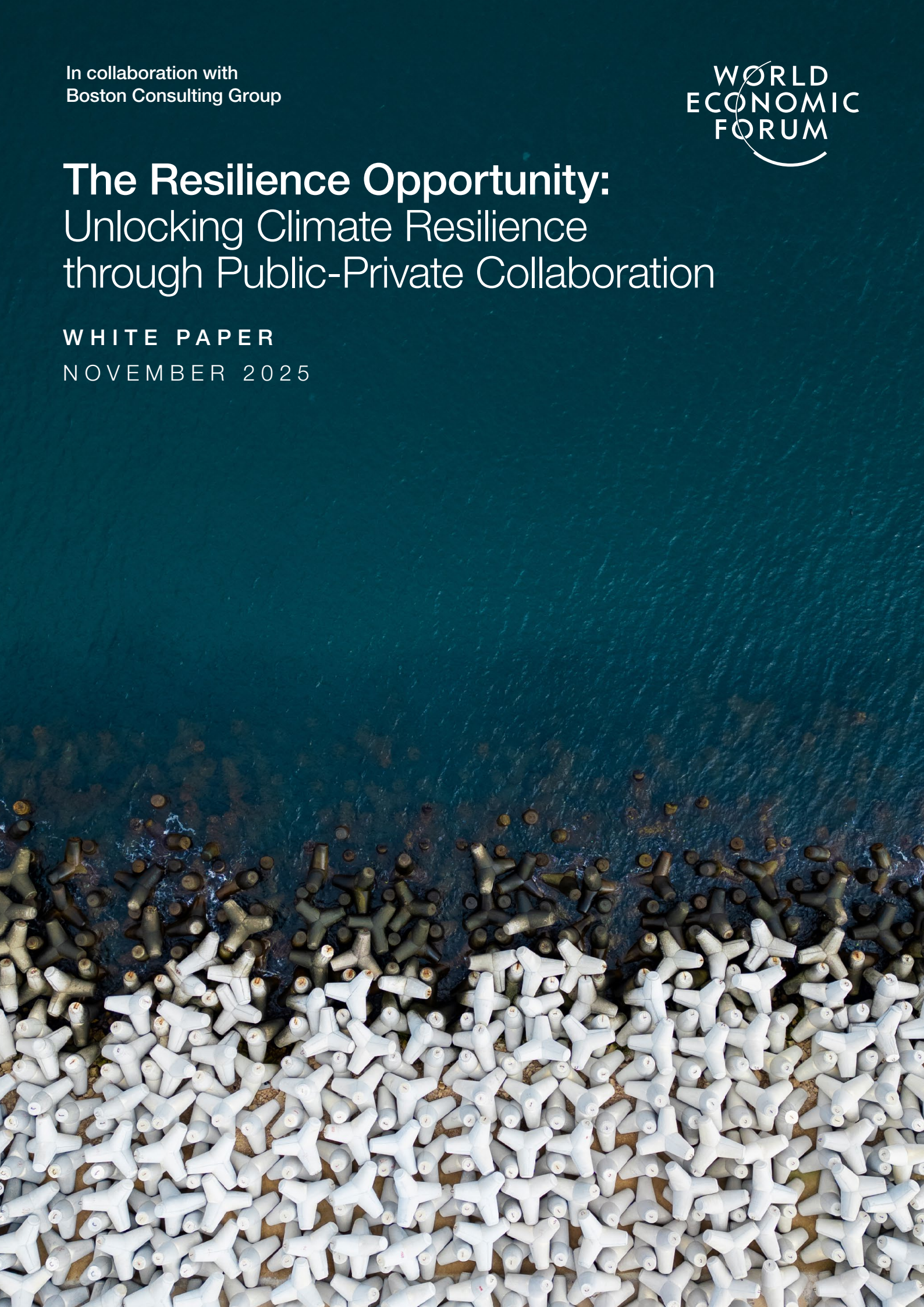
In collaboration with
Boston Consulting Group

WORLD ECONOMIC FORUM

The Resilience Opportunity:
Unlocking Climate Resilience through Public-Private Collaboration

WHITE PAPER

NOVEMBER 2025



Images: Adobe Stock, Unsplash

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Foreword

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Climate resilience is a global imperative for business and government. Each year, climate hazards become more immediate, severe and systemic. These are no longer isolated shocks, but increasingly interconnected disruptions that affect livelihoods, infrastructure and entire economies.

Global businesses are unprepared for the impacts of our current climate, which has already warmed an average of 1.3°C above pre-industrial levels.[1] As rising greenhouse gas emissions put us on track to exceed the Paris Agreement commitments – and for a devastating 2°C scenario by 2050 – in the next few years, all economies will face increasingly constrained and costly climate resilience options.

In this moment of growing urgency, businesses can act on three fronts: protecting their operations, growing the market for resilience solutions and collaborating with the public sector to drive systemic change and long-term value creation. While an expanding body of literature and guidance helps the private sector achieve the first two imperatives, a significant gap remains in understanding how businesses can collaborate with the public sector to deliver large-scale, system-wide resilience outcomes.

This paper by the World Economic Forum, in collaboration with Boston Consulting Group (BCG), explores this collaborative opportunity. It presents clear archetypes for private-sector engagement with public stakeholders. Additionally, it outlines critical levers to enable investment in climate resilience projects that create long-lasting economic and societal climate resilience. We hope this work catalyses deeper dialogue among business and government leaders – for more ambitious partnerships and, above all, for action.

Executive summary

Unlocking public-private collaboration is key to transforming resilience into an investable, scalable opportunity.

Climate resilience is becoming a strategic priority across the public and private sectors. As climate risks intensify, the pressure to protect people, infrastructure and economies is mounting. Yet, despite growing awareness, current investment levels remain below what is required. Public funding alone cannot meet the scale of demand (particularly for large, shared-risk infrastructure), making private-sector engagement not just beneficial, but essential.

Recent market analysis estimates that climate adaptation and resilience represents a trillion-dollar annual investment opportunity by 2050. Within this, in the analysis conducted for this paper, **$320–500 billion per year** will be needed to deliver large-scale infrastructure, such as flood protection systems, drought mitigation and urban resilience networks, where **public-private collaboration offers the most effective and efficient path forward**.

This paper presents a strategic blueprint for unlocking the full potential of public-private collaboration on resilience. It introduces **six archetypes that define practical roles for private-sector participation** in scaling climate resilience. These archetypes can be **applied individually or blended within a single initiative** to enhance overall bankability, align incentives and improve delivery outcomes.

The paper then identifies three main levers to integrate different archetypes and enable investment. First, resilience projects can be anchored in **viable revenue models** (e.g. bundling with commercial infrastructure or monetizing co-benefits). Second, many small or localized projects need to be **aggregated into larger, investment-ready platforms**, such as regional initiatives. Third, projects can integrate **mechanisms to manage risk-return expectations**, especially for different stakeholders. Case studies like the SMART Tunnel and RISCO (Restoration Insurance and Financial Services Company) demonstrate how adaptation and resilience projects can be viable, scalable and impactful when designed effectively.

To advance this urgent agenda, public- and private-sector leaders can work together to **identify suitable entry points, align on shared objectives, and co-design and co-develop projects that integrate commercial and resilience value**. With structured design and public-private collaboration, climate resilience can become a scalable, investable pillar of the global climate response.

Note: Throughout this paper, the term “climate resilience” is used to describe the ability to resist, respond to and recover from hazardous climate impacts, adapt to new climate conditions and maintain stability.

Introduction

Resilience is rising on the global agenda, presenting an urgent but untapped opportunity for private-sector action.

> Unlocking meaningful private-sector participation will require new thinking – both in how projects are designed and how risk, returns and responsibilities are shared between public and private actors.

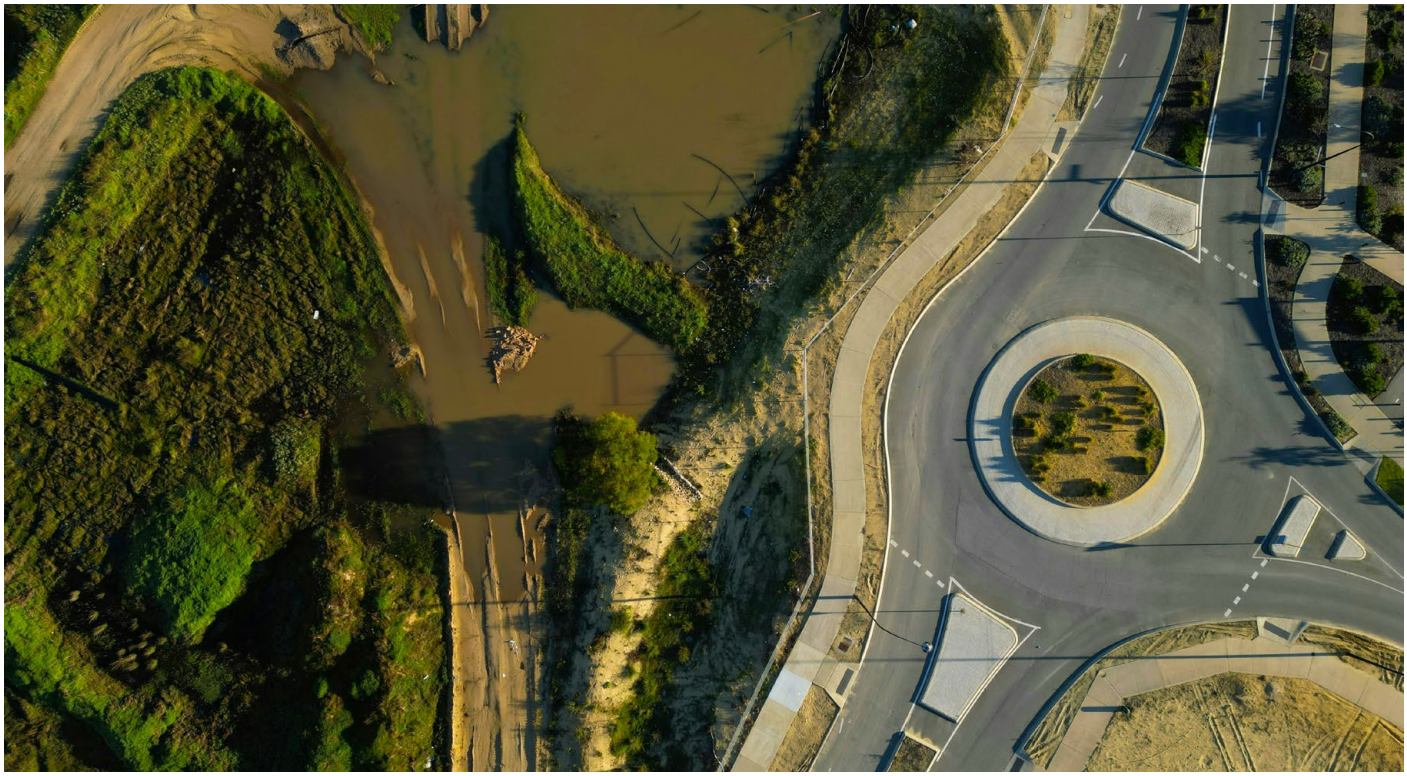
Recent extreme weather events have once again underscored the intensifying impacts of climate change and the urgent need to scale resilience efforts globally. In July 2025, central Texas experienced catastrophic flash floods, with the Guadalupe River rising nearly 30 feet in a few hours. The deluge overwhelmed local infrastructure and claimed more than 100 lives.[2] At the same time, Western Europe faced its warmest June on record, with temperatures soaring above 40°C and peaking at 46°C in parts of Spain and Portugal.[3]

These events are not isolated shocks – they reflect a broader pattern of escalating physical climate risks that are increasingly material to economies, communities and ecosystems. Recent scientific assessments also indicate that adaptation becomes more difficult and less effective as warming intensifies, making early and coordinated investment more critical.[4] Yet, alongside these rising risks lies a growing strategic opportunity – the chance to build climate resilience as a new frontier of value creation.

For many companies, capturing this opportunity will require looking beyond their own operations, as the benefits often extend past traditional business boundaries. Large-scale, system-wide resilience often depends on collaboration, particularly with public actors, to align mutual interests and deliver shared resilience outcomes.

Unlike mitigation, where revenue models are often more direct, investment in climate adaptation and resilience faces structural barriers. Many resilience projects protect public goods, span multiple sectors or yield co-benefits that fall outside a single entity's balance sheet. Traditional private investment frameworks, built around short payback periods and clearly attributable returns, struggle to accommodate this complexity. As a result, while the case for climate resilience is clear, scalable investment models remain elusive. Unlocking meaningful private-sector participation will require new thinking – both in how projects are designed and how risk, returns and responsibilities are shared between public and private actors.

This paper aims to accelerate that collaboration. It provides a market-oriented perspective on climate resilience, identifying practical archetypes for private-sector participation and unpacking the levers required to design viable collaborations. The goal is to help unlock private capital and capabilities in ways that generate lasting value for both business and society.



1 From risk to opportunities – unlocking resilience for the private sector

Major investment is needed in climate resilience, creating a growing opportunity for private-sector leaders.

The climate resilience agenda is accelerating alongside the need for large-scale investment. As physical climate risks intensify, the world must build resilience into infrastructure, supply chains, public services and natural systems. Yet, while the case for climate resilience is clear, the capital required to deliver it remains under-mobilized. Unlocking this opportunity will require far greater involvement from the private sector, through investment, innovation and delivery.

1.1 From cost centre to value driver

Historically, climate resilience measures have been viewed by the private sector through the lens of cost – a reactive expenditure aimed at minimizing damage. That narrative is changing. Climate resilience is increasingly recognized as a proactive investment in safeguarding assets, strengthening operational continuity, future-proofing supply chains and enhancing competitive positioning. With the right approach, climate resilience can unlock cross-cutting benefits across sectors, from resilient agriculture to climate-smart infrastructure.

This transition reflects a broader shift in private-sector climate action – moving from a focus on mitigation-only strategies to integrated approaches that also emphasize climate resilience. Analysis from leading institutions suggests that climate resilience investments can yield high benefit-cost ratios (BCRs),[5] particularly when compared against the rising cost of inaction.

1.2 An emerging investment landscape

$63 billion

was deployed towards climate adaptation and resilience in 2022.

Despite the growing momentum on climate resilience, the investment landscape remains early-stage, and more critically, difficult to measure, especially for private investments. According to the Climate Policy Initiative (CPI), an estimated $63 billion was deployed towards climate adaptation and resilience in 2022.[6] More than 90% of this was contributed by public-sector bodies, including development finance institutions and national governments, with the remainder from the private sector. This is a stark contrast to mitigation finance, for which the private sector contributes over half of investments. However, this discrepancy is also because private resilience finance is far harder to quantify and capture, and the current figure tracked by CPI likely represents just a portion of actual private-sector investment in climate resilience.

In addition, current tracked private investment is concentrated in sectors such as water and wastewater, with significantly lower capital deployed towards agriculture and cross-sectoral infrastructure.[7] The funding gap remains especially challenging in developing economies, where climate vulnerability is high and access to capital is constrained.

Yet, while the current picture is fragmented, the investment potential could be significant. As climate risks become more visible and climate resilience solutions mature, a growing number of institutions and investors are recognizing the opportunity. Understanding how to unlock this opportunity at scale will be critical to building a more resilient future.

1.3 A trillion-dollar market in the making

Momentum around climate resilience is accelerating across the global financial, policy and corporate landscape. Over the past few years, multiple organizations, including development institutions, academic centres, asset managers and advisory firms, have begun quantifying the scale of the resilience market and the capital required to close the gap.

A synthesis of recent market studies illustrates a significant investment opportunity in climate resilience:

- Boston Consulting Group (BCG) and Temasek[8] project an annual climate adaptation and resilience investment need of $500 billion to $1.3 trillion by 2030, based on United Nations (UN) estimates.
- GIC and Bain[9] estimate that adaptation-related revenues already exceed $1.1 trillion annually, with the potential to reach $2.0–2.3 trillion by 2030 and $4.3 trillion by 2050. The cumulative investment opportunity could be as high as $9 trillion by mid-century.
- Tailwind[10] estimates a $1.4 trillion global climate adaptation and resilience market, with governments currently spending $737 billion, complemented by $647 billion in consumer activity and $58 billion from corporations, indicating that demand is already taking shape across sectors.
- BCG and the University of Cambridge[11] underscore that achieving meaningful resilience outcomes will require annual climate adaptation and resilience investments to reach 0.5% of global gross domestic product (GDP), or $1.2 trillion, by 2050.

The insights reflect the trillion-dollar commercial potential for climate adaptation and resilience markets, spanning a wide range of sectors including resilient infrastructure, water systems, health security, sustainable agriculture, emergency preparedness and climate risk analytics.

1.4 A call for private-sector mobilization

To bridge the investment gap, the private sector can step decisively into the arena. Public funding will remain catalytic, but it won't be sufficient to meet the full investment requirement. Beyond the question of financing, businesses have a critical role to play in designing, delivering and scaling climate resilience solutions.

For business leaders and investors, climate resilience investments are not a sunk cost but a competitive advantage. Climate resilience offers pathways to protect assets, access new markets, secure supply chains and strengthen long-term value creation. Previous studies reveal that investment in climate adaptation and resilience yields a very positive anticipated payback, ranging from $2 to $19 for every dollar invested.[12] In many cases, climate resilience is not only aligned with core business strategy, but also essential to sustaining it.

Some structural and perception barriers still exist. For example, climate resilience solutions may take longer to see measurable returns, revenue streams can be unclear, and benefits may be spread over several parties, given their broader socioeconomic and environmental value. This paper explores how private-sector players can reframe these barriers and opportunities, and engage in the climate resilience agenda through collaboration with the public sector in the transition towards a more resilient global economy.

2 Public-private collaborations as the catalyst

Overall, public-private collaboration opportunities worth an estimated $320–500 billion by 2050 will be critical to scaling climate resilience.

Structured collaboration models are essential to aligning public interests with private incentives and unlocking scalable, investable solutions.

The private sector has a critical role to play in advancing global climate resilience. Businesses are no longer limited to reactive responses. Instead, they can identify clear roles in climate resilience that align with their strategic interests, capabilities and risk exposures. From protecting core operations to co-investing in public infrastructure, companies and investors have multiple pathways to engagement.

To date, most of the activities and guidance are concentrated on the private sector's own interests in climate resilience, focusing on either protecting the business or capturing the growth momentum. For example, the World Economic Forum and BCG's report *The Cost of Inaction: A CEO Guide to Navigating Climate Risk*[13] outlines a four-step action framework for corporate leaders to assess physical risk exposure and formulate a company-wide climate resilience strategy. The BCG-Temasek report[14] highlights investable opportunities in climate adaptation and resilience, offering deep dives into solution spaces such as climate intelligence, resilient building materials, smart water infrastructure and resilient agriculture.

At the same time, many large-scale climate adaptation and resilience projects (e.g. flood protection, watershed infrastructure and resilient transport systems) are less discussed as they often deliver non-exclusive, non-rival benefits that serve mutual interests for both private and public sectors. These initiatives generate multiple outcomes, from risk reduction to economic development and ecosystem services, which are hardly attributed to one single actor. **Public-private collaboration offers a key to unlocking the full value of these benefits**. The complexity of climate resilience infrastructure and the diffuse nature of its benefits often limit the clarity of roles or incentives for private actors. Structured collaboration models are essential to aligning public interests with private incentives and unlocking scalable, investable solutions.

To estimate the investment required for large-scale climate adaptation and resilience, two analyses were conducted for this paper: a top-down macro-level sizing anchoring climate adaptation and resilience needs within global investment flows, and a bottom-up estimation based on hazard-specific solution costs. Using both approaches ensures that projections are both relevant at the macro level and realistic to the predicted risks. Methodologies for each approach are detailed within the Appendix.

Based on top-down estimations, the investment need for large-scale, public-private climate adaptation and resilience infrastructure will reach $240–370 billion annually by 2030 and $330–500 billion by 2050 (Figure 1). Meanwhile, the emerging market would require more collaboration projects, given the often limited financial capability to invest in climate resilience and competing priorities of the public sector within developing and emerging markets.

Based on the bottom-up analysis conducted, an estimated $230–320 billion per year by 2030 and $320–400 billion per year by 2050 (Figure 1) in climate adaptation and resilience investments will be required through public-private collaboration. The model includes the investment needs in three major groups of solutions: drought and water scarcity solutions, coastal and riverine flood solutions, and extreme wind solutions.

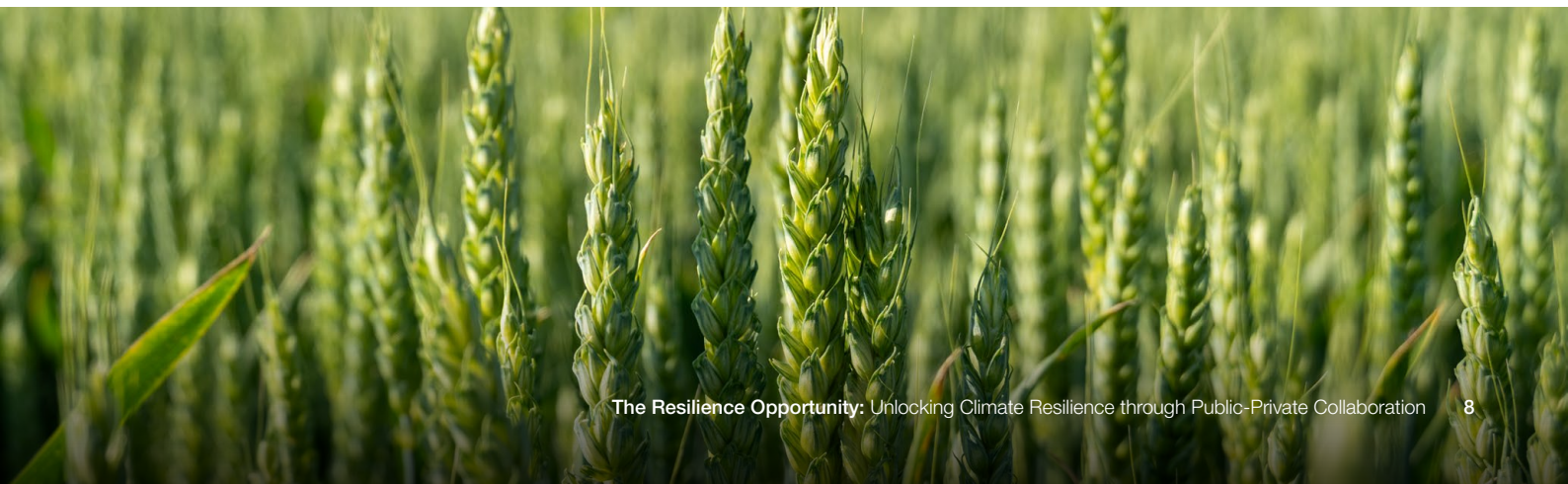
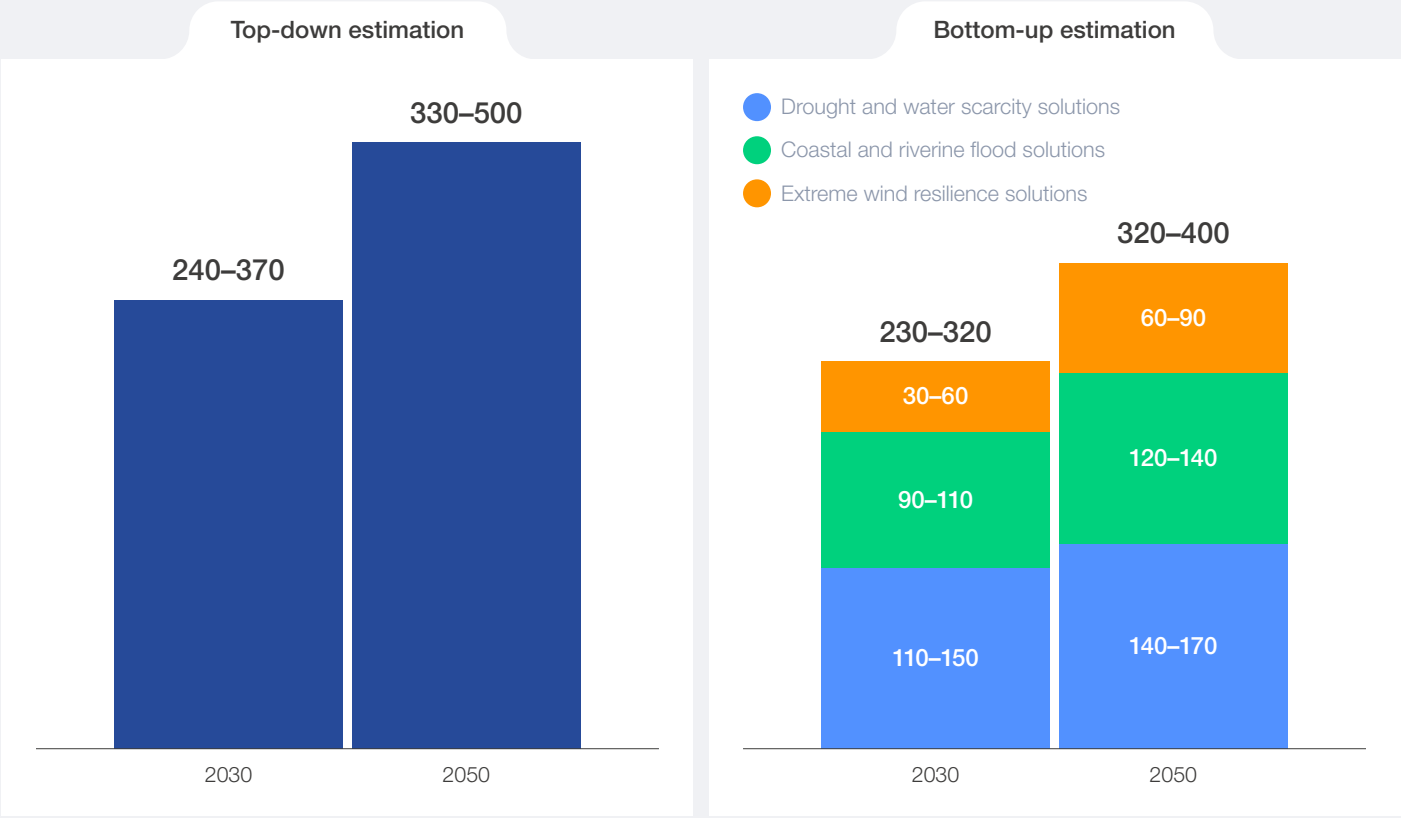


FIGURE 1 **Required annual investment for large-scale climate resilience infrastructure for collaboration in 2030 and 2050 in $, billions**



Source: Boston Consulting Group (BCG) analysis.

Both top-down and bottom-up analyses converge on a consistent insight – an estimated $320–500 billion per year will be required by 2050 to deliver large-scale climate resilience infrastructure suitable for public-private collaboration. As climate resilience gradually moves from planning to implementation, the private sector is increasingly positioned to contribute beyond internal risk management.

Participating in system-wide solutions that deliver both public and private value represents one of the largest untapped opportunities in the climate resilience space. Capturing this opportunity will require a focused effort to identify potential business value from individual private-sector actors and carefully design bankable projects to align public and private incentives.

BOX 1 **What makes collaboration on climate resilience different from traditional public-private partnerships?**

While public-private partnerships (PPPs) have traditionally been used to finance and deliver infrastructure, especially in sectors like transport, energy and water, they typically involve excludable and/or rival services, where users can be charged for access (e.g. tolls, tariffs) and private operators receive predictable returns.

In contrast, **many climate resilience projects deliver public goods** in the economic sense, i.e. **non-excludable and non-rival**, such as flood protection, early warning systems or urban cooling. These benefits are widely shared and difficult to monetize directly, and often accrue over long timeframes through avoided losses or improved system resilience.

Moreover, climate resilience challenges cut across jurisdictions, sectors and stakeholder groups, requiring coordination well beyond what standard PPP models are designed to manage.

Due to these factors, climate resilience collaborations often require more flexible and blended approaches. Rather than replicating standard PPP mechanisms, they benefit from a wider mix of private-sector interests, public grants, concessional finance, risk-sharing tools, and stakeholder engagement. Success depends not just on financial structuring, but on monetizing resilience value, developing co-benefits, aligning incentives, building trust, and delivering resilience outcomes at scale.

3

Six archetypes for private-sector actors to scale climate resilience

Six archetypes – each with different motivations and business values – are defined to guide actions.

> Investments in climate resilience can create or raise the long-term value of land, real estate, tourism zones or commercial developments by improving environmental conditions, safety or liveability.

To clarify the business value and provide pathways for action, **six practical archetypes are defined for private-sector involvement in climate resilience collaborations**. These archetypes span the spectrum of projects focusing on risk/cost avoidance and those with commercial returns, each aligned with different strategic objectives, value realization models and potential collaboration mechanisms (Table 1):

Archetype 1: Joint protection for own operations

Companies co-invest in climate resilience infrastructure (e.g. flood barriers, heat mitigation) or services (e.g. workforce training) that directly protect their physical assets, facilities or workforce to enhance business and operational resilience. These investments are often triggered by site-level risk assessments and integrated into business continuity or capital expenditure (CapEx) planning.

Archetype 2: Joint investment in supply chain resilience

Private actors support climate resilience measures that secure key suppliers, logistics infrastructure or distribution channels (e.g. agri-food companies invest in upstream cocoa sourcing). This may involve working with governments or local partners to maintain the resilience of agricultural zones and practices, transport corridors or industrial clusters and avoid supply chain disruptions.

Archetype 3: Revenue stream from adaptation benefits

Businesses deliver services or infrastructure with climate adaptation benefits that have a direct customer or payment mechanism (e.g. payment for ecosystem services, insurance tied to resilient assets, use-based fees for resilient infrastructure).

Archetype 4: Monetization of co-benefits

Climate resilience actions that generate marketable environmental or social outcomes as co-benefits (e.g. carbon credits, sustainable agriculture products, biodiversity tourism) offer new revenue streams for the developers. Success depends on measurable outcomes and access to functional markets or certification systems.

Archetype 5: Asset value uplift from climate resilience

Investments in climate resilience can create or raise the long-term value of land, real estate, tourism zones or commercial developments by improving environmental conditions, safety or liveability. This archetype harnesses resilience to unlock economic activity or property value gains.

Archetype 6: Collaboration for diffused economic benefits

This archetype focuses on private-sector participation in climate resilience initiatives that deliver broad societal and economic benefit, for example by maintaining market stability, protecting community livelihoods or enhancing basic service continuity. While the financial returns to the private actors may be indirect, they are critical to sustaining demand, enabling long-term operations and preserving economic ecosystems in climate-vulnerable areas. The realization model is still nascent and under development. Some models like the Adaptation Benefit Mechanism (ABM) illustrate how structured, verifiable outcomes, like certified adaptation benefits (CABs), can provide a new asset class and financing pathway to align public, private and community interests in advancing shared resilience.

These six archetypes involve collaboration with governments, donors and multilaterals in the investment and delivery of climate resilience outcomes. While varying in complexity and return profiles, all require alignment between public mandates and private incentives.

An illustration of different archetypes can be found in Figure 2.

TABLE 1 **Six archetypes for private-sector actors to engage in climate resilience**

Archetype	Description	Value realization or commercial model
1 **Joint protection for own operations**	Co-invest in climate resilience measures with public actors to protect own physical assets, facilities and workforce from climate risks	Avoided direct losses due to climate hazards, reduced operation disruption, lower insurance premiums, improved business continuity
2 **Joint investment in supply chain resilience**	Partner with public or private actors to invest in infrastructure or services that secure upstream or downstream supply chain resilience	Reduced disruptions from production and delivery, reduced sourcing costs and supply chain volatility
3 **Revenue stream from adaptation benefits**	Invest in or deliver climate adaptation infrastructure or services where the resilience benefit has a paying customer (e.g. climate-resilient water systems)	Revenue from direct payments for use (e.g. payment for ecosystem services, user fees), or service-based risk-sharing (e.g. insurance premiums)
4 **Monetization of co-benefits**	Generate and monetize environmental or social co-benefits (e.g. blue carbon credits, sustainable agriculture products, biodiversity services)	Return through sales of verified carbon credits or sustainable products (e.g. seaweed, regenerative crops)
5 **Asset value uplift from climate resilience**	Invest in climate resilience that improves surrounding assets or ecosystems, increasing the value of owned or adjacent assets	Asset value gain through land value/property appreciation, higher rental or lease income, or enhanced asset performance over time
6 **Collaboration for diffused economic benefits**	Invest in building broader societal resilience that protects or enhances societal continuity, market stability and license to operate in vulnerable regions	Still relatively nascent, potentially through ABM to generate CABs to reflect the impact

Source: Boston Consulting Group (BCG) analysis.

FIGURE 2 | **An illustration of the six archetypes**

Archetype 1:
Joint protection for own operations

E.g. coastal industrial companies work with the public sector to build seawalls and breakwaters to prevent coastal floods

Archetype 2:
Joint investment in supply chain resilience

E.g. agri-food players co-invest with local public sector in drought-resistant crops to reduce supply volatility

Archetype 3:
Revenue stream from adaptation benefits

E.g. companies co-develop solar-powered irrigation systems and charges the user fees for the irrigation services

Archetype 4:
Monetization of co-benefits

E.g. companies co-develop mangrove restoration to issue and trade blue carbon credits

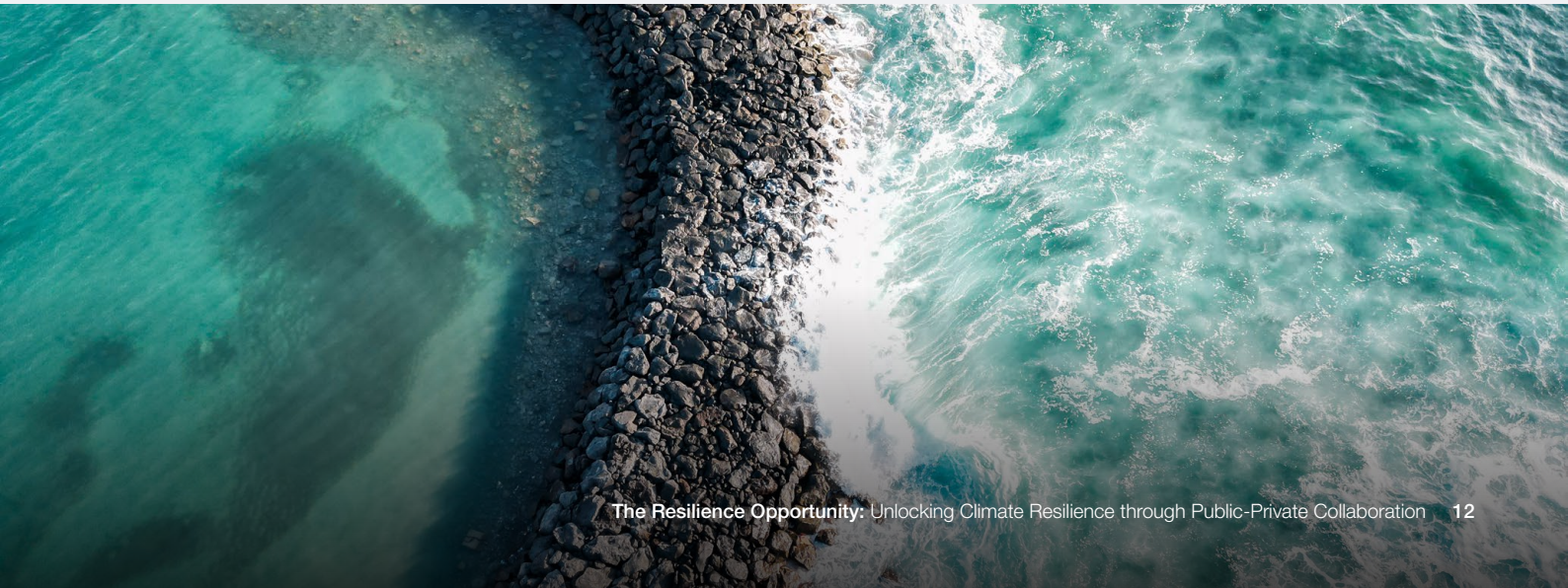
Archetype 5:
Asset value uplift from adaptation

E.g. real estate companies co-design the waterfronts to reclaim and redevelop lands for coastal resilience

Archetype 6:
Collaboration for diffused economic benefits

E.g. private sector collaborates to develop upstream wetland restoration to reduce downstream flood risk

Source: Boston Consulting Group (BCG) analysis.



> Cities and states are evaluating the possibility of redeveloping flood-prone areas with climate resilience features to enable private sector land development.

Real-world examples across sectors highlight how these archetypes take shape in practice:

- In Southern California, a leading food and beverage company partnered with a regional water authority to co-invest in groundwater replenishment infrastructure, demonstrating **archetype 1** in Archetype example 1.
- A global food and beverage company partnered with smallholder farmers in West Africa to implement climate-smart agricultural practices to enhance both crop resilience and supply chain stability, showing the viability of **archetype 2** in Archetype example 2.
- In the northern US, a private consortium led the design, financing and operation of a climate-resilient river diversion project under a performance-based contract with public authorities, exemplifying **archetype 3** through Archetype example 3.
- **Archetype 4** is increasingly observed in climate adaptation and resilience project development. In Chapter 4, two case studies are featured, thoroughly illustrating how a climate resilience initiative could integrate and monetize the co-benefits to attract private-sector investment.
- In a major Asian city, an urban stream restoration project initiated by the public sector significantly increased surrounding property values and commercial activity, illustrating the possibility of **archetype 5** from Archetype example 4. In addition, cities and states are evaluating the possibility of redeveloping flood-prone areas with climate resilience features to enable private sector land development.
- **Archetype 6** is still nascent and in the early stage of development, with few mature examples but several pilots under way. ABM, led by the African Development Bank,[15] is one of the most notable, aiming to create verifiable outcomes (i.e. CABs) to attract private finance into community-scale adaptation and resilience projects. Early pilots, such as climate-resilient cocoa farming in Côte d'Ivoire, demonstrate how private actors can engage where climate resilience yields widespread but indirect economic benefits. These initiatives offer a glimpse into future models where businesses can support systemic resilience while unlocking new impact-aligned capital flows.

Together, these cases demonstrate how private actors can reduce shared risks, deliver core climate adaptation and resilience services and enhance long-term asset performance through tailored collaboration models.

ARCHETYPE EXAMPLE 1

Co-investing in urban water resilience infrastructure

A leading food and beverage company partnered with a regional water authority in Southern California to co-invest in groundwater replenishment infrastructure. The collaboration supported the construction of an inland injection well aimed at enhancing aquifer sustainability and long-term water security for both industrial operations and the broader community.

Background and context

Recurring droughts, declining groundwater levels and increasing reliance on imported water sources have placed pressure on both public water systems and industrial water users across Southern California. Recognizing the critical role that reliable local water supplies play in sustaining production operations, the beverage company sought to strengthen its long-term water security in key risk regions. The regional water authority, facing infrastructure financing gaps, welcomed the opportunity to partner with a private-sector stakeholder with shared water dependency and aligned sustainability goals.

Solutions deployed

The company provided a multi-million-dollar grant to support the design and construction of a pilot inland injection well at an advanced treatment facility. The project aimed to capture and inject treated water into a local aquifer, enhancing its recharge capacity and drought buffer. Delivered in collaboration with engineering partners, the project represents one of the region's first PPPs in groundwater resilience infrastructure.

Impact

The injection well project enhanced the region's ability to replenish aquifers and maintain its water supply during prolonged dry periods. The company strengthened its water security in a critical operating region while aligning with broader sustainability and resilience commitments. For the public partner, private capital enabled faster project delivery, de-risked implementation and expanded technical collaboration. The initiative has since been recognized by water industry associations as a model for private-sector engagement in public climate resilience infrastructure, helping to bridge resource gaps while delivering long-term resilience benefits to both industry and communities.

Source: PepsiCo. (2022, 7 January). *PepsiCo Beverages North America Announces $1.5 Million Partnership with Water Replenishment District of Southern California to Help Protect the State's Most Used Basins* [Press release]; Brown and Caldwell. (2022, 23 August). *PepsiCo and partners to discuss collaborative water replenishment programs at World Water Week* [Press release].

ARCHETYPE EXAMPLE 2

Strengthening supplier climate resilience

A global food and beverage company partnered with smallholder farmers in West Africa to implement climate-smart agricultural practices to enhance both crop resilience and supply chain stability.

Background and context

The company's supply chain relies heavily on smallholder farmers producing grains, dairy and coffee. Facing unpredictable rainfall patterns, soil degradation and rising temperatures, these farmers were increasingly unable to meet volume and quality requirements, posing risks to both procurement and climate commitments. The company sought to address this by financing adaptive measures at the farm level.

Solutions deployed

Through a climate-smart agriculture initiative launched in partnership with a local agricultural non-governmental organization (NGO) and a regional development fund, the company supported thousands of farmers across two states. Interventions included regenerative soil management, drought-tolerant crop varieties, agroforestry systems and digital advisory tools. Farmers received training, on-site demonstrations and access to premium markets through formal purchase agreements, all under a structured "regenerative supply chain" framework.

Impact

Within the first year, participating farmers reported significantly improved yield stability and resilience to climatic shocks. Income predictability increased due to premium pricing and reduced crop losses. The company achieved secure and traceable supplies for key commodities, enhanced its corporate profile and generated positive local economic outcomes, further supported by recognition from regional agricultural authorities.

Source: Nescafé. (2024). *Nescafé Plan 2030 Progress Report 2023*; TechnoServe. (2025, 6 May). *AGRA, Nestlé, and TechnoServe Launch Groundbreaking Climate-Smart Agriculture Initiative in Nigeria* [Press release].

ARCHETYPE EXAMPLE 3

Climate-resilient river diversion via structured public-private finance

In a flood-prone region of the northern US, a private consortium partnered with a public authority and federal agencies to co-develop the stormwater diversion channel component of a comprehensive flood diversion system protecting an urban corridor. The construction of the stormwater diversion channel used a design-build-finance-operate-maintain (DBFOM) contract model to mobilize long-term private capital for climate resilience infrastructure.

Background and context

Repeated large-scale flooding events have threatened tens of thousands of homes as well as critical infrastructure across urban and agricultural zones. A traditional public delivery model lacked the speed and financial flexibility to address rising climate risks. To accelerate action and spread cost over time, a hybrid PPP structure was adopted to deliver one-third of the comprehensive project (the stormwater diversion channel).

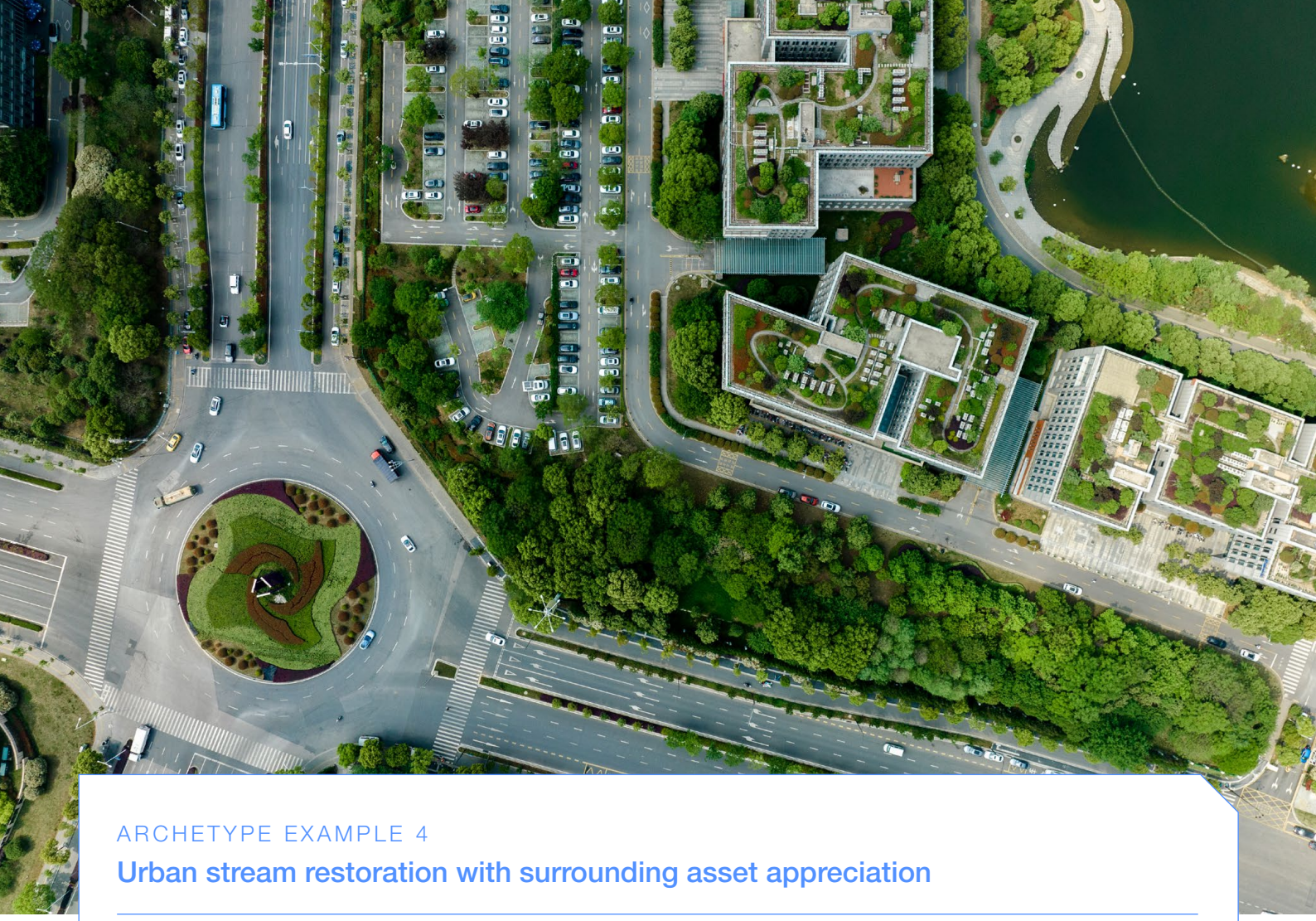
Solutions deployed

The private consortium financed the majority of the private capital investment using a mix of private equity and green-labelled infrastructure bonds, alongside federal and local contributions. In return, the consortium receives construction milestone payments and annual availability payments over a 30-year operations and maintenance period, contingent on the infrastructure being operational and maintained to performance standards. These payments are drawn from a dedicated regional authority budget, secured through multi-level governmental agreements.

Impact

The comprehensive project is projected to protect 260,000 people and billions in economic assets from 100-year and 500-year flood events. Private-sector participants associated with the stormwater diversion channel benefit from reliable, long-term payment flows tied to service delivery, while public actors gain rapid delivery, transferred risk and reduced disaster response costs. The model demonstrates how performance-based financing can support climate resilience at the regional scale.

Source: Metro Flood Diversion Authority; U.S. Department of Transportation Federal Highway Administration. (n.d.). *Project Profile: Fargo-Moorhead River Flood Diversion P3 Project, North Dakota*. https://www.fhwa.dot.gov/ipd/project_profiles/fargo_moorhead_flood diversion.aspx.



ARCHETYPE EXAMPLE 4

Urban stream restoration with surrounding asset appreciation

A major Asian city revitalized a buried urban stream by replacing an elevated roadway with an open green corridor. Though publicly led, the project demonstrated how nature-based climate resilience measures can enhance real estate values and catalyse broader urban regeneration, offering important signals for future private sector-involved developments.

Background and context

The city faced recurring stormwater flooding, heat island effects and deteriorating public space quality in its central district. It implemented a large-scale stream restoration project, integrating climate-resilient design elements, such as vegetated banks, permeable surfaces and adaptive water channels, to manage runoff, reduce temperatures and restore ecological function.

Solutions deployed

The project transformed over 5 km of covered waterway into a multifunctional urban parkway. Flood resilience was embedded through stormwater retention basins, widened channels and vegetated edges. The restored corridor also served as an urban cooling zone, pedestrian spine and ecological habitat.

Impact

Post-restoration, land prices and commercial property values within a short radius of the corridor increased by approximately 30–50% compared to pre-project benchmarks and doubled the rate of property increases in other areas of the city. Local businesses reported increased foot traffic, and microclimate monitoring showed meaningful reductions in ambient temperatures. While private investors were not involved in the initial project, the results provide a compelling case for embedding similar nature-based climate resilience features into future developments in which commercial stakeholders can directly capture the resulting asset uplift.

Source: Landscape Performance Series. (n.d.). *Cheonggyecheon Stream Restoration Project*. https://www.landscapeperformance.org/case-study-briefs/cheonggyecheon-stream-restoration-project.

Ultimately, these archetypes help to identify engagement models in different contexts, whether the driver is protection, value creation or public impact. However, motivation and business value identification are just the first steps towards success. To unlock the collaboration opportunities, public and private stakeholders would need to work together to define shared objectives, clarify risk and return expectations, and co-design delivery approaches that reflect their respective values and strengths. When structured well, these collaborations can deliver climate resilience solutions at scale in a financially viable, socially beneficial and climate-resilient way.

4

Design viable resilience: stacking value across archetypes

Combining archetypes presents a feasible approach to implementing successful interventions in public-private collaboration.

Despite growing recognition of the need for public-private collaboration in climate resilience, many high-potential projects still struggle to reach implementation. Even when public and private interests are aligned in principle, practical barriers – such as fragmented pipelines, unclear commercial models and limited financing mechanisms – often constrain the progress. Relying on a single archetype is usually insufficient to overcome the barriers, justify the business case and mobilize private-sector investment.

A promising path forward is to **blend multiple archetypes within a single initiative** to strengthen the overall business case. To do this, public and private-sector actors can harness the archetype models to evaluate potential pathways in which multiple value enablers can be unlocked, helping to overcome investment barriers by diversifying revenue streams, sharing risks and demonstrating clearer returns.

BOX 2 **Mangroves as an example – how blended archetypes could work in a single initiative**

Mangrove restoration initiatives have the potential to integrate multiple archetypes, enabling diverse private-sector actors to engage based on their risk exposure and interests:

- Coastal manufacturers or logistics operators can co-invest in mangrove restorations to reduce flood and storm surge risk that threatens their facilities or critical coastal infrastructure, representing operational protection **(archetype 1)** or supply chain resilience **(archetype 2)**.
- Insurers can invest in the mangrove restoration and underwrite parametric insurance products for nearby communities, enabled by reduced coastal flood risk and improved modelling confidence **(archetype 3)**.
- Carbon market participants or sustainability-focused corporates can purchase blue carbon credits generated from mangrove restoration to meet emissions reduction targets **(archetype 4)**.
- Hospitality developers or seafood companies can benefit from long-term ecosystem improvements, which enhance tourism potential, nearby habitats and aquaculture productivity **(archetype 5)**.
- Local retailers or consumer-facing companies can contribute to the mangrove restoration project to safeguard community livelihoods and stabilize household purchasing power in the face of climate hazards **(archetype 6)**.

The example of mangroves illustrates the potential of **integrating multiple archetypes within a single climate adaptation and resilience project** to unlock broader value, diversify revenue streams and mobilize a wider set of private-sector actors. However, achieving this level of integration requires thoughtful design and construction of clear revenue models, a balanced risk-return profile that works for diverse stakeholders and aggregation to a scale that is meaningful for private-sector engagement. Having these in place is critical for building more scalable and investable climate resilience initiatives.

4.1 Three levers for unlocking scalable climate resilience collaborations

Climate resilience projects can be bundled with other revenue-generating models such as large infrastructure, urban development projects or other business models with steady revenue streams.

Unlocking private-sector archetypes in public-private collaboration – particularly for large-scale, shared-resilience infrastructure – requires a fundamental shift in how projects are structured. While climate adaptation and resilience projects are often justified by their social or environmental benefits, they can also offer a credible investment proposition to mobilize private capital at scale. This means going beyond traditional grant or public-led delivery models and developing mechanisms that allow private actors to capture value and manage risk. There are three essential strategic levers: **defining the revenue model, matching project scales for engagement** and **managing risk-return expectations**.

1 Define the revenue model

One of the core barriers for private-sector engagement is that most climate adaptation and resilience projects do not generate direct user fees or tradable assets. However, this does not mean they lack economic value. The first lever is to **rethink how resilience value is captured and translated into investable returns**, potentially through stacking various commercial return-oriented archetypes.

Several pathways are emerging. In select cases, performance-based payments tied to resilience outcomes, such as reduced flood losses or service continuity, can offer structured returns to private investors through public contracts, donor support or insurance-linked instruments, as indicated in archetype 3.

Another opportunity is to integrate with archetype 4 to monetize co-benefits, such as carbon credits or byproducts. For example, flood buffer wetland restoration projects could issue high-quality carbon credits for industrial players to offset their emissions, while coastal mangrove restoration could integrate with sustainable aquaculture to enhance the economic value realization. In addition, climate adaptation and resilience projects can be bundled with other revenue-generating models such as large infrastructure, urban development projects or other business models with steady revenue streams (e.g. transit corridors, housing or commercial districts).

While still relatively uncommon in current markets, the potential for asset value uplift in archetype 5 could be harnessed where appropriate. This includes land value appreciation from resilience-focused redevelopment in flood-prone areas, coastal protection efforts with land reclamation or increased real estate value driven by well-integrated resilience features in climate-vulnerable zones.

These approaches require climate resilience to be framed not just as a cost, but as a value multiplier. By embedding climate resilience within broader commercial systems and explicitly linking it to economic performance, project developers and public agencies can expand the range of viable revenue models available to the private sector. This would convert a purely protection-based climate resilience project (e.g. in archetypes 1 and 2) into a revenue-generating business (e.g. in archetypes 3, 4 or 5).

2 Match project scales for private sector thresholds

The scale of climate adaptation and resilience projects plays a critical role in determining commercial viability. Many interventions, such as micro-dams, decentralized water systems or community-level irrigation upgrades, are highly effective locally, but too small or fragmented to attract private investment on their own. From an investment perspective, these projects often fall below the minimum ticket size that institutional investors, infrastructure funds or corporate capital teams can justify.

To bridge this gap, public and development actors can explore ways to **aggregate or integrate smaller interventions into larger investment platforms**. This could include bundling projects by geography (e.g. regional watershed initiatives), by theme (e.g. urban cooling networks), by industry (e.g. climate-proofing supply chains) or even by different archetypes with shared interests. When grouped under a unified framework, with common standards, shared procurement, and coordinated governance and oversight, these projects can reach the scale required to unlock financing while retaining resilience impact.

Such structuring not only improves visibility for investors but also allows for more efficient deployment of financing mechanisms, performance-based payments and long-term operations. In doing so, it expands the universe of climate adaptation and resilience projects that can transition from public programming to investable infrastructure.

3 Manage risk-return expectations for different stakeholders

A core barrier to scaling private investment in climate resilience is the mismatch in risk-return expectations across a diverse set of stakeholders. Many climate adaptation and resilience projects

> Tools such as blended finance, concessional capital, guarantees and first-loss capital, as well as currency-hedging instruments, can mitigate downside risks and improve risk-adjusted returns.

involve uncertain or delayed cash flows, complex delivery models and regulatory ambiguity, making them difficult to evaluate within conventional financing models. These challenges are often compounded by long lead times, unclear asset ownership and exposure to evolving climate hazards. In emerging and developing markets in particular, heightened return expectations are driven by perceived country risk and local currency exposure, which can make long-term climate resilience investments appear less competitive.

Addressing these concerns requires **a combination of financial, regulatory and policy mechanisms from both private and public sectors**. On the financial side, tools such as blended finance, concessional capital, guarantees and first-loss capital, as well as currency-hedging instruments, can mitigate downside risks and improve risk-adjusted returns. On the regulatory side, fiscal incentives, transparent processes, streamlined permitting and resilience-linked procurement can reduce friction and perceived country risk, and increase predictability for the private sector.

By embedding these mechanisms into project design and financing structures, different stakeholders with diverse motivations can manage uncertainty more effectively, making climate resilience investments more attractive, more scalable and better aligned with commercial capital expectations.

4.2 Case studies to demonstrate future possibilities for climate resilience

Case studies 1 and 2 demonstrate how these levers could be used in practice. The **Stormwater Management and Road Tunnel (SMART Tunnel)** in Malaysia demonstrates how bundling flood control with tolled infrastructure, combined with a clearly defined PPP, can create a viable model for long-term, blended investment. Case study 2 shows an innovative model that combines performance-based mechanisms and co-benefit monetization to unlock new revenue pathways for nature-based solutions. These examples illustrate that when operational, financial and regulatory enablers are in place, climate resilience solutions not only become feasible, but also investable, offering repeatable models for scaling public-private collaboration.

CASE STUDY 1

SMART Tunnel – bundling climate resilience with revenue-generating infrastructure

Overview of the project

To address frequent floods in Kuala Lumpur's central business district and worsening traffic congestion, Malaysia built the **SMART Tunnel**. Opened in 2007, the 9.7km tunnel diverts monsoonal runoff from the Klang-Ampang River confluence while also serving as a 3km double-deck motorway to ease traffic into the city.

Project description

The SMART Tunnel operates through four distinct modes driven by river flow rates and storm severity: two modes in dry conditions (mode 1: open for traffic, and mode 2: half open for motorways) and two modes in flood mode (mode 3: closed for major storms, and mode 4: dedicated water passage). The Supervisory Control and Data Acquisition (SCADA) system will detect water level, and the flood sensors will control the operations of automated flood control gates. Post-flood, the tunnel is cleared within 48 hours, returning to normal traffic use.

By pairing flood diversion with a tolled motorway, SMART creates a **revenue model for climate resilience infrastructure**. Furthermore, traffic tolls generate income during dry periods, offsetting CapEx and operational costs. In flood mode, the motorway converts seamlessly into a water conduit to deliver its flood resilience function.

Private-sector engagement and public-sector support

The project was delivered through a joint venture between Gamuda Berhad and the Malaysian Mining Corporation (MMC) Berhad, under the oversight of two government agencies, the Department of Irrigation and Drainage (DID) Malaysia and the Malaysian Highway Authority.

The project was financed through a traditional **PPP model**, with a total capital cost of approximately $510 million – of which the private sector contributed $170 million to finance the development, operation and long-term maintenance of the toll expressway and its supporting systems.

The private consortium recoups its investment primarily through **toll revenue**, collected from vehicles via electronic systems using the 3km motorway during dry conditions (modes 1 and 2). Although tolling is suspended during flood-mode operations (modes 3 and 4), the overall revenue model is robust due to consistent urban traffic demand and the tunnel's role as a high-capacity southern gateway to the city.

In parallel, public-sector responsibility remains in place for the flood control system. The DID under the Ministry of Environment and Water prepares an annual operational and maintenance budget for the tunnel's stormwater management components. This division of responsibility ensures long-term functionality while keeping critical resilience infrastructure publicly supported and financially sustainable.

Impact delivered

- **Frequency of activation:** Since opening, the tunnel has entered some form of flood-control mode over 600 times, with 11 major activations in mode 4 (exclusive drainage mode). This includes a significant event in December 2021, when it diverted 5 million cubic metres (m^3) of floodwater during a single 22-hour operation.
- **Damage prevention:** DID estimates indicate that the tunnel has prevented approximately $337 million in flood damage since 2007, representing around $24 million annually.
- **Flood mitigation efficacy:** In a 2022 event where total flood losses reached RM 6.1 billion (Malaysian ringgit), the SMART Tunnel alone was estimated to mitigate 45% of potential flood damage in the Klang Valley, preventing extensive traffic and infrastructure disruptions.

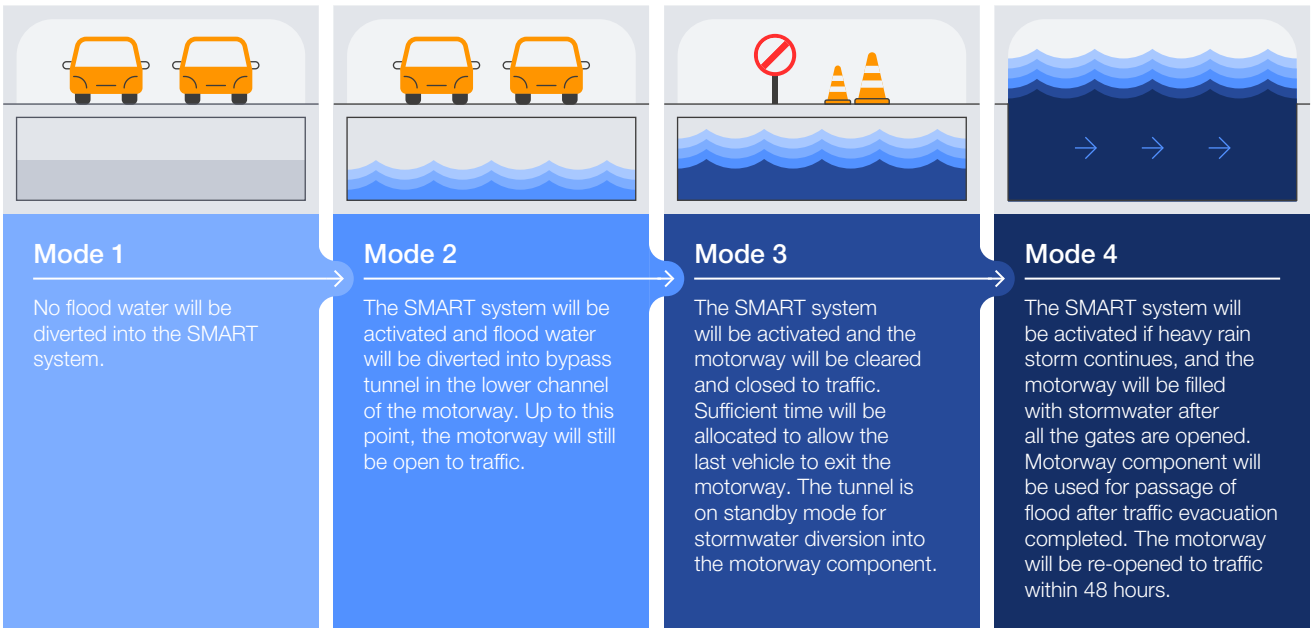
Key takeaways and implications

The SMART Tunnel provides a replicable blueprint for how cities can rethink infrastructure to address climate risk and urban development simultaneously. It offers a powerful demonstration of how large-scale climate resilience infrastructure can be made commercially viable, harnessing multiple archetypes and key design levers introduced in this paper:

- **Bundling climate resilience with revenue-generating infrastructure** creates a compelling investment case. By integrating flood control benefits with an urban toll road, the project defines a clear revenue stream from the stormwater management system, which is usually a public good.
- **Clearly defined roles and revenue pathways enable effective risk sharing for different stakeholders**. The PPP structure clearly delineates public and private responsibilities. Toll operations and maintenance were handled by the private sector, while the government retained ownership of flood control infrastructure. This aligns with the third lever **(manage risk-return expectations)** and highlights how thoughtful contract design can facilitate private engagement in resilience systems. In addition, the continuous value tracking validates the importance of **measurable outcomes** in attracting commercial capital and scaling future public-private climate resilience efforts.

The SMART Tunnel demonstrates how archetype 4 can generate revenue streams from climate resilience infrastructure through monetization of its co-benefits.

SMART tunnel operational models



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CASE STUDY 2

RISCO – monetizing restoration as a service

Overview of the project

RISCO (Restoration Insurance and Financial Services Company) is an innovative nature-based adaptation platform. It offers a mechanism to restore mangroves in vulnerable communities, using a unique blend of mangrove-positive business, blue carbon credits and insurance offerings. RISCO's model **monetizes two core ecosystem benefits: flood mitigation and carbon sequestration**, while **aggregating and supporting mangrove-positive businesses** that provide local livelihoods. In doing so, it transforms nature-based adaptation into a structured, investable platform, aligning public resilience goals with private returns.

Business model description

RISCO operates as an innovative platform that delivers nature-based adaptation through three interlinked mechanisms:

1. **Inclusive enterprise financing:** RISCO provides low-interest loans, technical support and training to mangrove-positive enterprises, such as integrated aquaculture, Nypa processing and ecotourism ventures. These businesses not only provide livelihoods but also reinforce conservation goals.
2. **Co-benefit monetization:** RISCO aims to generate revenue from blue carbon credit sales, quantified through standardized methodologies and sold to corporate buyers seeking high-integrity nature-based offsets.
3. **Insurance provision:** RISCO promotes parametric or risk-transfer insurance products to coastal municipalities, communities and businesses.

In RISCO's model, inclusive financing could provide financial support and engage local communities closely in developing mangrove-positive small and medium-sized enterprises (SMEs), while insurance products would enhance the overall community resilience in emergencies. Potential blue carbon credit sales could further monetize co-benefits from the mangrove restoration. By stacking up different value propositions in the business model, RISCO presents a viable model for integrating archetypes 3 and 4, and potentially even archetype 6, in the design.

Public sector support in de-risking

While RISCO aims to operate as a commercially viable enterprise, its early-stage development was enabled by strong public and philanthropic support. Conservation International and various philanthropic foundations served as the founding sponsors, ensuring ecological and community integrity while attracting early partners. Collectively, this collaboration provides the early risk absorption and institutional alignment needed to move RISCO from concept to market. It **de-risked the business model at an early stage** and laid the groundwork for scaling private investment into nature-based solutions.

RISCO has formally launched operations in the Philippines following a detailed feasibility study and a successful small-scale pilot. With regulatory approvals secured, it is actively forming partnerships with local government units, academic institutions and civil society organizations. RISCO plans to expand from its current hub in the Philippines to other climate-vulnerable geographies across South-East Asia and Latin America, focusing on regions where mangrove restoration yields high risk reduction and carbon benefits.

Key takeaways and implications

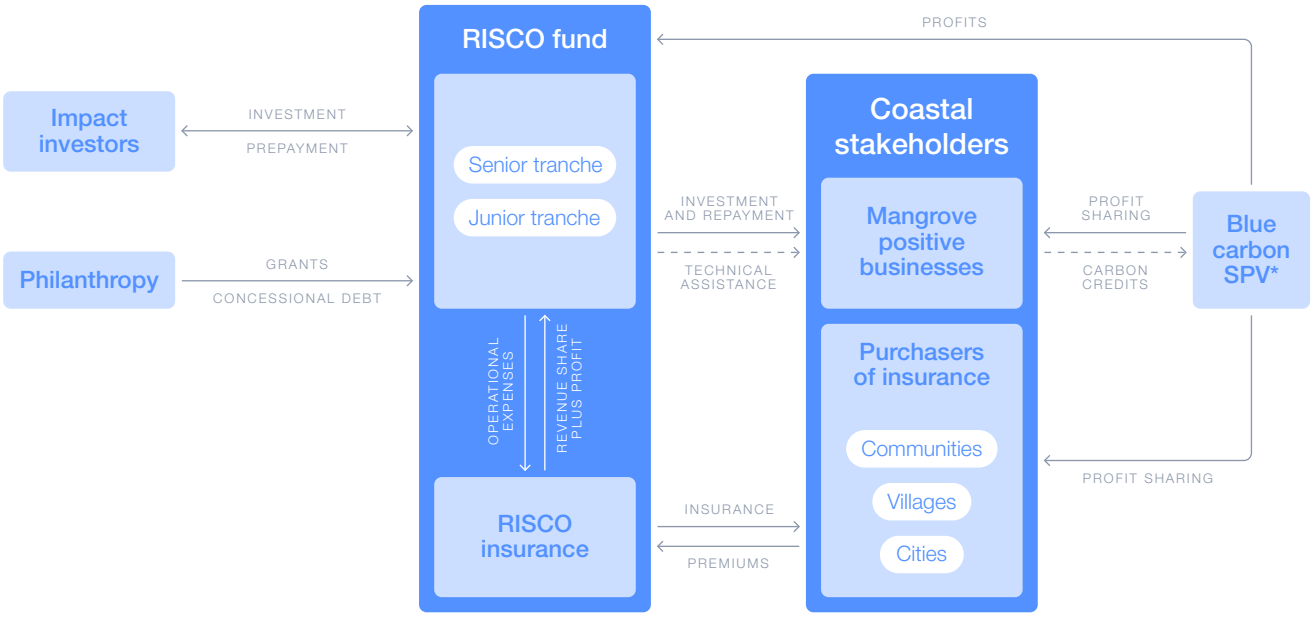
RISCO's early pilots demonstrate how ecosystem restoration, when paired with innovative revenue model design, aggregated local efforts and a suitable de-risking mechanism, can evolve from a donor-funded intervention into a self-sustaining climate resilience business model for the private sector. It reinforces and extends the principles in this paper and demonstrates the possibility of replicating them in other projects:

- **Monetizing climate resilience co-benefits opens new investment pathways**. RISCO's model unlocks value from restoration in ways applicable to other sectors; cities might apply similar logic to heat mitigation (via green infrastructure) or watershed services (via forest protection), creating layered revenue streams to support climate resilience financing.

- **Aggregating value as a platform of local stakeholders simplifies investment decisions**. RISCO works directly with local communities and aggregates the needs in a central platform to seek development support. The model creates local economic opportunities (e.g. through support for mangrove-positive SMEs and community benefit-sharing mechanisms) reduces complexity and creates an investable platform, offering a replicable template for climate resilience initiatives in rural coasts or small island states with limited public support.

- **Blended finance is essential to unlocking early-stage investment**. RISCO would not have been possible without NGO, philanthropic and concessional capital that underwrote early modelling, community engagement and product development. This reinforces the importance of upfront de-risking and soft capital to catalyse innovative, high-potential climate resilience models, particularly in emerging markets where resilience solutions are urgent but financially nascent.

RISCO business model



*special purpose vehicle

Sources: The Earthshot Prize. (n.d.). *RISCO*; The Earthshot Prize. (n.d.). *Unlocking Critical Finance for Climate & Economic Resilience*; The Lab. (n.d.). *Restoration Insurance Service Company (RISCO)*; Swiss Re. (n.d.). *Conservation International: Mangroves pay their way*; RISCO.

5 Key takeaways for public and private decision-makers

Translating climate resilience ambition into action requires public and private actors to align on strategy, investment models and delivery roles.

Takeaways from the SMART Tunnel, RISCO and other examples illustrate clear actions that both public and private leaders can take, supported by the archetypes and levers outlined in this paper. Achieving large-scale climate resilience requires a shift from fragmented efforts to structured collaboration. To unlock scalable, investable climate resilience solutions, decision-makers must take deliberate, coordinated actions.

5.1 Private sector: proactively engage in resilience collaboration

Private-sector actors, such as corporations, investors, utilities and supply chain leaders, have a growing stake in building resilience across the systems they rely on. To participate meaningfully, businesses could consider four key actions:

1. **Clarify immediate climate resilience needs:** Identify where physical climate risks intersect with operations, supply chains and customer markets, as well as where investments are necessary to avoid direct losses or reduce supply chain disruptions.
2. **Harness six archetypes to identify engagement models:** Use the archetype framework to identify the motivations and business values based on the company's risk exposure, commercial opportunities and desired role in project delivery.
3. **Engage suitable partners to co-design climate adaptation and resilience projects proactively:** Partner with local governments and other stakeholders to co-design project objectives, revenue models, scale requirements, risk-sharing mechanisms and implementation structures.
4. **Use structured blended finance funds and tools:** Harness well-structured blended finance funds or tools to simplify the risk-return profile matching and save preparation time in structuring climate adaptation and resilience projects.

5.2 Public sector: creating the conditions for scalable collaboration

Public institutions, such as national governments, development banks and subnational authorities, play a foundational role in shaping markets for climate resilience solutions. To enable effective and efficient private participation, they can consider four priority actions:

1. **Translate climate adaptation and resilience strategies into investable pipelines:** Move from high-level national, regional or local "adaptation plans" to actionable, bankable projects with defined ownership, feasibility assessments and clear revenue models, supporting de-risking mechanisms and implementation pathways.

2. **Enable blended finance to de-risk investment:** Use public and concessional capital strategically to improve the risk-return profile of climate adaptation and resilience projects – for example, through first-loss capital, guarantees or outcome-based payments.

3. **Clarify entry points for private-sector engagement:** Refer to the six archetypes introduced in this paper, ranging from co-investment in infrastructure to delivery of resilience-linked services, to start engagement with potential private actors.

4. **Reduce friction in project delivery and implementation:** Streamline permitting, introduce resilience-aligned procurement processes and consider incentives for climate resilience investments. At the same time, equip cities, regions and utilities with the tools, coordination platforms and institutional support needed to implement scalable, locally led climate resilience projects.

Together, these actions offer a practical roadmap for structuring effective public-private collaboration in climate resilience, aligning capital, capabilities and incentives to deliver resilient systems at scale.

Conclusion: A shared agenda to unlock climate resilience

Achieving climate resilience at scale will require bold, sustained collaboration between the public and private sectors. As climate risks become more severe and systemic, the cost of inaction continues to rise, and the urgency to act grows more acute. Public resources alone are not sufficient to meet the demand, particularly for large-scale, cross-sector climate resilience systems. The private sector will now necessarily step into a more strategic, proactive and co-leadership role.

This paper sets out a clear roadmap for doing so through public-private collaboration. It highlights the trillion-dollar opportunity in climate adaptation and resilience by 2050, including $320–500 billion per year in large-scale infrastructure where public-private collaboration is more suitable. It outlines six archetypes for private sector participation and presents a practical set of tools to develop commercially viable projects, including revenue model innovation, aggregation strategies, and risk-aligned financing mechanisms.

Looking forward, the private sector has a clear opportunity to evolve from a passive stakeholder to an active co-architect of the resilience agenda. Businesses could integrate resilience into enterprise strategy, investment planning and operational design. They could consider engaging early with public institutions, co-developing resilient infrastructure and bringing capital, technology and delivery capabilities to the table. By doing so, they could not only protect assets and supply chains but also help shape the systems that underpin long-term societal and economic stability.

Meanwhile, public actors could continue to lead in setting ambition, designing policy and building investable project pipelines. They can strategically deploy public finance to crowd in private capital, remove barriers and ensure equitable access to adaptation and resilience benefits.

Climate adaptation and resilience is not only about managing future risks. It is a platform for shared resilience and long-term value creation. With the right partnerships, tools and leadership, climate resilience can scale and deliver outcomes that protect people, sustain economies and build a more stable future.

Appendix: Methodology

Quantifying the scale of the investment opportunity is critical to attracting private-sector interest and guiding potential collaboration. For businesses and investors to engage meaningfully in climate resilience, especially through a public-private collaboration model, they need a clear view of the addressable market, its composition and where commercial logic can apply.

To seize this opportunity, both top-down and bottom-up approaches were used to estimate the annual investment required by 2050 for climate resilience infrastructure suitable for public-private collaboration.

Top-down analysis and methodology

A three-step approach was designed for the top-down estimation. Using the annual global infrastructure investment as the baseline, this figure was then adjusted by applying the share of resilience-related infrastructure in total infrastructure spending, followed by the share of collaborative investment within overall climate resilience flows.

According to the *Global Infrastructure Outlook*, total global infrastructure investment is projected to reach approximately $4.6 trillion per year by 2050.[16] Based on benchmarks from the *UNEP Adaptation Gap Report*, 7–12% of this infrastructure investment is expected to address climate resilience needs, covering areas such as water systems, coastal defences, flood management and resilient urban infrastructure.[17] This range remains a conservative estimation of the resilience infrastructure required, as more resilience features will be gradually introduced to different categories of infrastructure. Moreover, 50–80% of the mentioned resilience investment would involve co-financing from public or concessional sources.[18] Notably, the emerging market would require more collaboration projects given its limited public-sector capability and competing priorities.

Applying these parameters, the estimated investment need for large-scale, public-private resilience infrastructure will reach $330–520 billion annually by 2050 from the top-down analysis. This figure represents the investable opportunity space for collaborative models, in which public institutions and private actors share financing, risk and delivery responsibilities to protect vulnerable systems and enable resilience at scale.

Bottom-up analysis and methodology

To complement macro-level perspectives, a hazard-based, bottom-up analysis was conducted to estimate the annual investment required for climate resilience infrastructure aligned with public-private collaboration. This approach evaluates the capital needed across key climate hazards for most material and applicable resilience solutions.

The bottom-up analysis is also structured using a three-step methodology. This approach assesses the economic cost of inaction across vulnerable regions exposed to multiple climate-related hazards, defines the protection potential of feasible large-scale resilience solutions and determines the capital needed to implement them.

The first step models the direct economic losses from acute climate hazards – including floods, droughts, wildfires and extreme winds – under two emissions scenarios: Representative Concentration Pathway (RCP) 4.5 and RCP 8.5. The cost of inaction is derived by overlaying three dimensions of climate science: hazard, exposure and vulnerability. A bottom-up approach applies high-resolution spatial data[19] to map hazard exposure, linked to asset distribution and GDP forecasts,[20] enabling projections of annualized damage and disruption across different geographies and time horizons (2030, 2050, 2100). Annual expected losses are calculated by integrating hazard probabilities (e.g. 1-in-100-year flood events) and relevant damage functions, adjusted for the potential influence of resilience measures. Some limitations remain, including reliance on static asset datasets and coverage that's restricted to select economic sectors.

The second step assesses the maximum economic value that can be protected through current climate resilience solutions, particularly through resilience infrastructure that serves both public and private interests. These include engineered and nature-based systems such as seawalls, water retention basins, climate-smart agriculture and urban cooling strategies. This step also incorporates the concept of adaptation limits, recognizing that solution effectiveness declines under higher warming scenarios. For example, the protective effect of some water-based infrastructure significantly decreases as warming intensifies.

The third step estimates the capital needed to implement adaptation measures that offer realistic and cost-effective risk reduction. Specific solutions are mapped to relevant climate risks, and sector-level BCRs are applied to quantify required investments. The focus is primarily on infrastructure-intensive interventions, including large-scale flood and drought resilience. The resulting estimation, $320–400 billion per year by 2050, represents the investment required to protect critical systems and mitigate cascading climate impacts across food, water and infrastructure networks. This signals the opportunities in potential public-private collaborations.

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Acknowledgements

The World Economic Forum and BCG would like to extend their gratitude to the following individuals for their valuable contributions to this paper. The paper does not necessarily reflect the views of these individuals and/or their organizations. Expert advice is purely consultative in nature and does not imply any association with the takeaways or conclusions presented within this paper.

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Endnotes

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