The Adaptation & Resilience Innovation Playbook

DECEMBER 2024

Tailwind

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About Tailwind

Tailwind

Tailwind is an advisory and investment firm focused on accelerating the development and deployment of climate adaptation and resilience (A&R) solutions.

Emilie Mazzacurati and Katie MacDonald launched Tailwind because they saw the urgent need for a climate adaptation innovation ecosystem. They have spent their careers building, investing in, and growing companies, products and programs into global successes.

Tailwind is dedicated to addressing **3 market failures**:

1. **Capital Gap** – Lack of sufficient investor capital available to A&R innovators.
2. **Demand Gap** – Lack of clear demand from A&R solution buyers.
3. **Ecosystem Gap** – Lack of adequate support for innovators from academic and innovation support organizations.

OUR WORK

Advisory

We provide consulting services to corporations and investors and conduct philanthropically-funded work to build the field of adaptation innovation.

Investment

We place investments into early-stage climate adaptation startups with technologies and services we have conviction in.

Foreword from the Founders

The impacts of climate change call for rapid investment into and implementation of adaptation and resilience (A&R) solutions to protect communities, ecosystems, and economic assets.

We believe technological innovation, used wisely, can play a critical role in enabling climate resilience. We think innovation can make climate adaptation cheaper, faster, better and enable communities to flourish in the face of mounting climate hazards.

We wrote this Playbook to enable investors, innovators, corporations and governments to navigate the market for A&R solutions, with the goal of identifying key innovation needs, increasing capital into A&R solutions, and accelerating innovation. We hope all actors in the innovation ecosystem see both the opportunity and the responsibility to innovate and tackle this existential challenge. We look forward to working with you.

Emilie Mazzacurati
Co-Founder, Tailwind

Katie MacDonald
Co-Founder, Tailwind

Thank You

Funders

We are grateful to the groundbreaking funders who supported our vision to publish this report as both a foundation and catalyst to drive innovation and investments into adaptation & resilience.

- **Autodesk Foundation** – Jean Shia, Beth Foster-Chao
- **Battelle** – Melinda Sych
- **Breakthrough Energy Fellows** – Ashley Grosh, Meghan Bader, Taylor Carvalho
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Partners

Vibrant Data Labs was a central partner for the research underlying the startup and investor data. Special thanks to Eric Berlow, Jay Hirschton, and Lara Reichmann for all your time and collaboration.

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We are also grateful to the **Climate Policy Initiative (CPI), Resilient Cities Network (RCN), CleanTech Group** and **Fors Marsh** for sharing access to their data and rich discussions. Thank you!

Team

This project was supported by two exceptional individuals who were critical contributors to this report: **David Babikian** and **Brooke Zhang**. We thank them for their extensive contributions.

Thank you to the **Urban Future Lab at NYU** for being Tailwind's headquarters for this project!

EXECUTIVE SUMMARY

ES: Global Demand for Adaptation Solutions

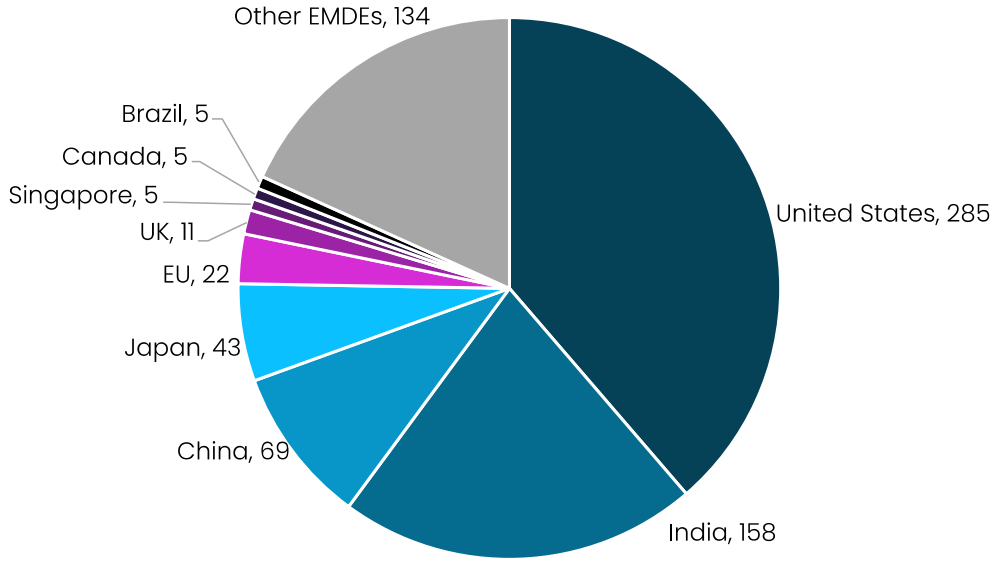
Tailwind

Governments and consumers drive USD1.4 T worth of spend on A&R solutions and activities globally.

Our team conducted desktop research to assess overall global demand for climate adaptation solutions in three core segments:

1. **Government Demand**
   - We tallied **USD737 B** of annual spend on adaptation in 2023 (51% of total demand).
2. **Consumer Demand**
   - We estimate that households spend up to **USD647 B** on adaptation products and services annually (45% of total demand).
3. **Corporate Demand**
   - We identified **USD58 B** of spend via a limited sample of corporations on (4% of total demand).

Public Spend on Adaptation, 2023 (USD737 B)



Government Demand Highlights

The **US leads** government demand globally with **USD285 B** spent in 2023. The **US plus other industrialized countries drive USD370 B** of demand annually, with **emerging and developing countries** driving **USD366 B** of demand.

Consumer Demand Highlights

Households in the US invest to harden their houses and keep temperatures cool. Smallholder farmers in developing countries spend **USD368 B** on adaptation solutions equivalent to **20-40% of their own income.**

Corporate Demand Highlights

Sampled corporations that disclosed their A&R budget on average spend **USD200 M annually**. 60% of corporations are already experiencing climate impacts, **35% are already investing in physical risk solutions**.

ES: Global Adaptation Solution Needs

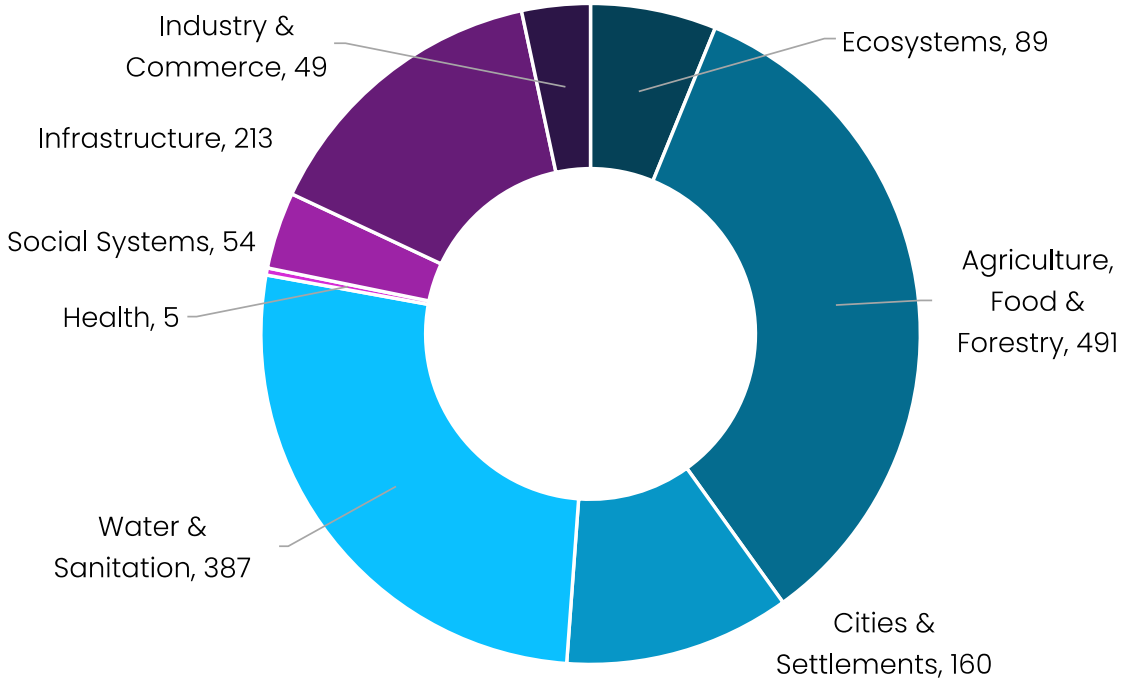
Tailwind

Demand centers around hardening infrastructure, managing water, and protecting agricultural lands.

We found each customer segment had its own priority adaptation needs with some notable overlaps.

1. **Government Demand:**
   - 60% of funding is focused on **infrastructure** (USD173 B), **Water** (USD160 B), and **Cities & Settlements** (USD69 B), with flood prevention and management as a top priority.
   - **Agriculture, Food & Forestry** (USD69 B) and **Ecosystems** (USD54 B) together made up 26% of public spend (30% in Developing Countries and Emerging Economies).
2. **Consumer Demand:**
   - Globally, consumer demand manifests primarily in **Cities & Settlements** (13%), **Water & Sanitation** (29%), and **Agriculture, Food & Forestry** (58%).
   - In the US, 43% or 2 in 5 Americans are likely to have invested in home hardening and adaptation landscaping solutions. 37% or 1 in 3 Americans are likely to or have already bought a generator.
3. **Corporate Demand:**
   - The most cited risks were **water stress** and acute impacts like **extreme weather events.**
   - Primary concerns associated with extreme weather events were damaged infrastructure, harm to human capital, supply chain interruptions, and transportation difficulties.
   - Corporations were most likely to invest in **hardening sites, diversified suppliers and locations**, and water efficiency management.

Global spend on adaptation by sector, for all segments (USD737 B)



ES: Adaptation Startup Landscape

Tailwind

Pure play adaptation startups make up 12% of all climate tech startups but receive only 3% of the funding, USD4.5 B.

Tailwind partnered with Vibrant Data Labs to train an AI model to identify A&R startups and map them to the Tailwind Taxonomy. This effort allowed us to develop the **first detailed analysis of investment trends and bright spots for A&R in the startup ecosystem** by sector and funding stage over time.

Pure play A&R ('Adaptation') startups make up 12% of all funded climate tech startups, but receive only 3% of total funding, USD4.5 B total.

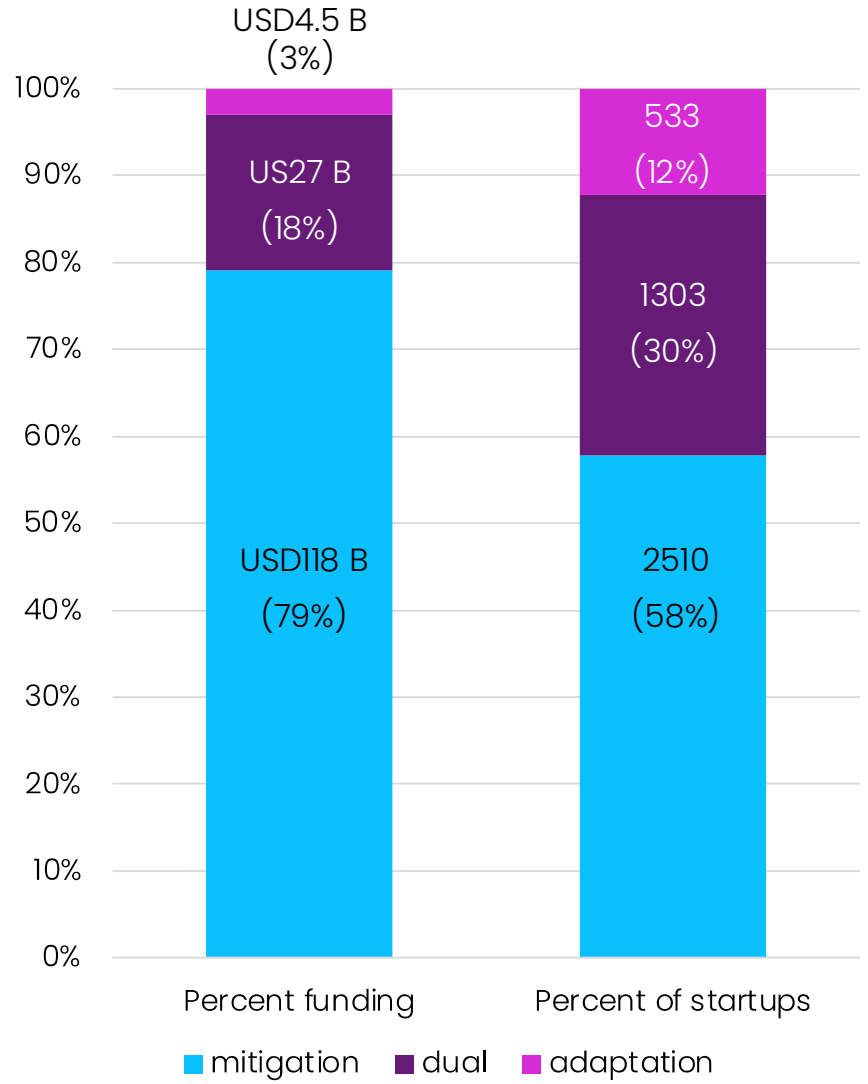
→ Adaptation startups include technologies that support climate risk and resilience activities but have little or no mitigation benefits, like climate risk analytics, insurance, disaster preparedness and recovery, flood prevention and mitigation, human cooling technologies, etc.

However, many mitigation startups also have adaptation co-benefits.

→These include very active sectors within the climate tech ecosystems, such as food and ag tech, grid resilience and microgrids, and energy and water efficiency.

Dual benefit startups constitute 30% of all climate tech startups, and receive 18% of total funding, USD27 B.

All in all, we found that **42% of climate tech startups have A&R benefits,** even if adaptation is not their primary focus.



VIBRANT DATA LABS

Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

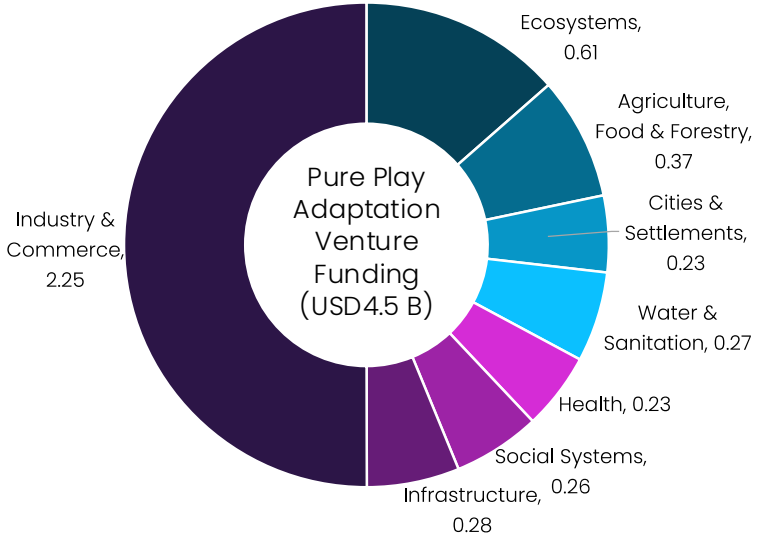
ES: Startup Growth Trends

Tailwind

Water infrastructure and IT dominate pure play. Agriculture, forestry, and food dominate dual.

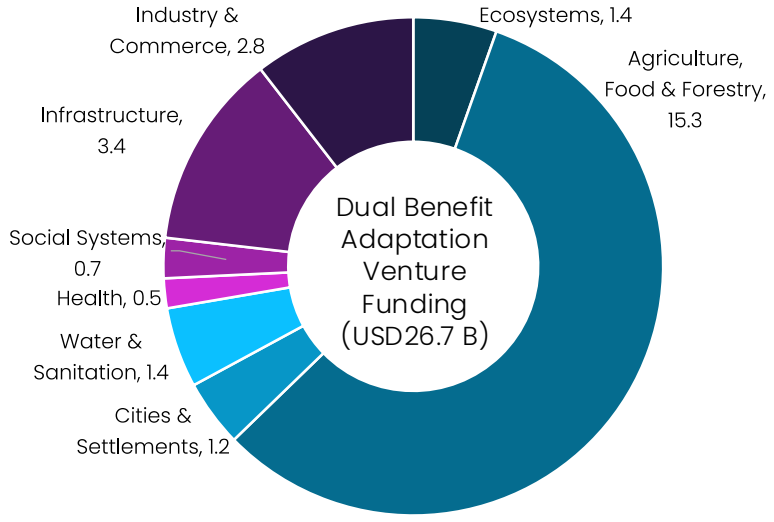
Pure Play Adaptation Trends

- **Industry & Commerce** makes up 50% of investments in pure play A&R startups (USD2.25 B). This includes climate risk analytics, earth observation, sensors and AI/digital solutions, as well as industrial tech, insurtech, fintech and construction tech.
- **Ecosystems** is the second most active sector, with USD610 M of investments in firetech, water management and oceantech.
- 71% of venture investments into adaptation companies go into digital solutions, AI and earth observation solutions, with less than 16% in physical risk reductions.



Dual Adaptation + Mitigation Trends

- Dual benefit startups received USD26.7 B in funding over 2019-2023, almost 6 times more than pure play adaptation companies.
- **Agriculture, Food and Forestry** dominate this category, due to a very active ecosystem in ag and food tech. Here we include regenerative ag, indoor farming, alternative proteins and smart irrigation.
- **Grid resilience** (Infrastructure), manufacturing (which includes **industrial energy and water efficiency**), and Water & Sanitation also received substantial funding.



VIBRANT DATA LABS

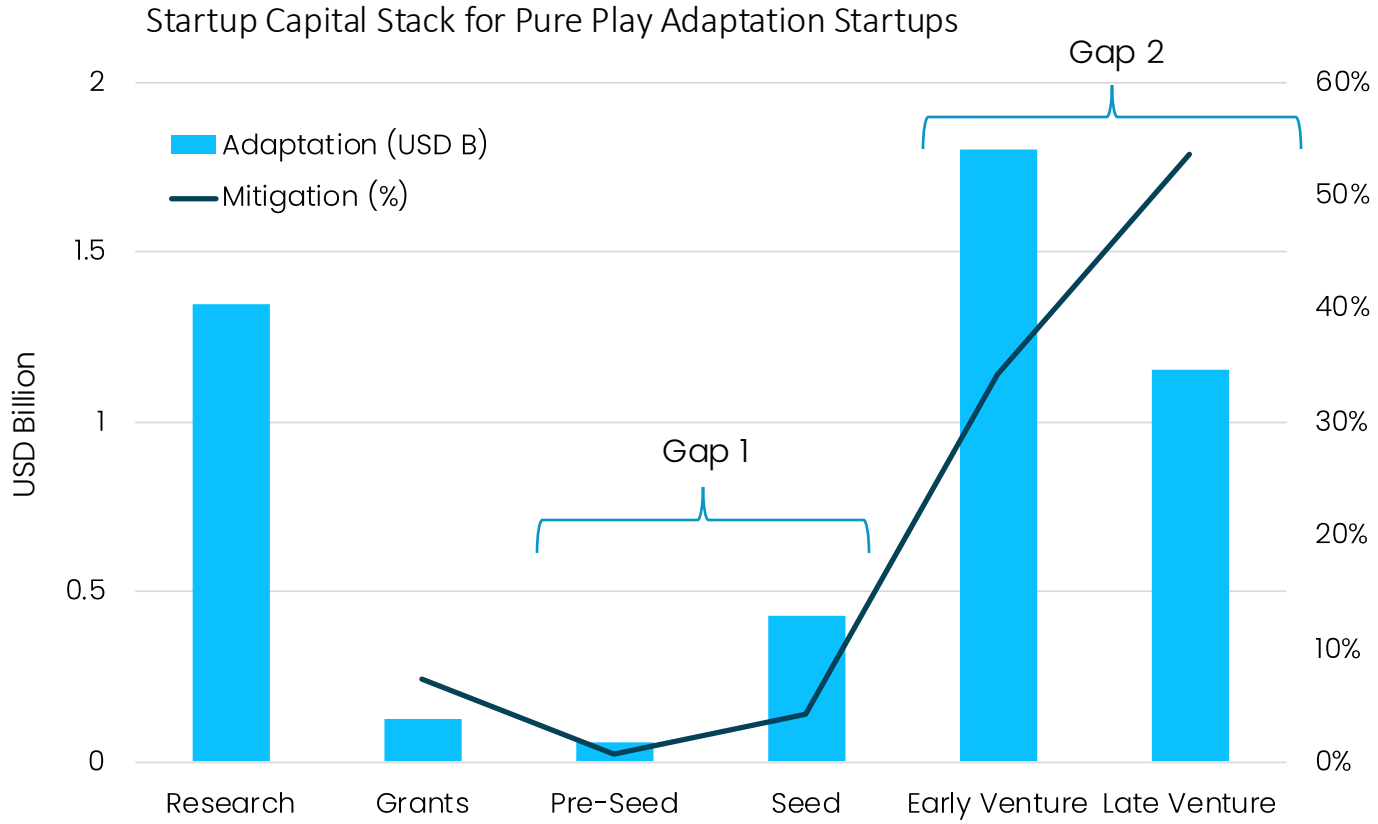
Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

Capital Stack: Startup Capital Needs

Tailwind

A&R innovation investment remains glaringly low for innovators at all stages, with a huge gap for startup formation (pre-seed) and product development (seed) and insufficient capital for all venture rounds.

Our findings on capital availability between 2019 and 2023 reveal that there is very little capital for innovators translating research into new businesses. Once products have been tested, venture funding can be hard to come by.



**Research dollars are for 2023 only, while funding stages numbers are cumulative for 2019-2023*
Percentages apply to the sum of equity rounds and grants, excluding debt.

Investment Trend Lines:

- **Capital Gap 1**: Like the initial capital gap in climate tech 1.0, we see a **dire need for more funds at the pre-seed and seed stages. This represents the most serious capital gap for A&R companies.**

- **Capital Gap 2**: While the early **venture and late venture** funds available trend upward from the pre-seed and seed funding gap, **they are relatively much smaller** compared to a 'healthy' capital stack, illustrated by the mitigation percent funding. Late-stage rounds are particularly limited.

VIBRANT DATA LABS

Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

ES: Innovation Roadmap

Tailwind

Across the adaptation space, there are many opportunities for innovators to develop solutions to meet existing and mounting customer demand.

Bright Spots

Water Infrastructure: Solutions enabling efficient water sourcing, distribution, utilization, and enabling resilient sanitation infrastructure.

Agriculture, Forestry & Food: Solutions driving the resilience of crop production, livestock production, forest products, and food systems.

Infrastructure (Electric): Solutions enabling grid resilience and reliability as well as solutions enabling power reliability.

Infrastructure (ICT), Industry: Solutions such as risk analytics, modeling and insurtech startups dominate these categories.

Cities & Settlements: Solutions enabling building cooling and thermal efficiency.

Dimension	Rating
Demand	High
# Active Startups	High
$ VC Invested	High
# Acquisitions / Exits	High

Hidden Gems

Cities & Settlements: Flood tech solutions for buildings, coastal resilience solutions, and other building hardening solutions.

Infrastructure (Transportation): Solutions that can enable the resilience of ground, maritime, and air transportation assets and systems.

Industry: Insurtech and climate risk intelligence solutions for real estate and corporations with at-risk physical assets.

Agriculture, Forestry & Food: Solutions that improve soil and microenvironmental health.

Ecosystems: Solutions for wildfire prevention, detection and suppression. Nature-based solutions for flood management and shorelines.

Dimension	Rating
Demand	High
# Active Startups	Med
$ VC Invested	Low
# Acquisitions / Exits	Low

Blind Spots

Health:

- Solutions to predict, prevent and treat respiratory, cardiovascular, and other negative health-related outcomes to heat, fire, and other climate hazards.
- Solutions to predict, alert, and track disease transmission of vector and waterborne illnesses.
- Solutions for body cooling (such as wearables and cool patches).

Social Systems: Early warning systems and solutions for post-disaster recovery. Temporary shelters and pre-fabricated / resilient housing.

Water Infrastructure: Solutions to enable air water capture and water access in areas of drought.

Dimension	Rating
Demand	High (Latent)
# Active Startups	Low
$ VC Invested	Low
# Acquisitions / Exits	Low

ES: Enablers of Change

Tailwind

There are a few enablers of change we think are important for A&R companies to consider as they grow. These elements can play a big role in whether companies achieve the impact they seek.

Ecosystem programs remain few and far between for climate adaptation companies. There are only a handful of A&R-focused accelerator and incubator programs (11) in contrast with 150+ mitigation/decarbonization-focused programs. **The ecosystem needs more programs supporting A&R entrepreneurs to scale.**

Measuring the impact of adaptation companies remains a challenge. There is no "one-size-fits-all" adaptation measurement framework or metric (akin to net zero), but numerous metrics already exist for measuring the success of an A&R solution. **Consensus on which metrics matter most and how best to measure success locally is critical to driving impact.**

Policies and regulatory frameworks are missing to incentivize adaptation solutions. We need more explicit incentives, financing programs, and adaptation mandates from subnational and national governments if we want to see a robust climate adaptation innovation sector that equips governments with the solutions needed to protect society and the economy. **Work must be done to define adaptation and adaptation spending as a priority across governments.**

Preventing maladaptation is essential so solutions do not unintentionally increase vulnerability to climate change or make a system more susceptible to climate-related risks. These risks include increased emissions, social vulnerability, ecosystem damage, and financial inequality. **Investors and solutions providers need tools and best practices to manage maladaptation risks and engage communities where these risks are most pronounced.**

ES: Recommendations

The Playbook outlines a set of recommendations for funders, entrepreneurs, corporations and policymakers interested in growing climate adaptation innovation to meet humanity's growing demands.

For Entrepreneurs

- We know many solutions are needed to make society and the economy resilient to climate change. Investors will do good business with Bright Spots and Hidden Gems. Our advice for entrepreneurs? Focus on **Hidden Gems** and **Blind Spots**.

For Funders

- **Philanthropic and Public Funders –** Focus on filling capital gap #1 and making sure grants and catalytic capital exist for adaptation solution providers at the pre-seed and seed stages.
- **Private Investors** - Focus on developing an investment thesis that includes climate adaptation and directing more capital into early and late venture rounds for adaptation companies.

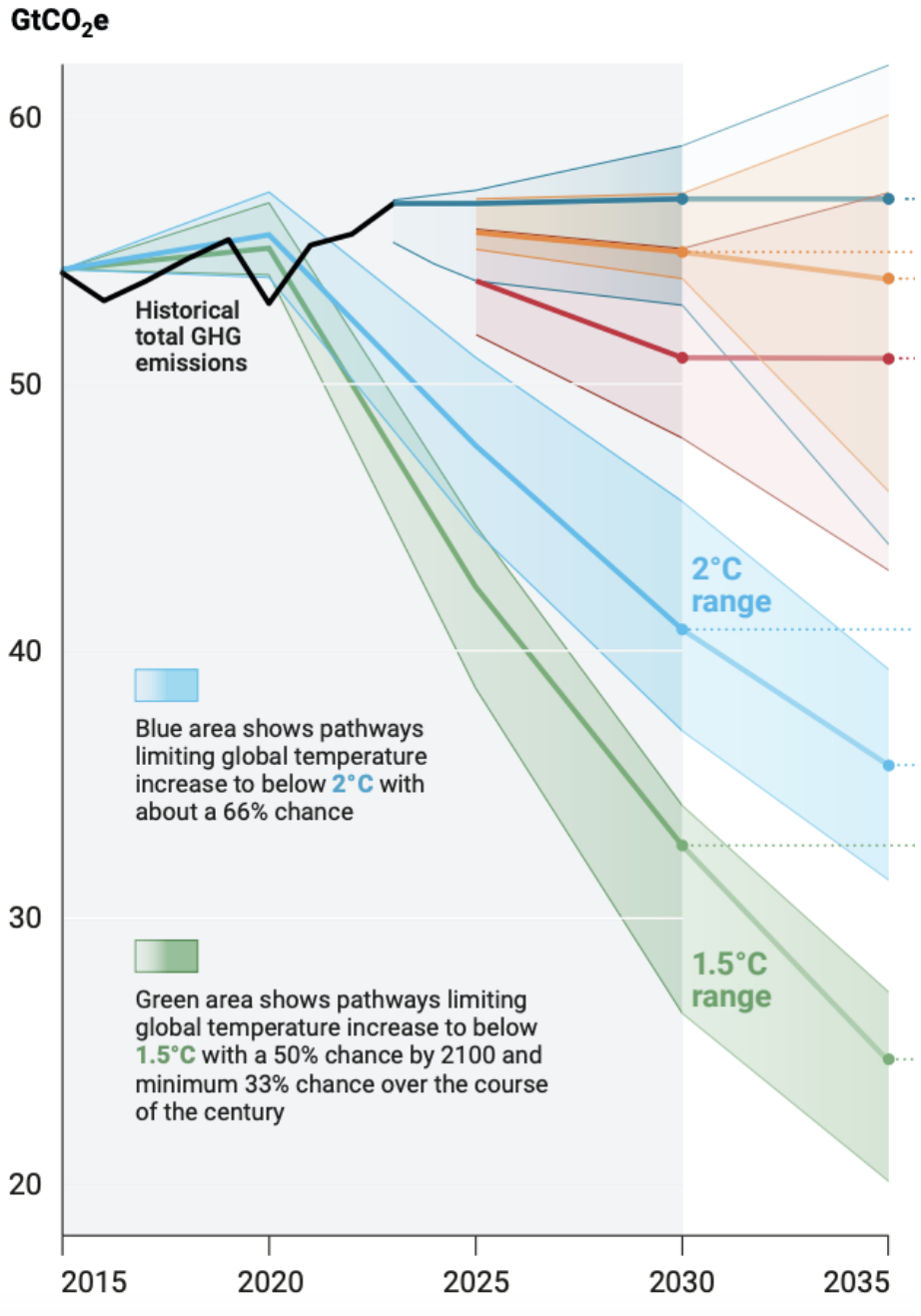
For Policymakers

- **Pass Resilience Focused Policies** - Whether it's at the national, state, provincial, or city level(s), ensure that we have robust legislation that ties adaptation and resilience goals to regulation and public investment.
- **Fund Innovation Programs** - Fund research, incubators, accelerators, and direct funding programs for climate adaptation startups and innovators.
- **Guide Standards Development** - Drive the development of definitions, metrics, and standards that can be used to ensure the performance and impact of adaptation and resilience solutions.

For Corporations

- **Protect Your Business –** Make sure your company has robust climate risk monitoring and invest in physical risk solutions to protect your business and the communities which you operate in from the impacts of climate change.
- **Remain Competitive** - Engage in external and internal innovation to build and acquire new adaptation solutions that can help your business meet the growing demands of governments, consumers and the private sector.

INTRODUCTION



The Adaptation Imperative

Unchecked emissions spell increased urgency for adaptation innovation.

As temperatures rise due to accelerating greenhouse gas (GHG) emissions, the physical impacts of climate change have already begun to exponentially increase in frequency and severity. **Climate shocks across the globe are both severe and unequally shouldered.**

The past two decades show stark increases in heat-related deaths, food insecurity, vector-borne diseases, and coastal, fluvial, and pluvial flooding.[1] **By 2050, climate change is anticipated to cause an additional 14.5 million deaths and USD12.5 T in economic losses worldwide.[2]**

Human and social impacts are paralleled by economic impacts: climate-related extreme weather events reached nearly USD1.5 T in economic losses in the decade leading up to 2019.[3] These losses are compounding: **the first half of 2024 had USD62 B in global insurance losses**, far exceeding the 10-year average of USD37 B.[4]

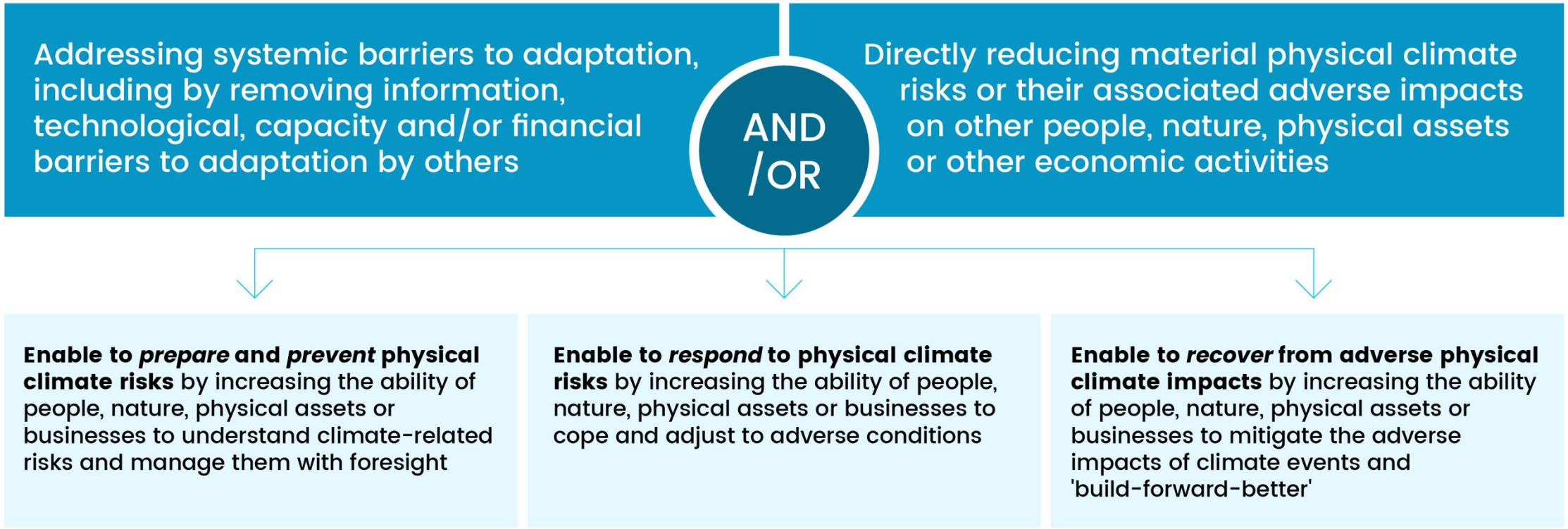
Investing in adaptation and resilience (A&R) is not only a moral imperative; **it is also an investment opportunity that is largely untapped** (WEF)**.**

Source: UNEP, 2024

Definitions: Adaptation & Resilience Solutions

Tailwind

Adaptation and Resilience (A&R) Solutions are products or services that prepare, prevent, respond to and/or enable recovery from climate shocks and stressors.

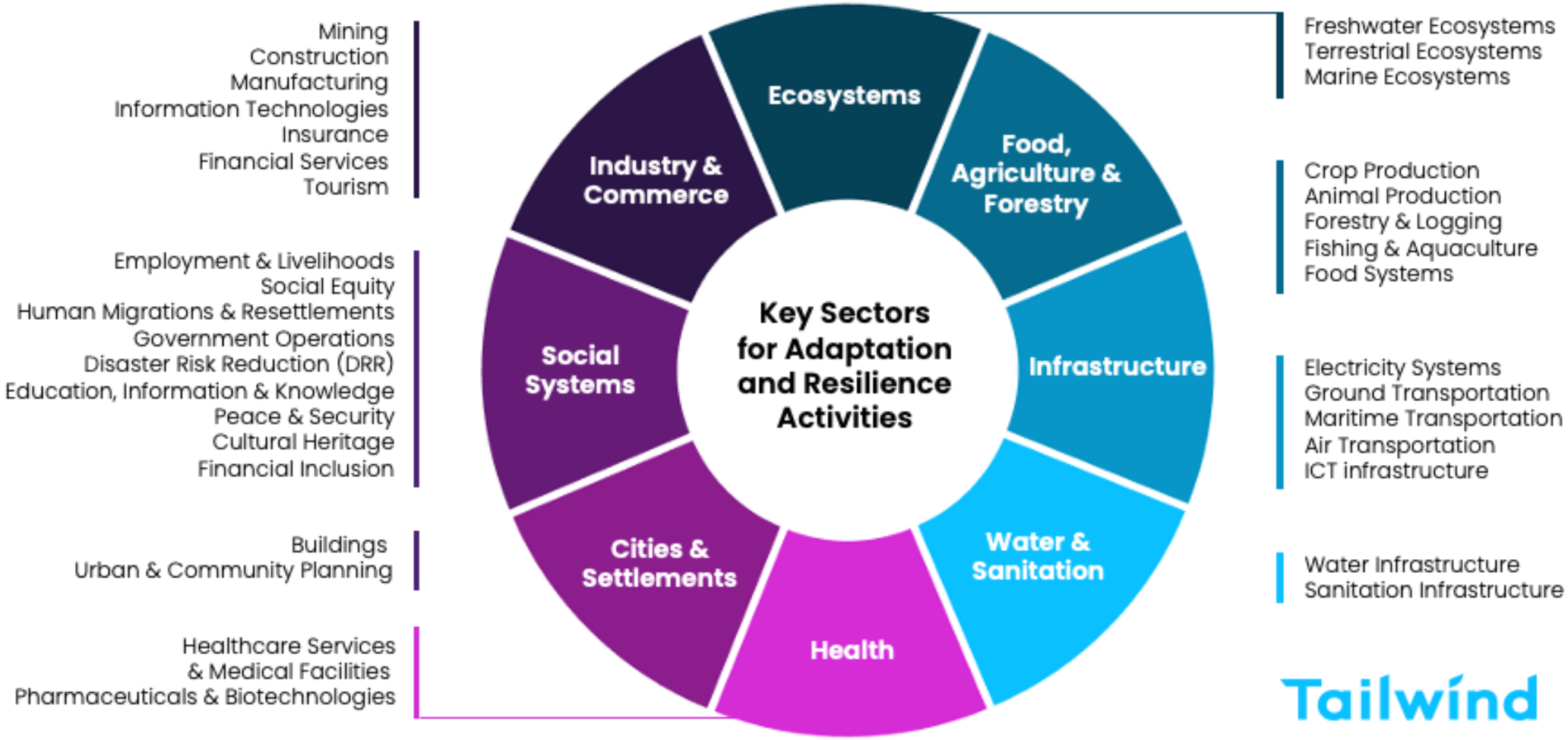


Source: GARI, 2024

Taxonomy: A&R Sectors

Climate change is affecting lives and livelihoods, economic, social and cultural assets, and ecosystems globally. The Tailwind taxonomy provides a structured breakdown of key sectors where A&R activities and solutions are needed.

See tailwindclimate.com/taxonomy for the full taxonomy, including detailed examples and mapping to common economic taxonomies.



DEMAND

Global Demand: Overview

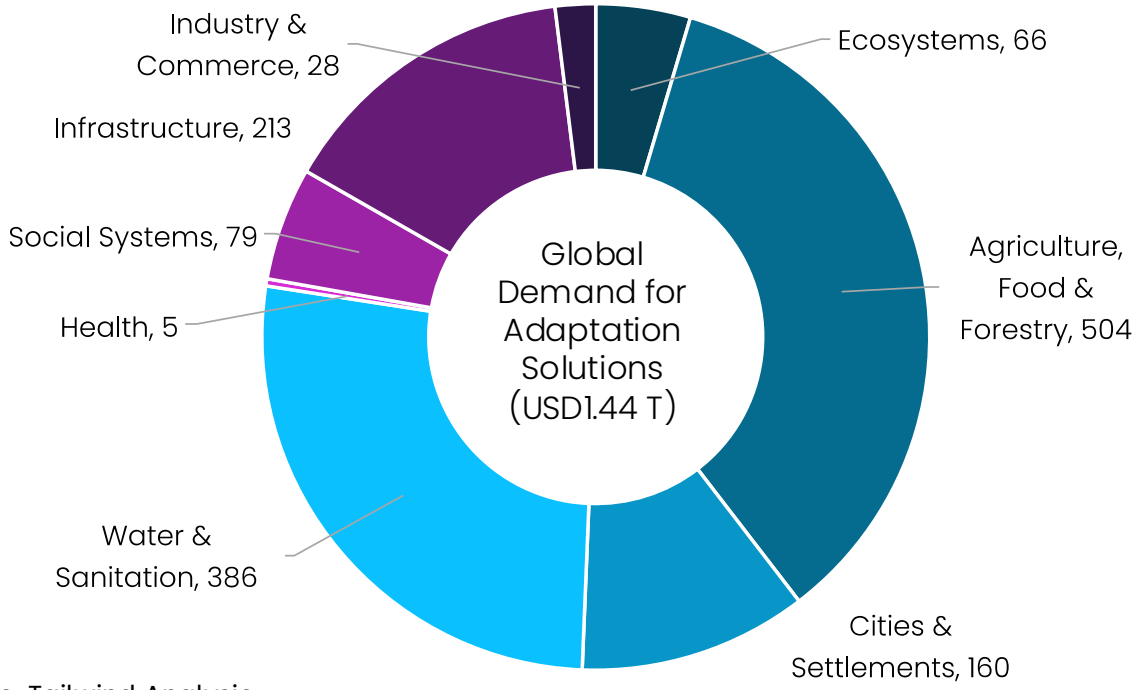
Governments and consumers drive USD1.4 T worth of spend on A&R solutions and activities globally.

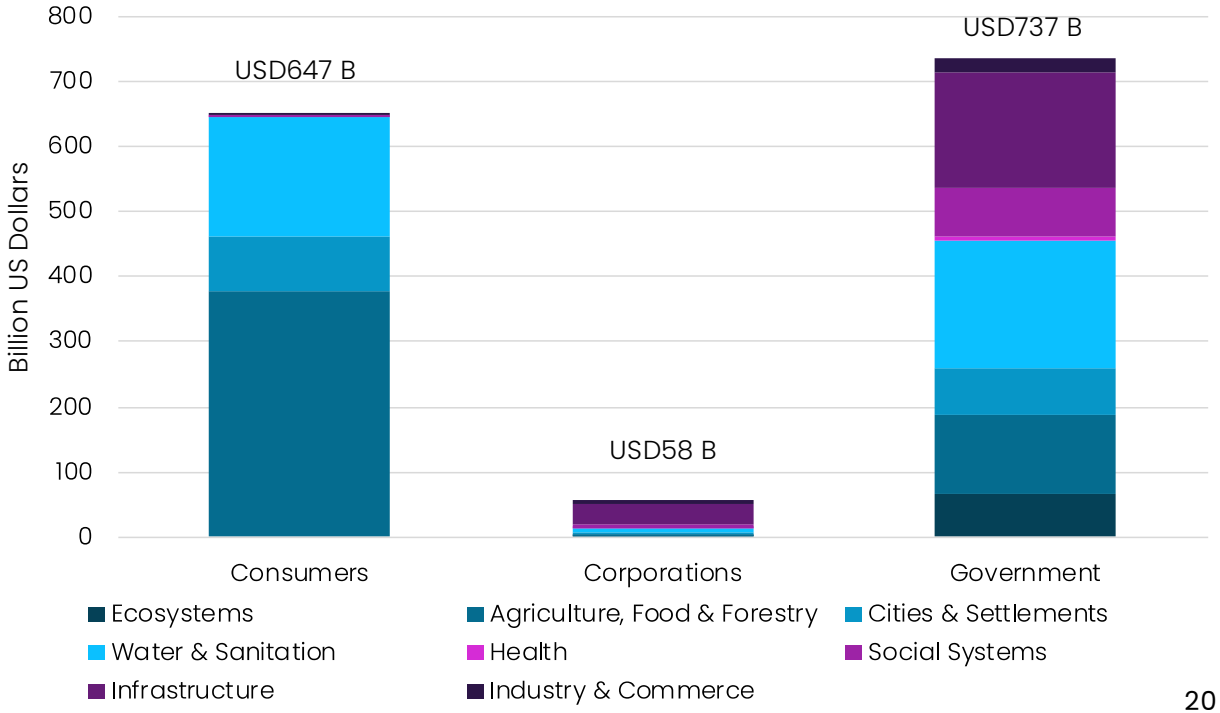
We found USD737 B of government spend on adaptation globally. While still insufficient compared to projected investment needs, and likely an underestimation, this shows governments are rapidly accelerating their investments to protect their communities. Looking at market spend for products likely to be used to adapt to the impacts of climate change, **we estimate USD647 B A&R spend from consumers**, showing that homeowners and smallholder farmers are not waiting for standards or regulations to invest in protecting their homes and their land.

We tracked **USD58 B of corporate spend across a sample of 80 large corporations and aggregate transaction data from CPI**. The number is orders of magnitude smaller than what is needed to address current and projected climate risks.

Philanthropic giving for A&R is estimated at USD650 M, less than 0.05% of global financial flows.

Global demand for adaptation solutions is primarily focused on Agriculture, Food & Forestry (35%) and Water & Sanitation (27%), and to a lesser extent **Infrastructure (15%)** and **Cities and Settlements (11%)** (which includes residential and commercial real estate). **Demand for solutions in Health (0.35%), Ecosystems (5%) and Social Systems (5%) is lagging**. They remain likely to be driven by government spend and smaller than the other sectors.





Source: Tailwind Analysis

GOVERNMENT DEMAND

Government Demand: Overview

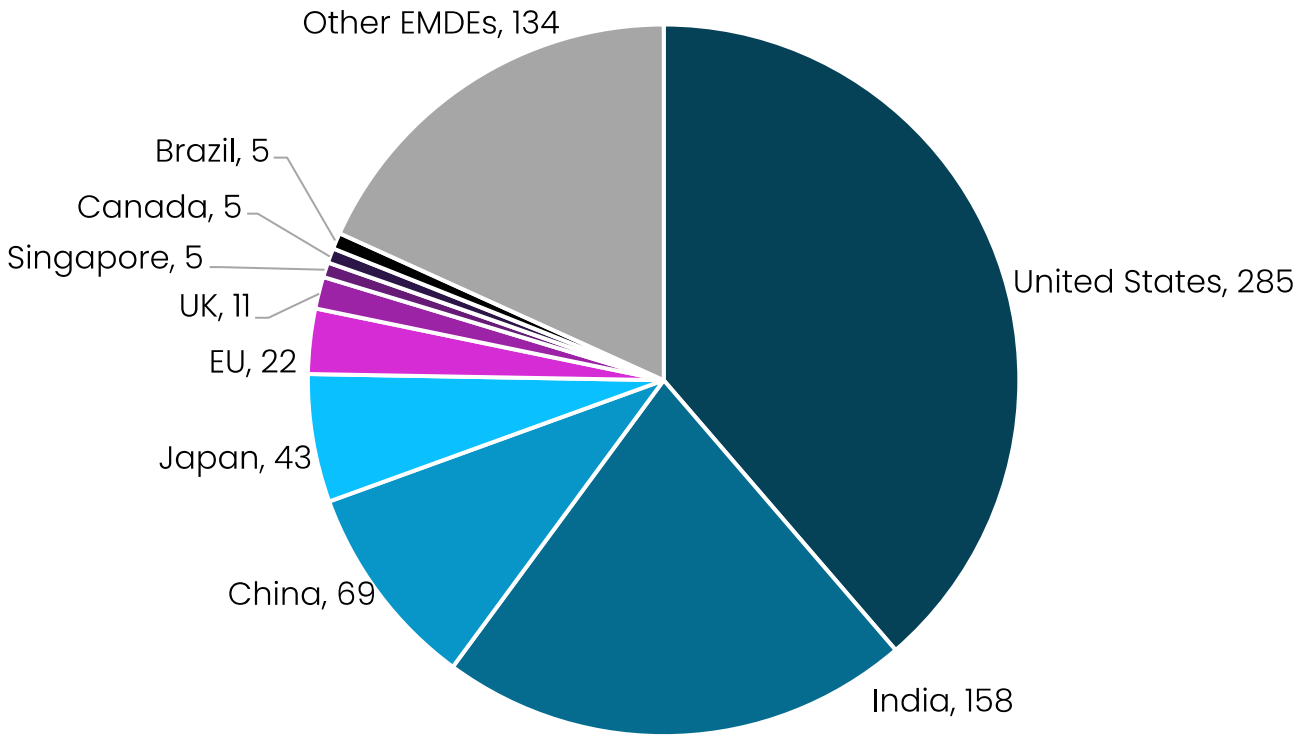
Tailwind

Public adaptation spend reached USD737 B in public programs and projects globally in 2023.

Through desktop research and literature review, we were able to identify **USD 737 B worth of public budget focused on adaptation** in the world's largest economies.

Our tally is far from being exhaustive – there is no single source of truth for government spend on adaptation, which remains generally very poorly tracked and measured (OECD 2024, CPI 2024). Notably, while we included a few local governments in the US, we did not research local spend in any other countries. **Many A&R investments are already being or will be conducted by local governments** (CPI 2023).

Of the countries we researched, we found an even split between industrialized economies and emerging markets and developing economies (EMDEs). However, this hides the fact that **only USD14.5 B goes to Least Developed Countries, and 2% (USD1.5 B) to Small Island Developing States**, where the needs are the greatest (CPI 2024). Developing countries' financing needs are estimated between USD215 B and USD387 B per year (UNEP 2024).



Data in Billion USD

Data sources: We performed extensive desktop research for the US, the EU and Japan, and more limited research for the UK, Canada, India and Singapore. We relied on CPI research for Brazil and Other EMDEs (for which *we include dual benefit financing as A&R*), and WRI for China. Sources are detailed in the following slides and in Appendix.

Data limitations: Our research did not include other countries (not even domestic spend in the EU27) nor regional or local governments. When 2023 data was not available, we used 2022 or 2024 as a proxy.

Government Demand: Trends

Tailwind

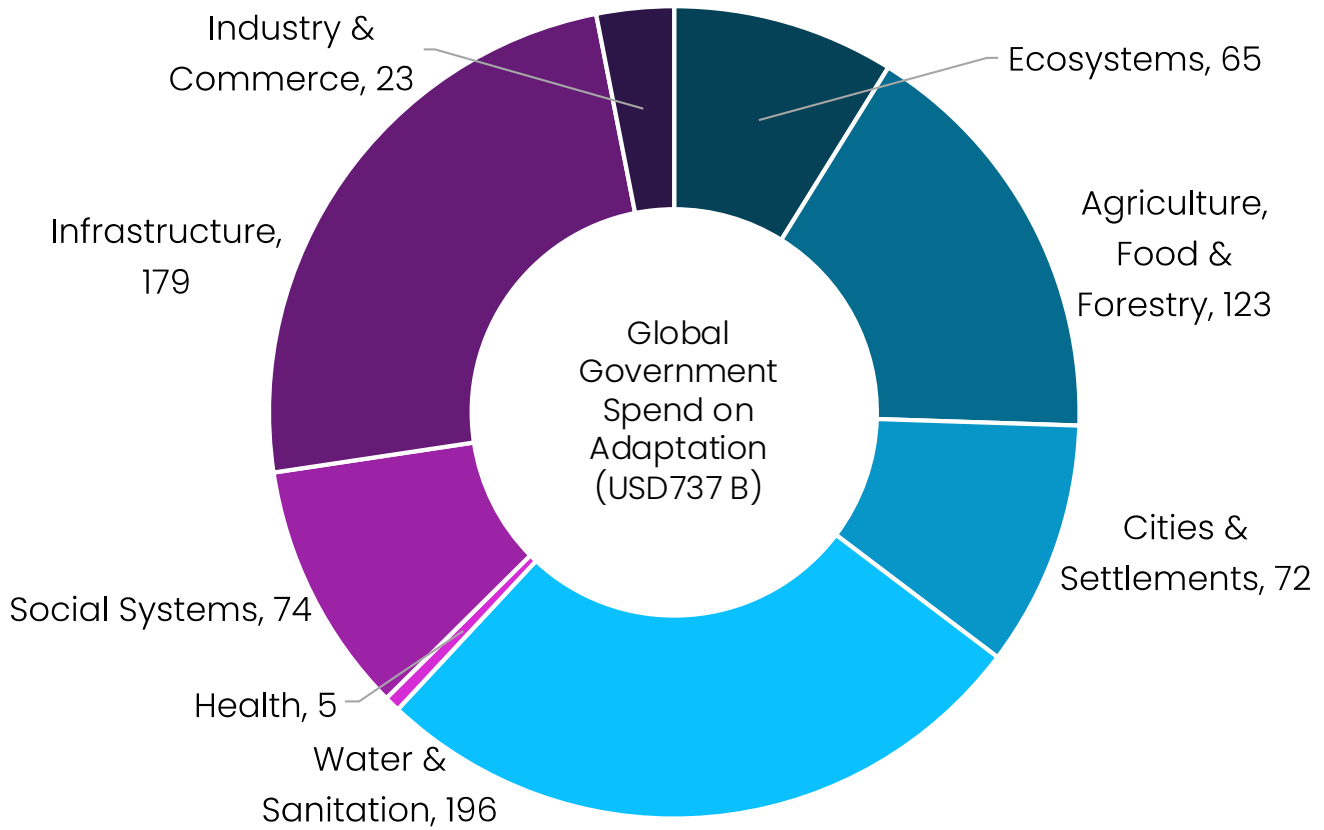
Over 60% of public spend is focused on resilience in Infrastructure, Cities & Settlements, and Water & Sanitation.

Across all public spend, **61% of funding is focused on Infrastructure (USD179 B), Water (USD196 B), and Cities & Settlements (USD72 B).** Flood prevention and management stands out as a priority for many government programs (marked as Cities & Settlements and Infrastructure).

Agriculture, Food & Forestry (USD123 B) and Ecosystems (USD65 B) together made up 26% of public spend globally (31% in Developing Countries and Emerging Markets).

Social System (USD74 B) programs dedicated to A&R are primarily focused on science and education (including early warning systems) and defense (in the US). It is likely that governments will need to spend more on social services due to climate impacts, to manage migration flows, and as compensation for loss and damages, etc. However, these expense increases are not marked as an explicit or separate budget item.

We found **very limited data on public spend related to climate and health**. Just like social systems, it is likely that climate impacts do affect public health spend, but it is not identified as a separate budget item.



Source: Tailwind Analysis

Government Demand: Policy Context

Tailwind

Countries are initiating plans that involve building resilience socially and economically.

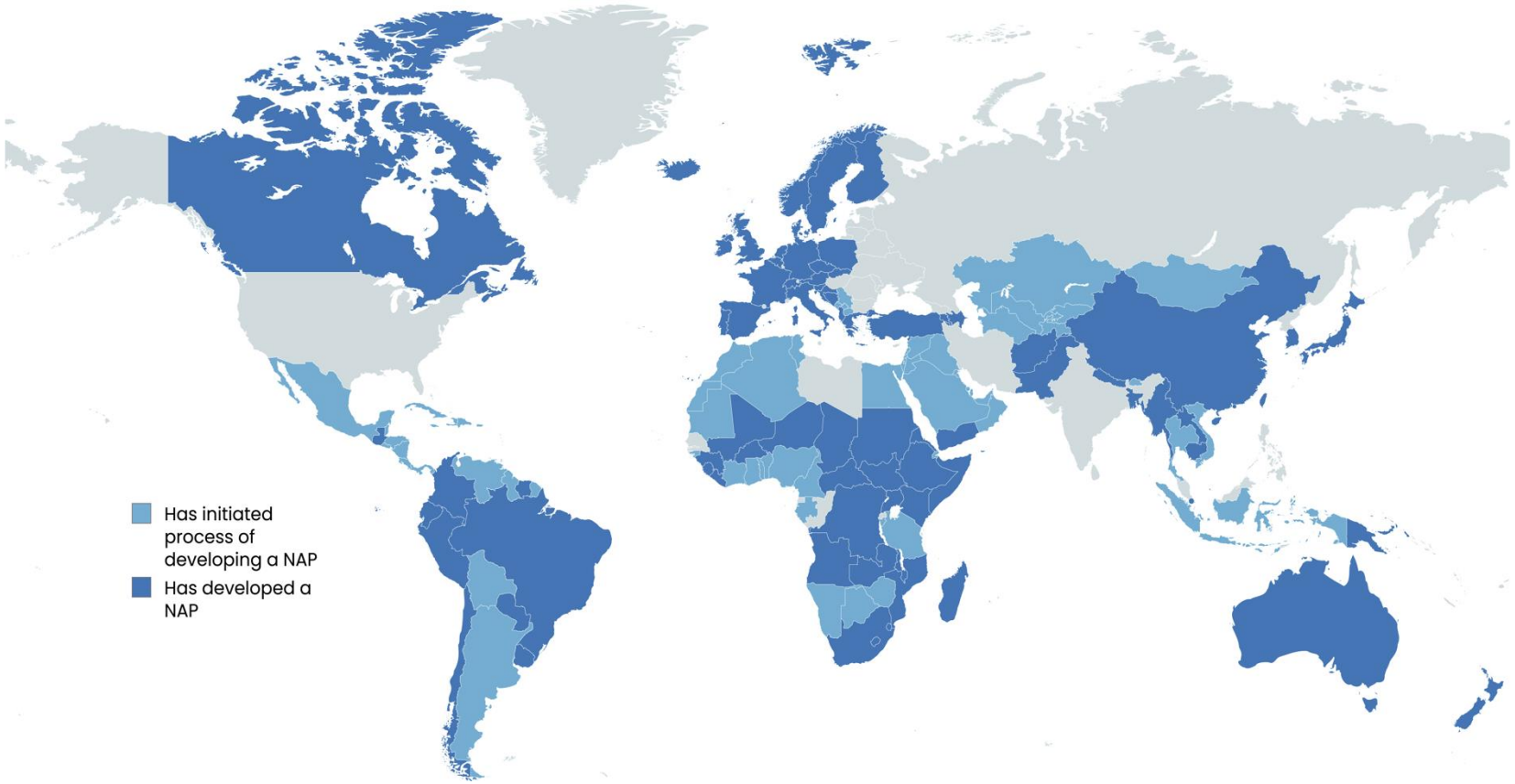
A Global Need

The intensifying impacts of climate change necessitate increased investment in adaptation measures, particularly in the poorest countries, which are disproportionately affected despite contributing the least to the problem. This said, countries around the world face mounting climate threats.

National Adaptation Plans (NAPs)

NAPs map the steps that countries can take to identify and address their near and long-term needs for adapting to climate change. **For developed countries, all have outlined NAPs except for one – the United States.**

The United Nations maintains a public map of NAPs, given they act as grants for action from international finance mechanisms. As of November 2024, the submitted plans of 59 countries were visible. 112 countries had included information related to NAPs.



30% of countries have a national adaptation plan in place.

57% of countries have started a national adaptation planning process.

Up to 71% of modeled adaptation costs are associated with activities typically financed by the public sector (UNEP, 2024).

Government Demand: Industrialized Economies

Tailwind

Adaptation funding is ramping up in Europe and Japan, with explicit efforts to address socio-economic impacts

The EU's Adaptation Commitment

Europe has sustained increasing climate disasters in recent years leading to widespread awareness on the need for climate adaptation and the financial cost (est. USD179 B (€170 B) by 2030) of inaction. In 2013 the European Commission enshrined the 'EU Adaptation Strategy' which sets out to make Europe climate resilient by 2050.

European governmental adaptation policy has facilitated an enabling environment for national, subnational, and private investment in A&R. In 2021, the EU updated its Adaptation Strategy, and the European Investment Bank (EIB) laid out its first Climate Adaptation Plan. As of 2024, all EU member states have adopted national adaptation strategies (EEA, 2024).

EU Investments

- **The EU announced 30% of its budget would be spent on climate, including adaptation** in the 2021-2027 budget.
- The **European Investment Bank (EIB)** committed an annual record **USD2.8 B (€2.7 B)** for adaptation in 2023 (EIB, 2024).
- The 2021 **Recovery and Resilience Facility** budgeted an estimated **USD8.6 B (€8.2 B)** on adaptation for the 2021-2027 (EC, 2024).
- The **Cohesion Policy** budgeted **USD13.3 B (€12.7 B)** to adaptation for 2021-2027 (EC, 2024).
- **Horizon Europe,** the EU's key funding program for research and innovation lists **USD98.1 B (€93.5 B)** is its funding amount for the period 2021-2027, including adaptation.
- The **Common Agricultural Policy (CAP)** includes **USD10 B (€9.6 B)** for climate resilience.

Other Highlights (excl. US)

- The **United Kingdom** is deploying USD6.82 B (£5.2 B) in **flood and coastal resilience** (U.K. Gov., 2020).
- Since 2020, **Canada** has invested USD4.95 B (CAD6.94 B) in A&R efforts, between their **Disaster Mitigation and Adaptation Fund** (DMAF), climate-smart housing retrofits, and disaster recovery (CAN Gov., 2021).
- **Japan** published its **2024 resilience budget** (including both climate and earthquake resilience), with over USD30 B (JPY4.6 T) on **flood prevention and management** and USD5 B (JPY763 B) on **health and disaster response.** (JPN Gov., 2024)

Government Demand: EMDEs

Tailwind

Emerging economics are rapidly ramping up domestic investments in adaptation, but overall adaptation finance still falls short of projected needs.

UNEP's 2024 Adaptation Gap Report calls for at least 13 times current finance levels for developing countries by 2030 (UNEP 2024).

Funding Sources

In developing and emerging markets, A&R investment needs are met by both the countries themselves and by financing from multilateral donors (e.g. the World Bank) and other development finance institutions, including development finance institutions (DFIs, e.g. USAID) and multilateral development banks (MDBs, e.g. the African Development Bank).

Funding Amounts

Green Climate Fund (GCF), the largest of the multilateral climate funds, is mandated to invest 50% of its resources to mitigation and 50% to adaptation in grant equivalent, largely focused on developing countries. After new pledges for replenishment at COP 28, GCF's portfolio reached a record **USD16 B,** with co-financing of an additional **USD61.5 B** (GCF, 2023).

Emerging Economies: Highlights

- The Chinese government plans to invest **USD70 B annually with emphasis on infrastructure and water** (WRI, 2021).
- At COP28 in 2023, **India's Prime Minister stated its total adaptation-relevant expenditure was 5.6% of GDP in 2021–22** (USD157 B) (Indian Ministry of Finance, 2024). The country estimates that USD680 B are required until 2030 without any additionality in a business-as-usual scenario (S&P Global, 2024).
- Brazil established its NAP in 2021. The farming sector constitutes 23% of Brazil's GDP and stands to lose approximately USD2.3 B (R$14 B) by 2070 (Brazil Ministry of Environment, 2021). In 2022, **Brazil spent USD5.4 B on adaptation in ecosystems and agriculture, food & forestry** (CPI, 2024).
- **Singapore is investing USD5 B in coastal resilience** (Straits Times, 2020).

Government Demand: US Overview

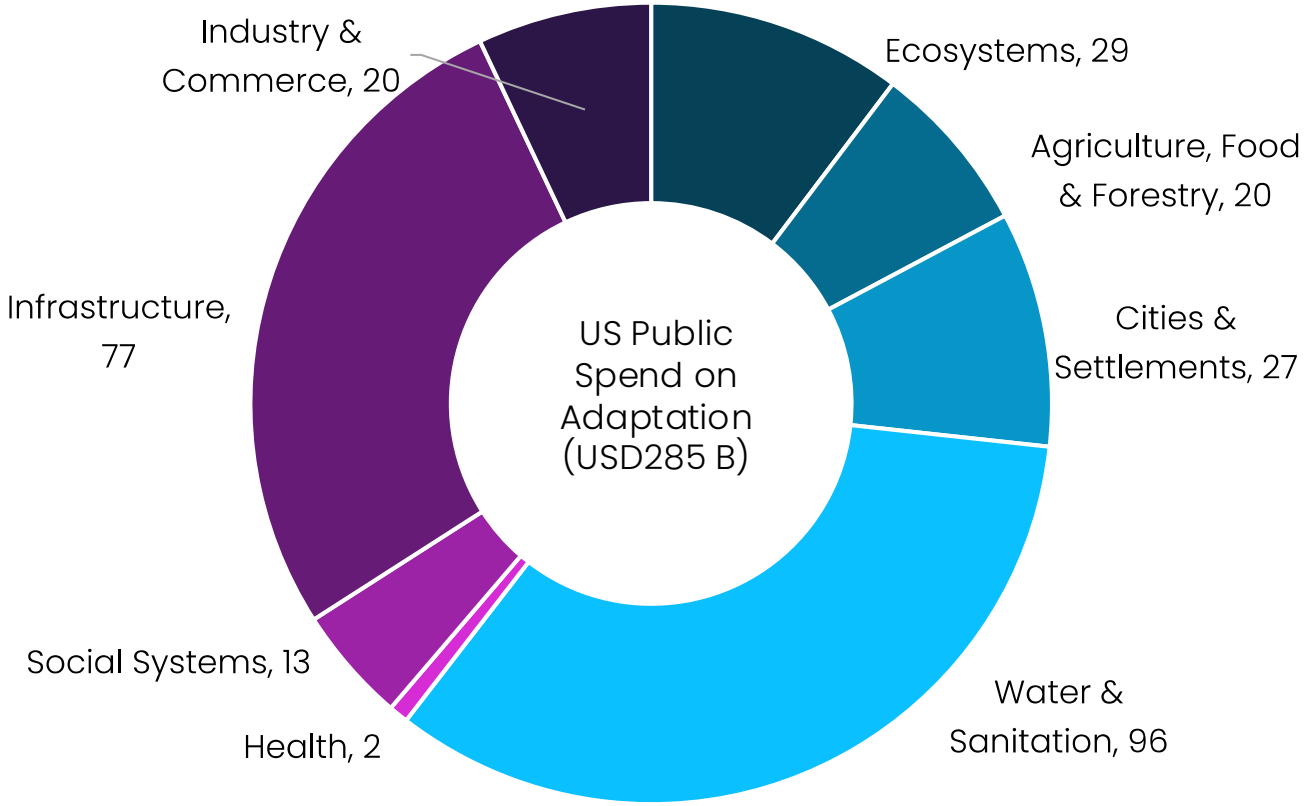
The US Federal government spent USD242 B on A&R in 2023, heavily focused on energy & water infrastructure.

We identified **USD285 B worth of A&R public investments in the US**, with 85% (USD242 B) of federal expenses, some of which is subsequently routed to local governments, and USD43 B (15%) from local governments.

Our research for local governments was very limited in scope and **grossly underestimates actual spend at the local level.**

Two-thirds of the expenses are focused on infrastructure and water, with infrastructure spend heavily tilted towards grid resilience.

At the local level, Cities & Settlements were the top priority (**34% of investments**) with a heavy focus on **flood management and prevention**. **Water** also received almost 30% of investments, followed by **Infrastructure** (27%), and **Ecosystems** (wildfire prevention, freshwater ecosystems, coastal resilience) making up another 12%.



Government Demand: US Federal Government

Tailwind

Recent federal policies have poured funding into A&R infrastructure, but priorities may shift with the new administration.

Federal-Level Progress

U.S. federal-level procurement of A&R solutions has grown significantly in the past decade. Under President Biden's administration, A&R funding grew rapidly, with the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA) investing more than **USD50 B** in climate adaptation and resilience (White House, 2023). In his first term, President Trump signed the Building Resilient Infrastructure and Communities (BRIC) program into law, which established **USD1 B** in funding for disaster risk mitigation projects under FEMA in 2023 alone. He also signed Executive Order 13806 focused on American defense supply chain resilience. **We expect that while resilience and adaptation programs and funding will not be pursued as aggressively in the coming administration, some of the initiatives launched between 2020 and 2024 will continue and many may grow due to their broad base of national support.**

Federal assets that fall under existing executive orders for resilience include over 300,000 buildings, USD700 B in annual procurement, and 4 million federal employees.

Federal Pathways to Drive A&R Demand

1. Funding the Resilience of the Federal Government and its Operations
   - Example: Executive Order 13653, "Preparing the United States for the Impacts of Climate Change" (2013) → Federal agencies required to assess vulnerabilities and create (+ update) Climate Adaptation Plans.
2. Distributing Capital to Subnational Actors (Cities, States)
   - Example: Building Resilient Infrastructure and Communities (BRIC), first available in FY 2020 → States, territories, cities, and tribes apply for funding for hazard-mitigative infrastructure project investment.
3. Deploying Capital to the Private Sector to Drive Resilient Outcomes
   - Example: Florida Power & Light leveraging tax credits from the Inflation Reduction Act to fund more community solar projects that give homes electricity reliability during grid-wide outages.

Government Demand: US Department of Defense

Tailwind

The DoD's view on climate adaptation as a vehicle for mission readiness promises to preserve momentum.

The Department of Defense has expressed significant concern around the national security impacts of climate change. Along with an increase in expected conflict, a warming world results in new requirements for personnel training, equipment, and infrastructure.

Top expressed defense concerns about force readiness are related to:

- Installations
- Training Operations
- Transportation of Military Supplies
- Movement of Forces
- Interactions with Foreign Adversaries
- Climate Hazard Response

"Today, no nation can find lasting security without addressing the climate crisis. We face all kinds of threats in our line of work, but few of them truly deserve to be called existential. The climate crisis does." – Secretary of Defense Lloyd Austin

The Department of Defense is a major investor in and procurer of A&R solutions. Per their own reporting, climate resilience is present within budgets, totaling **USD3.7 B** between the Army, Navy, and Air Force in 2024 (DoD, 2024). Looking ahead, the 2025 Budget Request Overview Book highlights a plan to further invest **USD3.6 B** to deploy advanced A&R technologies, adapt existing facilities, and improve mission/water resilience, among other initiatives.

USD634.3 M

Energy Resilience Conservation Investment Program (ERCIP) funding amount to improve energy and water resilience at DoD installations

USD211 M

ESTCP/SERDP Climate startup funding budget, which includes resilience

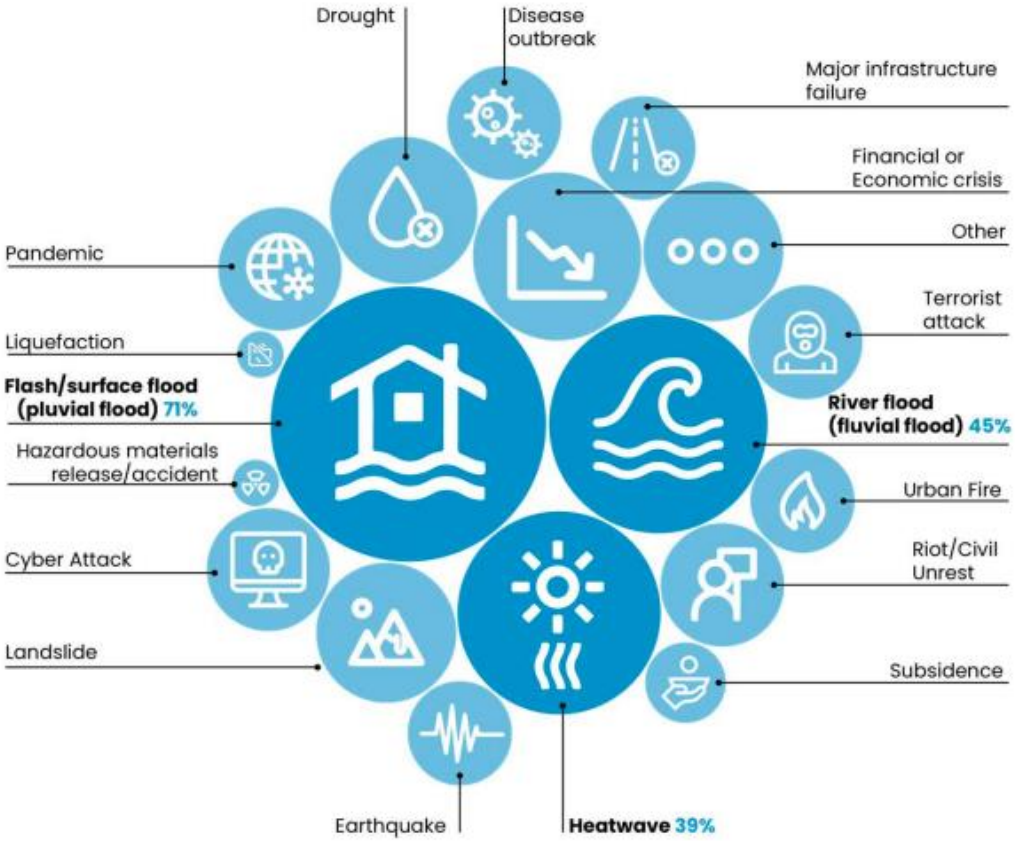
Local Government Demand: Global Survey

Tailwind

Cities worry about floods, heatwaves and climate health impacts, but report being inadequately prepared to manage these risks.

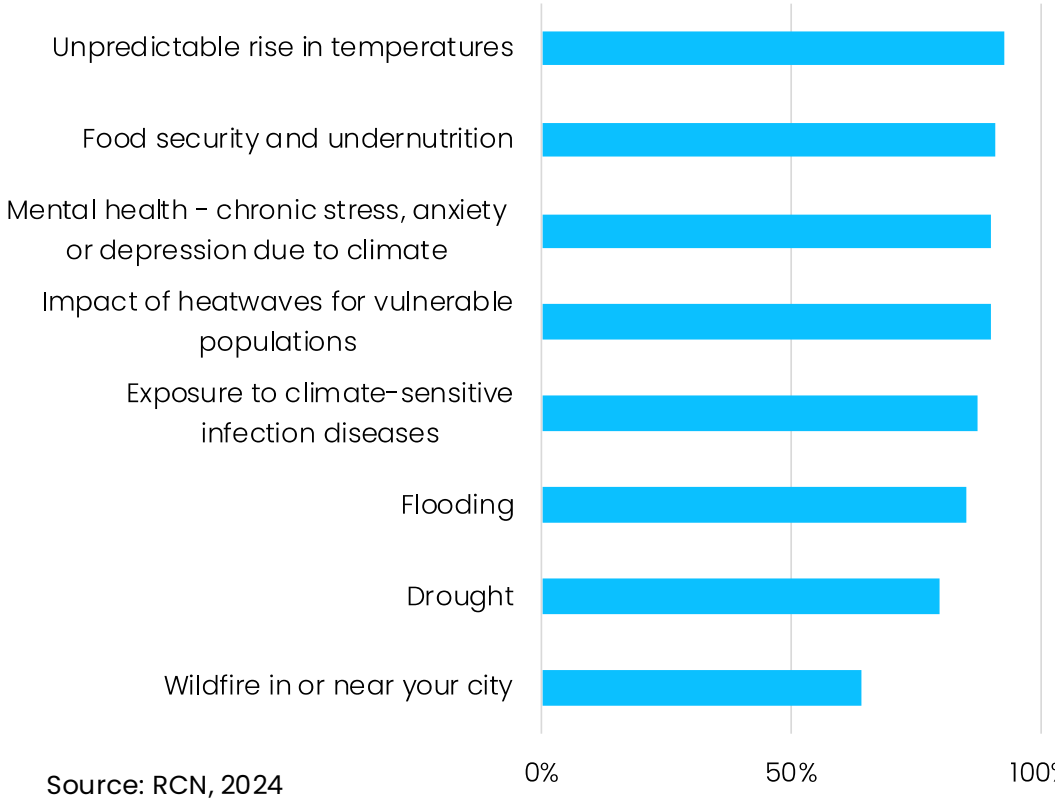
Resilient Cities Network (RCN) conducted a survey amongst its member cities, spread across 5 continents, about shocks, stresses, and resilience priorities. With 49 cities responding, RCN found **the primary shocks that cities are concerned about are flash/surface floods, followed by fluvial floods and heatwaves**. Climate resilience is now the top priority in all regions, selected by 82% of all cities.

Another RCN survey focused on climate health and equity also found that **cities were particularly concerned about heat and health**, but reported low availability of climate information and early-warning systems, and poor/fair-quality related infrastructure.



Source: RCN, 2024

Concerns about Climate-related Impacts on Health:
Percent of Cities Expressing High or Moderate Concern



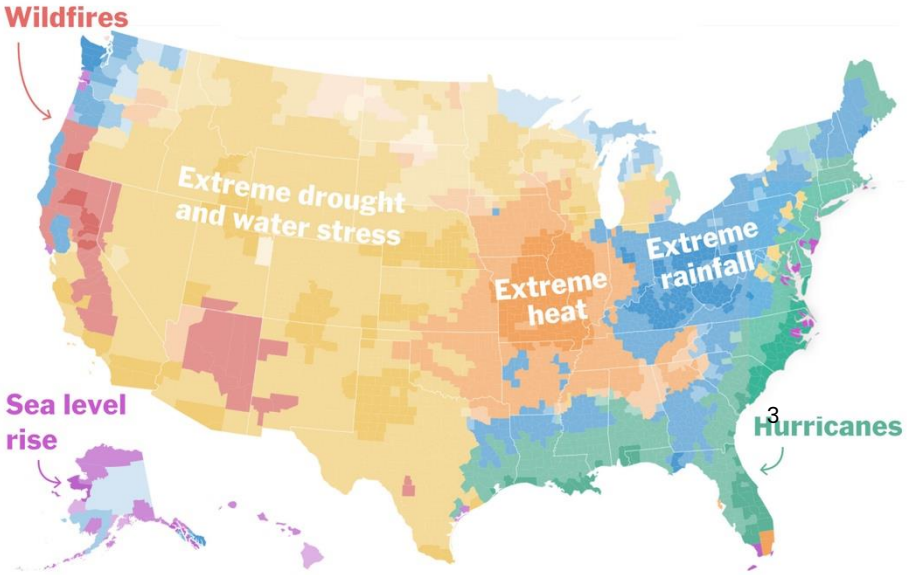
Source: RCN, 2024

Local Government Demand: US States

Tailwind

US states' preparedness and funding for A&R differ widely. California, Florida, New York and Massachusetts collectively are rapidly increasing funding levels.

U.S. states experienced a collective 28-billion-dollar weather and climate disasters in 2023. These states act independently, regionally, and in coalition nationally to design policies and fund programs that can drive adaptation impact, and protect both communities and economic assets. Momentum is building for statewide resilience initiatives.



Source: Four Twenty Seven via NYT

At the State-Level

As of December 2024:

- 30 states have adaptation plans in some form – managed through a climate office, health office, or funded by the EPA.
- 50% of states with adaptation plans also have a statewide Chief Resilience Officer (15 total).

Bright Spots

State governments with the highest rates of investment in A&R solutions to date are **California** (USD13.7 B), **Florida** (USD1 B), **Massachusetts** (USD1 B), **New York** (USD1 B), and **Washington** (USD1 B). In 2024, California passed a USD10 B resilience bond, the Governor of New York announced USD300 M in new investment for resilience, and the State of Massachusetts passed the Mass Leads Act which commits to funding USD400 M for both climate mitigation and adaptation technologies.

State-Level Investment

Some states have independently established governance structures for climate A&R. Ex. MA Office of Climate Innovation and Resilience and the CA ICARP Regional Resilience Planning and Implementation Grant Program.

Local Government Demand: US Cities

Tailwind

Taken in aggregate, major cities significantly outspend states in resilience funding.

At the City-Level

Of the largest ten cities in the country (ranked by tax revenue):

- Eight have public climate risk disclosures.
- Seven have Chief Risk/Resilience Officers. This role usually sits within a sustainability office or is included within the responsibility of a city's CSO.

City-Level Investment

Cities with the highest rates of investment in A&R solutions are **San Francisco, Seattle, New York City, and Boston**.

Major cities with known, significant risks have begun investing in resilience solutions and partnering with states, universities, and federal agencies.

Examples of Research and Innovation Hubs:

- The NYC Governor's Island Center for Climate Solutions
- The Chicagoland Climate Investment Alliance

Examples of Major Urban A&R Investments Deployed:

- San Francisco: **USD13 B** for coastal resilience (San Francisco Waterfront Coastal Study, 2024).
- Seattle: **USD10 B** for water infrastructure and drainage system improvements against worsening storms (King County).
- New York City: **USD1.5 B** in coastal resilience (NYC, 2024).
- Boston: Expected **USD757 M** for coastal resilience (Boston, 2018).

The majority of adaptation investments in cities are in **water infrastructure**, in preparation for/response to extreme weather events, and sea level rise.

Third-Party Convening Initiatives

Multi-city convening entities facilitate an environment where activated subnational governments can share best practices and collaborate on resilience initiatives together. Organizations taking initiatives to build adaptation capacity include:

- Megacities Alliance for Water and Climate
- Resilient Cities Network
- ResilienceFirst
- C40 Cities
- RegionsAdapt
- Race to Resilience

CONSUMER DEMAND

Consumer Demand: Overview

Tailwind

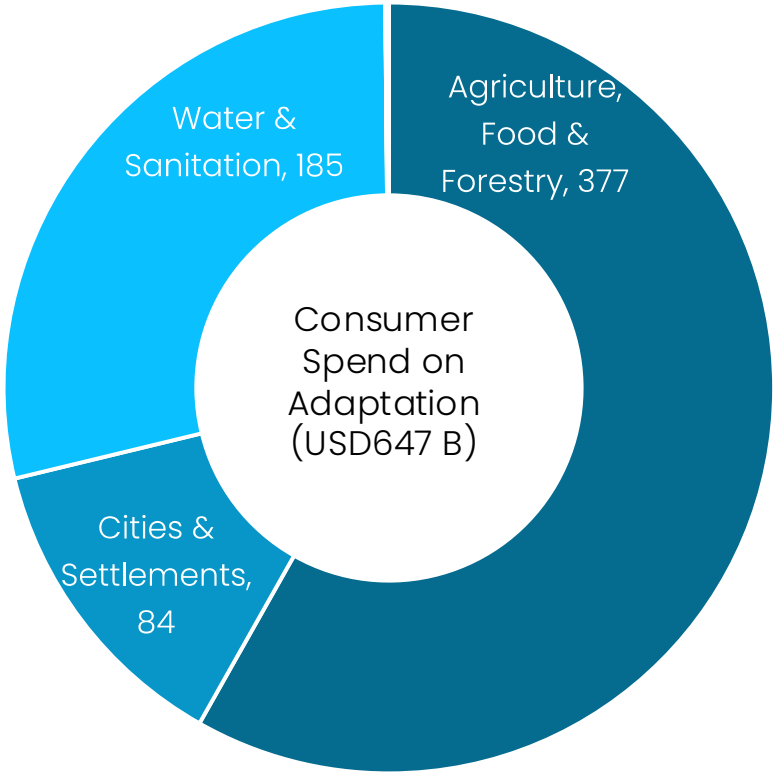
Globally, households spend USD647 B annually to protect their homes and livelihoods.

Building on CPI's analysis of consumer demand for A&R products (CPI 2024), **we estimate global consumer demand at USD647 B annually.**

Consumer demand for A&R currently takes two main forms:

- **Products and services to protect their home** from extreme weather disasters and keep it livable in a hotter, drier climate – Ex. flood protection, stormwater management, sanitation, hurricane-proof roofs, fireproof materials, insulation materials, rainwater harvesting, water filters, etc.
- **Products and services to protect their land** – Ex. subsistence farming.

We expect demand for additional products will develop over time to protect personal safety and health.



Smallholder Farmers

An estimated two billion people live in smallholder farming households, which contribute 35% of the world's food supply (World Bank, CPI).

Smallholder farmers in developing countries spend **USD368 B** on adaptation solutions, equivalent to **20-40% of their own income** (IIED).

Self-funded project areas include climate/weather adaptation information, pest and irrigation technologies, and crop diversification.

With an **average individual spend of $838 per year on adaptation**, innovations targeting this industry require scalable, low-cost frameworks with strong distribution networks (IIED).

US Consumer Demand: Trends

Tailwind

US consumers are already acquiring A&R solutions to prepare for and respond to extreme weather events.

Protecting Homes

For most Americans, their home is their highest-value asset. Across the nation, roughly 44.8% (USD22 T in a USD52 T market according to Zillow) of residential properties are at risk of "severe or extreme damage" from flooding, high winds, wildfires, heat, or poor air quality" (Realtor.com, 2023).

Americans spent an estimated **USD551 B** on home improvement in 2024 (**~$1,667 per household** on emergency repairs alone, USD220 B total) (HIRI, 2024; Angi, 2024).

Hurricane risk is cited as the hazard of greatest consequence to American homeowners, and property damage ranks as the highest-concern disruption after an extreme weather event (Federal Reserve, 2024).

Safeguarding Health

U.S. consumers face a wide array of health consequences to climate change: wildfires resulting in air quality deterioration, increased temperatures resulting in heat stroke, warmer climates growing the transmission range of infectious diseases, and drought and extreme weather events resulting in water and food scarcity. Children, pregnant women, vulnerable populations, and the elderly are the most at-risk.

As such, Tailwind predicts that there will be increased demand for health tech related to these hazards at the consumer level. The EIA estimates residential air conditioning consumption will increase by **59% by 2050** (EIA, 2024).

A&R Consumer Products

Consumer technology products are already proving growth as climate impacts mount:

- Generators, growing at a 5-year CAGR of 7% (GMI)
- Air conditioning units, growing at a 5-year CAGR of 6.9% (GVR)
- Air purifiers, growing at a 5-year CAGR of 7.1%. (GVR)

US Consumer Demand: Survey

Tailwind

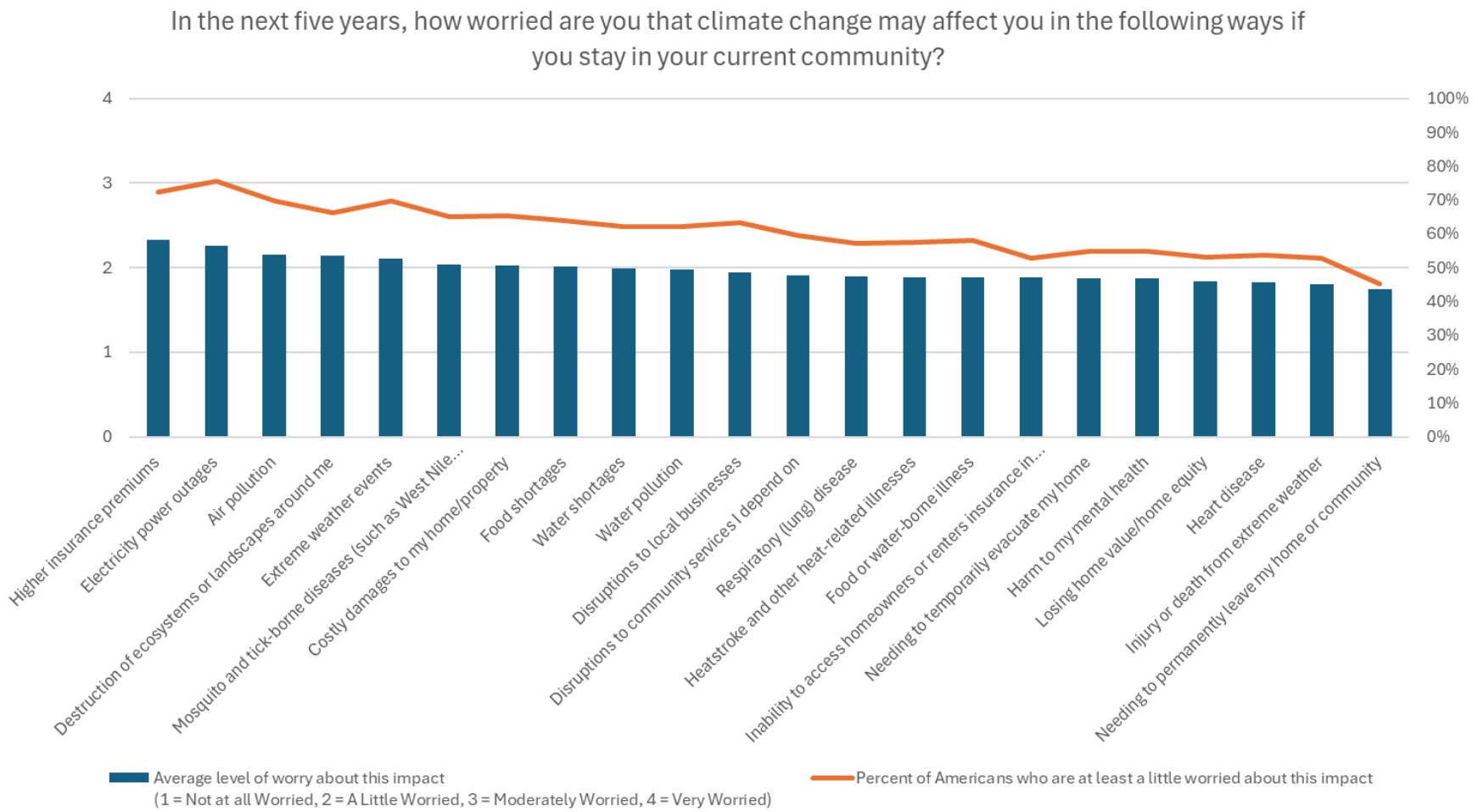
US consumers are concerned about insurance premiums, power outages, and air pollution.

According to a forthcoming study by Fors Marsh, as of January 2024, **Americans are most concerned about higher insurance premiums, power outages, and air pollution impacting them in the near-future.**

More than 75% of Americans are at least a little worried that climate-driven **power outages** will affect them in the next five years.

Of the individual actions listed in the survey, the investments that individuals are most likely to make to protect themselves from climate risk are:

- **Save money to cover potential losses** (50%, half of Americans are likely to or have already taken this action)
- **Invest in landscaping changes** such heat and drought-tolerant plants, improving drainage around the home, etc. (43%, 2 in 5 Americans are likely to or have already taken this action)
- **Buy a back-up generator** (37%, 1 in 3 Americans are likely to or have already taken this action)



Nationally representative insights from the Community Resilience Insights and Survey Project (CRISP), a partnership between Fors Marsh and the George Mason University Center for Climate Change Communications.

ForsMarsh

CORPORATE DEMAND

Corporate Demand: Overview

Tailwind

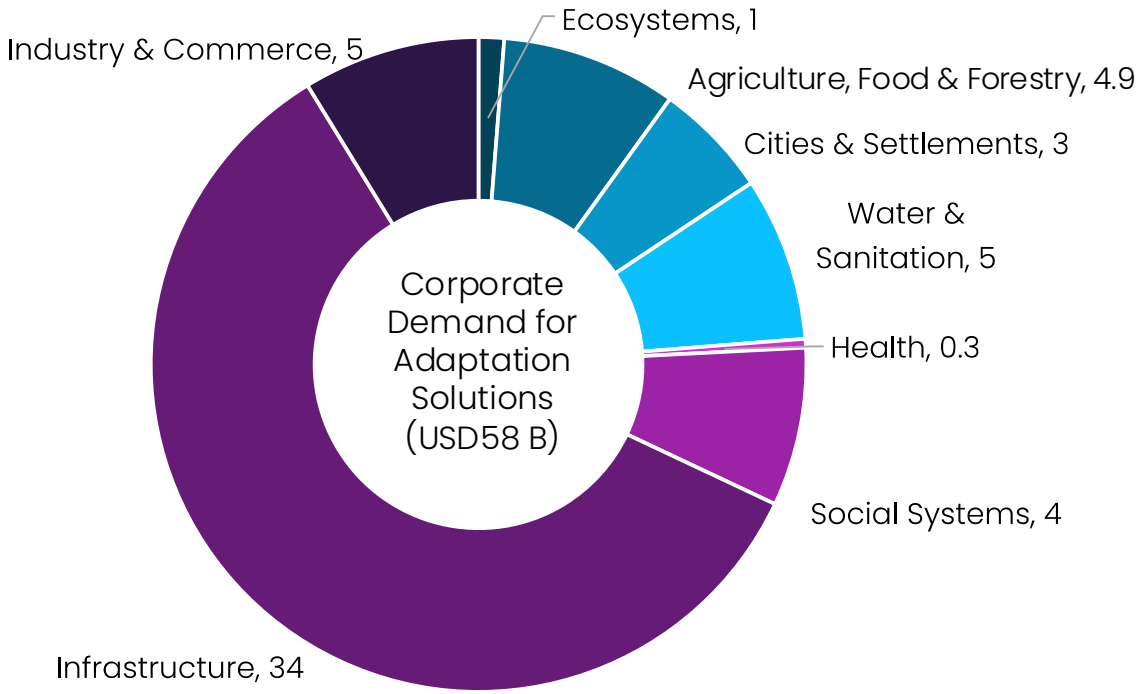
Corporations are the sleeping giants of climate adaptation, with limited current spend but high potential.

We found at least **USD58 B corporate spend on adaptation across , primarily spent on hardening Infrastructure and facilities** (Buildings, under Cities & Settlements).

Overall, this number severely underestimates how much corporations spend on climate risk management – corporations do not commonly disclose how much they spend on risk management, except for investor-owned utilities investing in grid resilience. In our sample of 80, less than half of the corporations we surveyed disclosed any kind of A&R budget.

The signal, however, is clear: corporations are the sleeping giants of A&R. **For corporations that disclosed their investments in A&R, the average was USD200 M per company**. Utilities, Transportation (railroads) stood out with the largest capital expenses, with USD1 B or more per company on average.

Assuming 10,000 publicly listed companies will conservatively spend USD50 M each on climate resilience investments, **the latent demand from corporations should be at least USD500 B annually.**



USD200 M

Average spend from 38 corporations that reported their adaptation expenses.

USD1 B Annually

Expected costs per utility in the Southeastern US to make its infrastructure climate resilient. (McKinsey, 2019) There are over 168 investor-owned utilities in the US. (IEA)

$13 to $1

Dollars saved for each dollar spent on A&R, according to the US Chamber of Commerce (2024): $6 in damage and cleanup costs, and $7 in economic savings.

Corporate Demand: Fundamental Drivers

Tailwind

Demand for A&R solutions is driven primarily by exposure to extreme weather events and water scarcity.

Corporations are exposed to the physical impacts of climate change across the entire value chain:

- Offices, factories and physical assets
- Operations and workforce
- Supply chains (including underlying raw commodities)
- Basic infrastructure (water, energy, ICT and transportation)

Some industries are both more exposed and more vulnerable to physical impacts. Climate risks are especially relevant for organizations with:

- **Long-lived fixed assets**
- **Locations or operations in climate-sensitive regions**
- **Higher dependencies on natural resources** including water
- **Value chains exposed to the above**

Most Exposed Industries	Physical Assets	Operations & Workforce	Supply Chain	Examples
Ag & Food	●	●	●	The agricultural supply chain is particularly vulnerable to even small changes in temperature and precipitation.
Manufacturing	●	●	●	Manufacturing across industries sees workers exposed to extreme heat, challenges with water scarcity, and high value assets exposed to extreme weather and flooding.
Healthcare & Pharmaceuticals	●	●	●	Pharmaceuticals manufacturing requires high-quality water. Heat affects the cold chain for storage and transportation of products.
Utilities	●	●	●	Extreme weather events and wildfires affect infrastructure, exposing workers to heat and limiting water availability for hydropower.
Construction	●	●		Workers and worksites are exposed to extreme weather and heat.
Mining	●	●		Mines and mine workers are exposed to extreme weather, floods, landslides, extreme heat, and water scarcity.
Telecom	●	●		Telecom infrastructure is vulnerable to extreme weather events that also expose workers to extreme heat.
Transportation	●	●		Roads, railroads, bridges, and airports are exposed to extreme weather events, floods and sea level rise.
Real Estate	●			Buildings are exposed to floods, extreme weather events and increased operational costs due to heat.
Information Technology	●			Data centers have high water and cooling requirements.

Corporate Demand: Awareness

Tailwind

Awareness of risk is at the highest level reported but does not yet translate into action.

Investors

- **57% of investors believe that physical climate change is already having a significant impact on the global economy**
- An additional 36% of respondents expected a significant economic impact in the future
- 45% of respondents expect impacts to materialize in the next 5-10 years
- 34% said that climate has had a major effect on the allocation of assets in their portfolio
- **Only 7% investors believe climate risk is fully priced in**

Survey of investors, banks and insurers, MSCI, November 2024

Corporations

- **Over 60% of firms reported being directly impacted by physical risk**
- 22% firms in Europe and 31% in the US reported having an adaptation strategy
- **29% in Europe and 36% in the US reported investing in solutions to avoid/reduce exposure to physical risks**
- 20% reported buying or renewing insurance products to offset climate-related losses
- 9% reported bringing new products to market in response to climate change (incl. mitigation)

Survey of EU and US corporations, EIB, November 2024

Infrastructure Investors

- 97% of infrastructure investors surveyed believed physical climate risk is significant
- 76% anticipated a medium or high impact of climate risk on their infrastructure investments
- **Only 16% believed that there is an adequate understanding of how physical climate risk will affect infrastructure assets**
- 66% of respondents had not conducted any evaluation of physical climate risk themselves

Survey of infrastructure investors, EDHEC, January 2024

Corporate Demand: Trends

Tailwind

Corporate spend on adaptation is focused on hardening against extreme weather events and water stress.

Tailwind analyzed the disclosures of the 75 highest-grossing companies across key sectors. In line with the expectation that larger companies are more likely to invest in A&R, we found **52% of the corporations we investigated had conducted a climate risk assessment and 54% had invested in one-off A&R measures**.

We found that the **most commonly-cited risks were water stress and acute impacts like extreme weather events**. The primary concerns associated with extreme weather events were **damaged infrastructure, harm to human capital, supply chain interruptions, and transport issues**.

The **most commonly-cited interventions include hardening sites using existing technology and diversifying suppliers** and locations. Among the most popular dual-benefit investments across sectors is **water efficiency management.**

Investments were typically categorized as capital expenditure, with some companies also reporting operating expenses like regular climate risk auditing and improved asset maintenance.

An analysis by S&P Global of financial impacts of climate risk in 2050 and 2090 found that **extreme heat could become the biggest driver of costs for corporations**, followed by water stress. (S&P 2023)

Enhancing Grid Reliability

Exelon's regulated utilities invested almost USD7.2 B in 2022 for grid advancements in reliability and resiliency. (CDP)

Sharing Climate Risk Assessment Tools

AT&T works with the federal government in creating the Climate Risk and Resilience (ClimRR) portal to make the world-class, climate-science modeling and data used in its infrastructure planning accessible to the public for free.

Corporate Demand: Innovation Bright Spots

Tailwind

Corporations innovate by developing new solutions and working with community groups to protect their value chains.

Few companies reported Investing in innovation to improve prevention and risk reduction. Qualitative interviews with corporates revealed different blockers, including:

- A lack of awareness of innovative technologies to address climate risk
- Limited capacity (team, budget) to source and diligence new solutions
- Mixed appetite from business units to pilot and try new technologies
- Unclear boundaries of internal responsibility

Amongst interviewees, a few corporate **leaders showed great sophistication in their approach to climate risk and opportunities**, including new products and services and market expansion in response to changing weather patterns and customer needs.

Over the next 1-3 years, we expect companies will start applying lessons learned from corporate innovation in climate (mitigation) tech and leverage internal capabilities to invest in A&R.

Managing Flood Risk at Headquarters

Meta works with local jurisdictions and organizations through the SAFER Bay Project to improve coastline resilience in bridge and shoreline infrastructure using both technological and nature-based solutions.

Building Resilience in Supply Chains

Michelin demonstrates leadership in developing products and conducting trainings with smallholder farmers to ensure a resilient supply of rubber. While this work is being done to ensure broad resilience across multiple business priorities, these types of initiatives can also drive positive climate resilience benefits.

Corporate Demand: Outlook

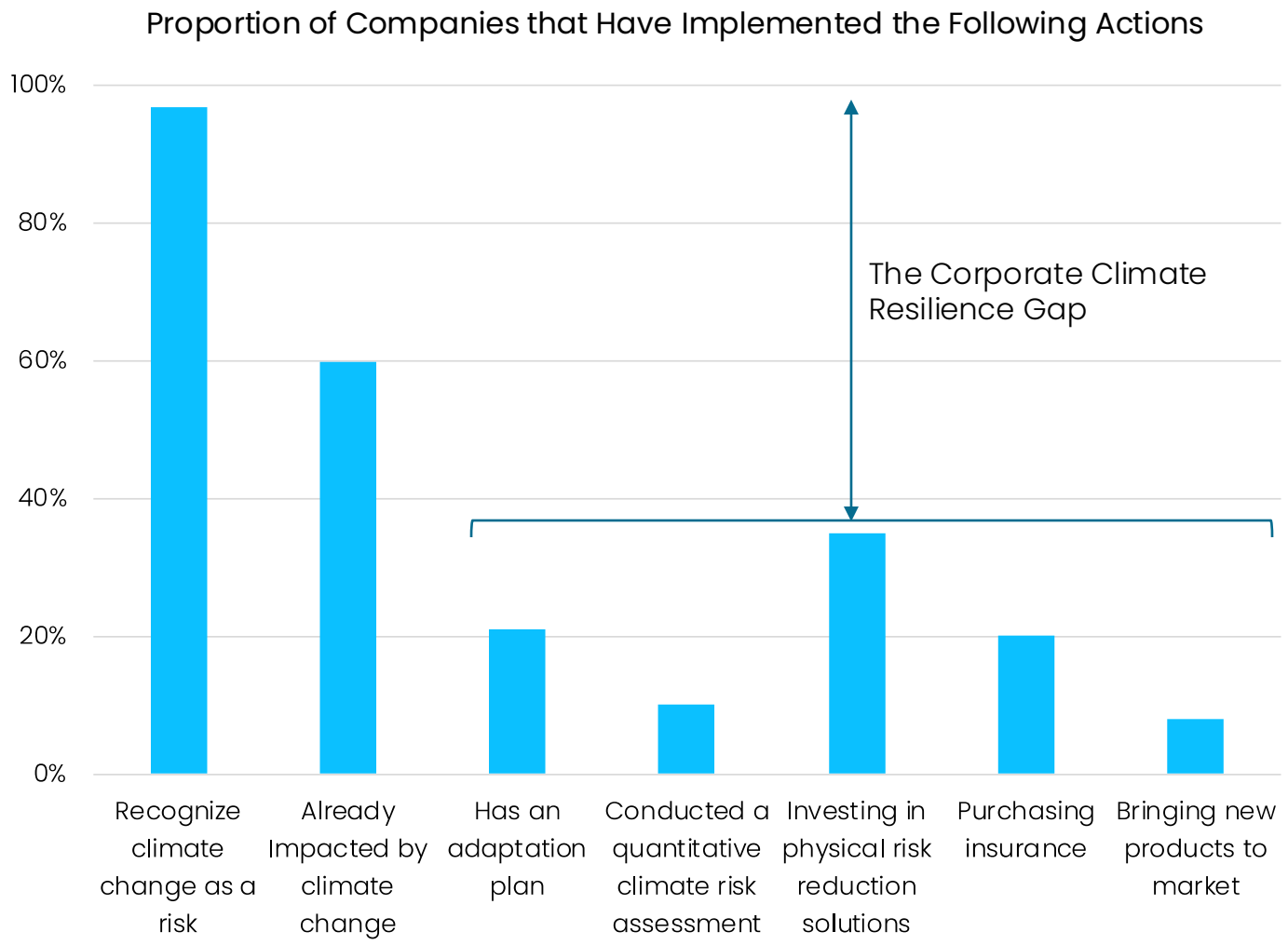
Tailwind

Corporations need help advancing more mature adaptation and resilience strategies and investment plans.

The discrepancy between costs of climate change (actual and projected) and investments in climate resilience indicate that **we are in very early days for the B2B adaptation solutions market.**

To mature from reactive to proactive climate risk management, corporations will need the following:

- **Improved access to climate data, earth observation and sensor data** to identify and monitor climate risk
- **Support identifying adaptation options and access to financial tools**, including identifying novel technologies and nature-based solutions, and tools to calculate the ROI of adaptation measures
- **Enhanced physical risk reduction solutions** for floods, water scarcity, extreme heat, and wildfire impacts on physical assets, workforce and local infrastructure
- A broader set of **financial risk transfer solutions** as a stopgap for unavoidable risks
- **Support identifying opportunities to innovate** to grow revenue through new A&R products and lower costs of climate risk management



Source: EIB 2024, EDHEC 2024, S&P 2023

Corporate Demand: Drivers for Insurance

Tailwind

Insurance is riddled with existential business risks due to climate change, and the industry is aware of them.

Overview

Historically, states like Florida, California, and Louisiana have been the epicenters of climate-related insurance losses due to hurricanes and wildfires. The problem has now spread across the country, affecting states like Iowa, Arkansas, Ohio, Utah, and Washington. Even in the Northeast, where insurance has traditionally been more stable, profitability is declining. **According to the New York Times, 8 states were unprofitable for residential home insurance in 2013. That number rose to 18 states (or 36% of states) in 2023.**

Insurers have responded by raising premiums, reducing coverage, and exiting high-risk markets. State Farm and Allstate have paused new business in California and will not renew thousands of existing policies. Farmers and AAA have also exited insurance markets entirely due to mounting risks. This **'insurance retreat'** from high-risk areas leaves many property owners reliant on state-mandated insurance pools. In Florida, between 2018 and 2022, the number of homeowners turning to the state-backed insurer of last resort, Citizens, more than doubled from less than 450,000 to 1.2 million. Others are struggling to pay **higher insurance premiums** as premiums for U.S. homeowners surged an average of 33% between 2020 and 2022.

Industry Perspective

Over the last decade, U.S. insurers paid out more in claims than they received in premiums, and those losses are increasing according to the ratings firm Moody's. Annual global insured losses (inflation-adjusted) of more than USD100 B have become standard. The insurance industry is speaking openly about the challenges around insuring against climate risks. According to a report by Conning, **91% of insurance executives expressed "significant" concern** about climate change as a threat to their businesses.

"Climate risk is a certainty, not a probability. Severe weather and climate related risks now pose an existential threat to the way we live and work."
Greg Case, CEO of Aon

"As we enter what is increasingly seen as the decisive decade to fight climate change, individual corporate actions are not enough; the entire industry must change investment patterns and share risk management lessons."
Thomas Buberl, CEO of AXA

According to PwC, 51% of global insurance CEOs have either made a net-zero commitment or are working towards making one. 62% of these CEOs say their motivation is to reduce climate risk.

SUPPLY

Supply: Adaptation Startup Landscape

Tailwind

Pure play adaptation startups make up 12% of all climate tech startups but receive only 3% of the funding, USD4.5 B.

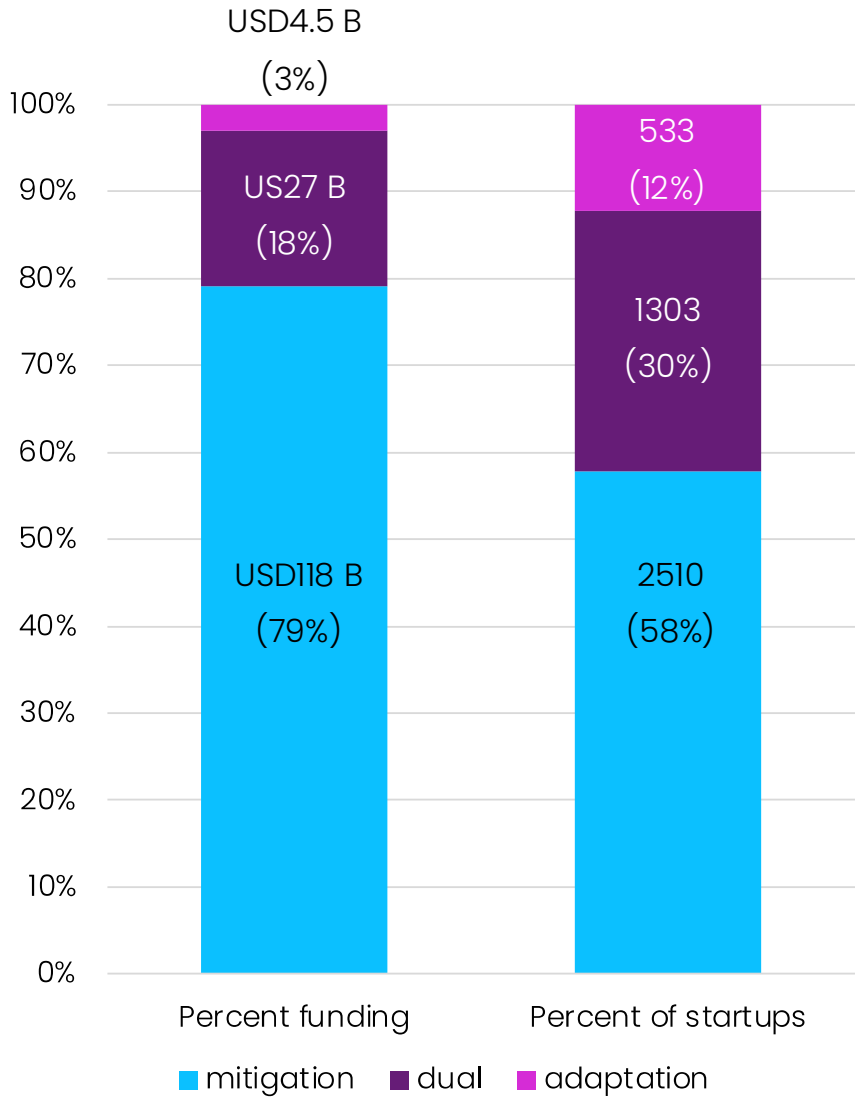
Tailwind partnered with Vibrant Data Labs to train an AI model to identify A&R startups and map them to the Tailwind Taxonomy. This effort allowed us to develop the **first detailed analysis of investment trends and bright spots for A&R in the startup ecosystem** by sector and funding stage over time.

Pure play A&R ('Adaptation') startups make up 12% of all funded climate tech startups, but receive only 3% of total funding, USD4.5 B total. Adaptation startups include technologies that support climate risk and resilience activities but have little or no mitigation benefits, like climate risk analytics, insurance, disaster preparedness and recovery, flood prevention and mitigation, human cooling technologies, etc.

However, **many mitigation startups also have adaptation co-benefits.** These include very active sectors within the climate tech ecosystems, such as food and ag tech, grid resilience and microgrids, and energy and water efficiency. **Dual benefit startups constitute 30% of all climate tech startups, and receive 18% of total funding, USD27 B.**

All in all, we find **42% of climate tech startups have A&R benefits,** even if it's not their primary focus.

Funding numbers are for all financing (venture, debt, grants) between 2019 and 2023. The number of startups refers to startups currently active (excluding those that may have been acquired or stopped operating.



VIBRANT DATA LABS

Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

Supply: Pure Play Startups

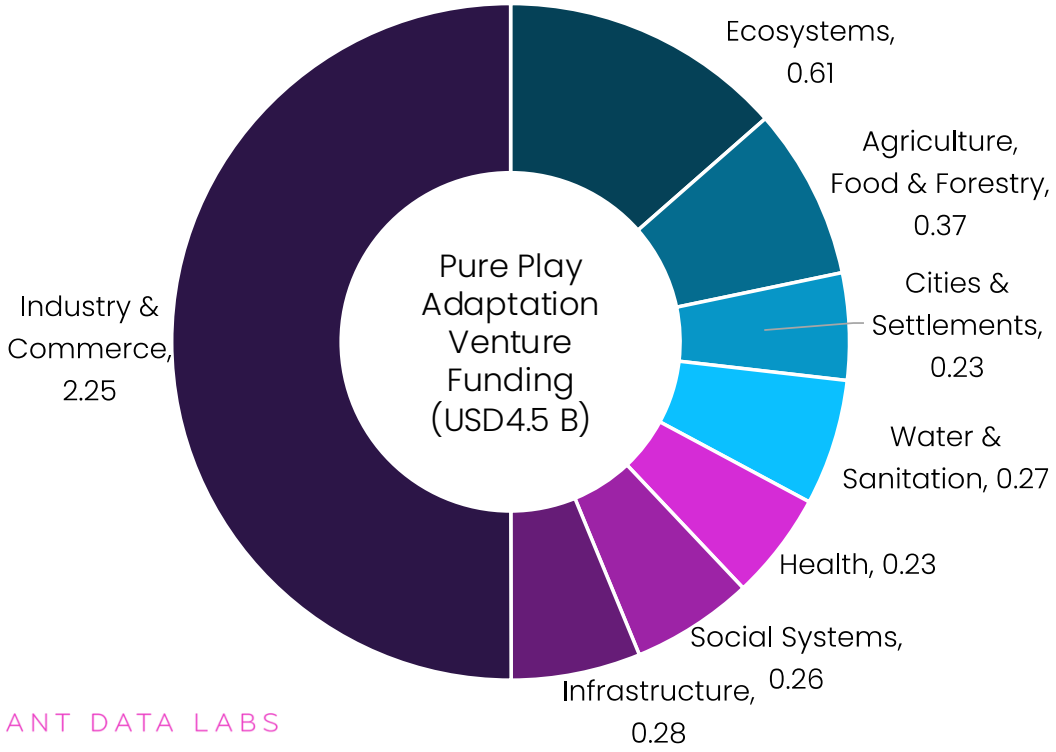
Tailwind

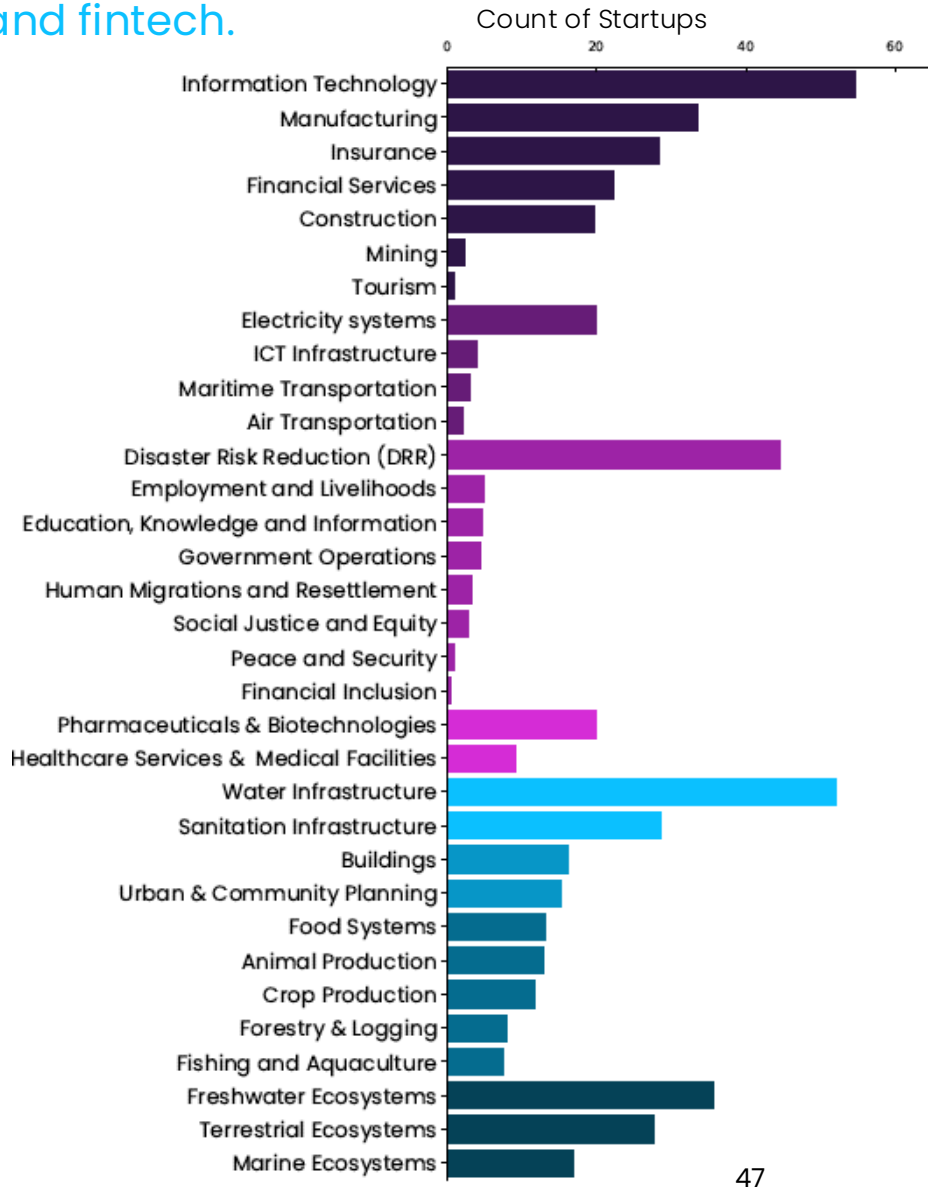
Pure play adaptation investments are dominated by IT, manufacturing and fintech.

Industry & Commerce makes up exactly half of investments in pure play A&R startups (USD2.25 B). Information Technology leads the pack with climate risk analytics, modeling and other software solutions, together with manufacturing, insurtech, fintech and construction tech.

Ecosystems is the second most active sector, with USD610 M of investments in fire tech, water management and ocean tech.

Other sectors like Water & Sanitation Infrastructure, Disaster Risk Reduction (which includes post-disaster recovery as well), Cities & Settlements (flood management, real estate, smart cities) received USD200-300 M each.





VIBRANT DATA LABS

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Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

47

Supply: Dual Benefit Startups

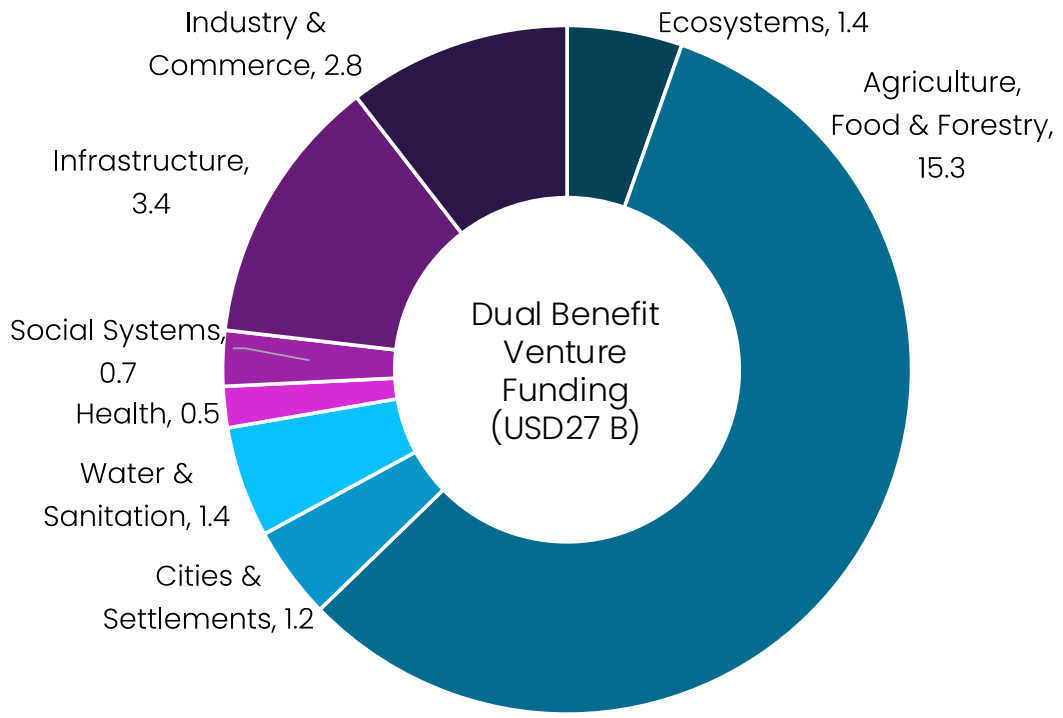
Tailwind

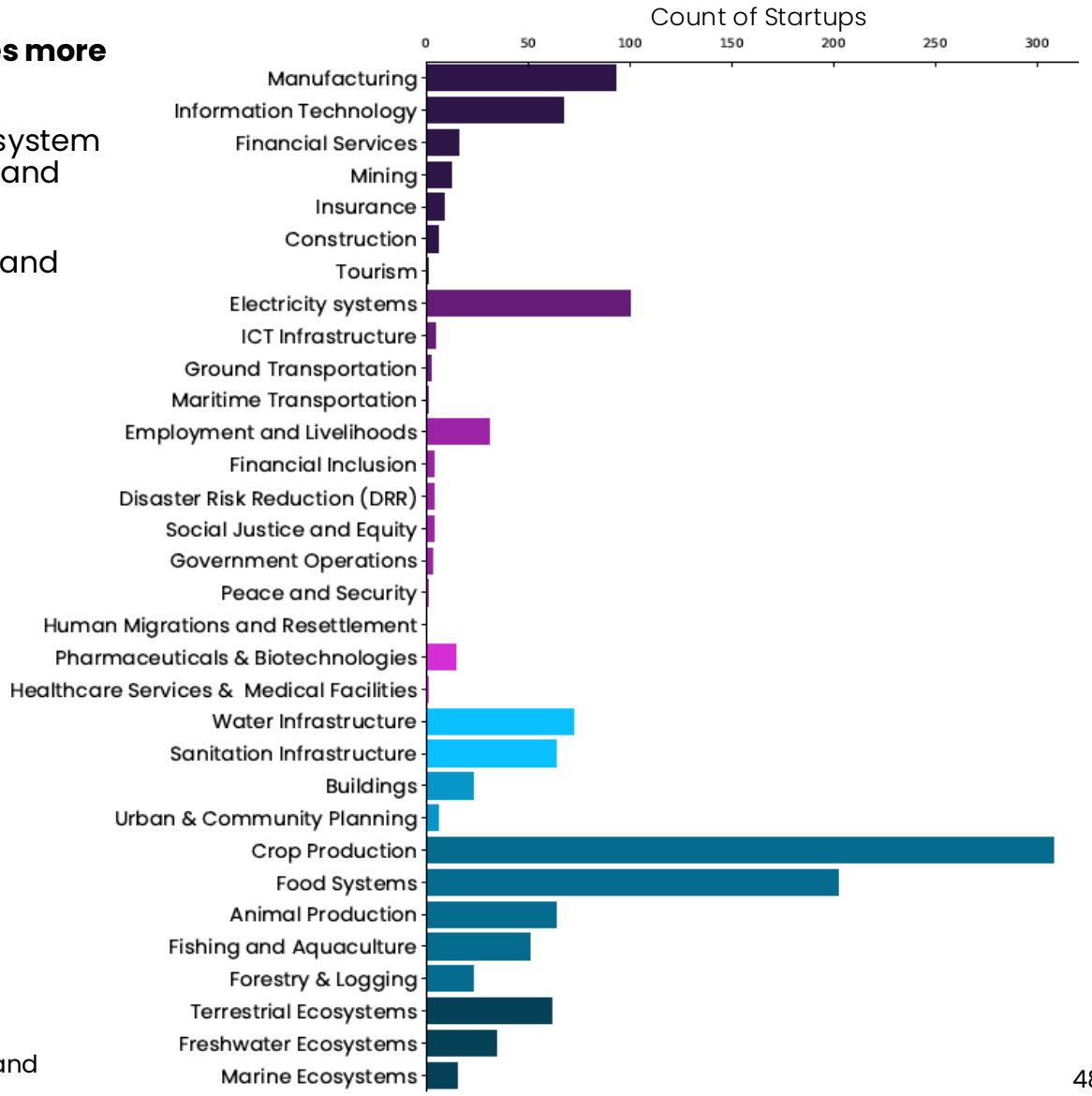
Agriculture, Food & Forestry and Electricity Systems (Infrastructure) lead dual benefit climate investments.

Dual benefit startups received USD27 B in funding over 2019-2023, almost 6 times more than pure play adaptation.

Agriculture, Food and Forestry dominate this category, due to a very active ecosystem in ag and food tech, include regenerative ag, indoor farming, alternative proteins and smart irrigation.

Grid resilience (Infrastructure), **Manufacturing** (which includes industrial energy and water efficiency), and **Water & Sanitation** also received substantial funding.





VIBRANT DATA LABS

Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs

Supply: A&R Funding Trends 2013-2023

Tailwind

Venture funding for adaptation has grown far more slowly than other climate tech investments.

Annual funding for pure play adaptation startups has doubled between 2013 and 2023, growing from USD332 M to USD850 M, with a peak at USD1.6 B in 2021.

Funding for dual benefit startups has grown at a much faster pace, starting at USD575 M in 2013, growing to USD7 B in 2021 and 2022, and receding back to USD3.8 B in 2023.

However, **these numbers pale in comparison to the investment growth for mitigation startups**, which have grown from USD3.4 B in 2013 to USD44.4 B in 2023, a 14-fold increase driven by strong ecosystem support, aggressive public investments and strong private investor interest.

The continued growth in mitigation finance in 2023 is largely driven by late-stage rounds of debt financing. Without debt, investments in mitigation companies follow a similar trend as that observed for dual companies (which more than halved between 2022 and 2023).

VIBRANT DATA LABS

Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

Supply: Technologies

Tailwind

Funding for pure play A&R goes overwhelmingly to software and data solutions.

We sorted pure play A&R startups in four categories:

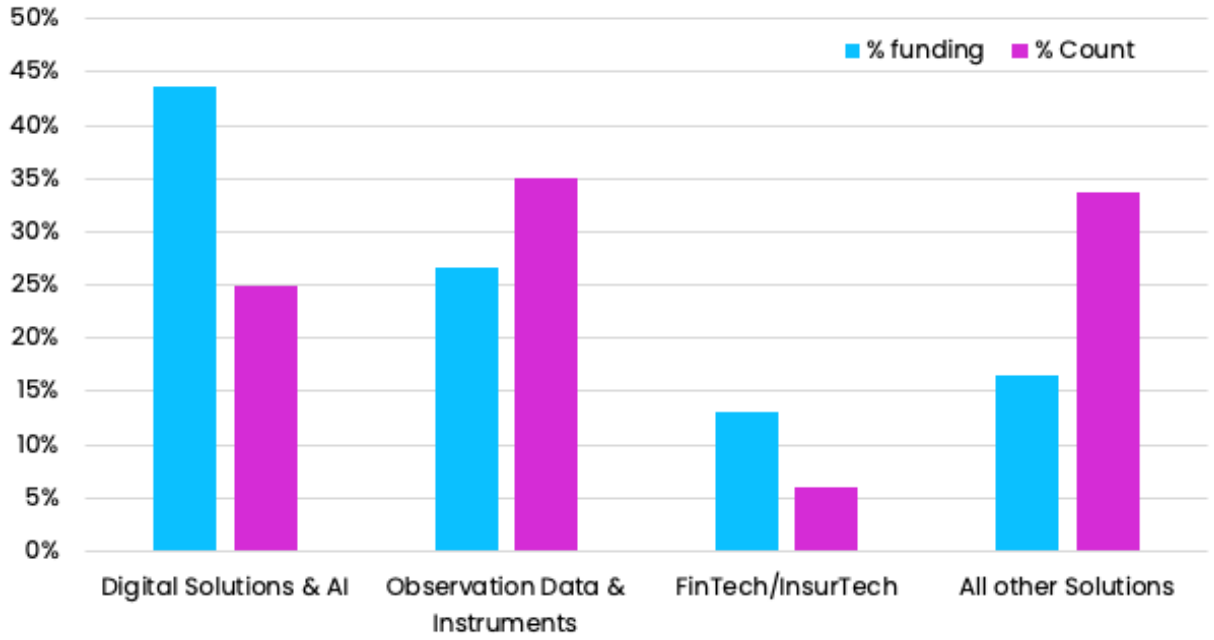
- **Digital Solutions & AI**
- **Earth Observation & Sensors**: Including mixed hardware/software solutions including satellites, drones, sensors, wearables, and IoT
- **FinTech/InsurTech**
- **All Other Solutions**: Including physical risk reduction technologies (e.g. materials, equipment, medications, filters, etc.) and non-financial services

Investments overwhelmingly go towards Digital Solutions & AI (44%) and Earth Observation & Sensors (27%). The latter includes a hardware component (satellites, drones, or sensors), but the value resides primarily in the data and insights generated. Both categories are key enablers of A&R - for risk identification, detection, to prevention and early warning systems.

In contrast, **only 16% of investments are directed towards physical risk reduction products and services**, even though one third of the companies are in this space. Hardware investments are frequently more challenging for VCs given their longer time to commercial maturity, but the nature of climate impacts calls for products that physically mitigate risks. Increased funding in this category will be needed.

FinTech/InsurTech receives a relatively greater proportion of funding compared to the volume of startups, but very few startups are in this space yet, despite the massive needs in the insurance sector.

Software v. Hardware Investments in Pure Play A&R



VIBRANT DATA LABS

Source: Data from Crunchbase. Analysis and charts by Tailwind and Vibrant Data Labs.

Supply: Academic Research Trends

Tailwind

Abundant academic research on A&R sets the stage for future innovation.

Through a desktop review of major research publications, we found that genetic modifications for climate-resilient crop species, coastal resilience solutions, reforestation, soil health, climate insurance tools, and data models for climate forecasting are especially bright research areas.

Highly-Active Research Areas

- Crop Production Solutions
  - Climate-Resilient Genetic Modifications (ex. Drought/Heat-Resistant Species)
  - Soil Health for Agriculture
- Disaster Risk Reduction Solutions
  - Coastal Resilience to Flooding and Sea Level Rise
  - Heat Stress and Urban Heat Island Impacts
- Satellite and Geospatial Mapping to Prevent/Predict Extreme Weather Events and Track Climatic Patterns
- Water Treatment Solutions
- Financial Tools (ex. Parametric Insurance for Climate-Related Natural Disasters, Crop Insurance)
- Tropical Conservation and Reforestation Solutions

Growing Research Areas

- Climate-Related Early Warning Systems for Health (ex. heat stress, smoke exposure)*
- Climate-Resilient Healthcare Infrastructure and Supply Chains*
- Groundwater Salinity and Saltwater Intrusion Impacts Due to Sea Level Rise
- Restorative/Biodiversity-Friendly Aquaculture
- Stormwater Modelling

**Analyses by influential groups such as the Lancet Countdown and McKinsey's Health Institute highlight the urgent and growing need for health-related R&D in climate adaptation*

Source: Tailwind Analysis

Supply: Accelerator & Incubator Ecosystem

Tailwind

Few dedicated programs exist for adaptation companies, but large accelerator portfolios include adaptation startups.

More accelerators and incubators are creating A&R programmatic tracks or dedicating their entire programs to A&R. These programs often emphasize cross-sector collaboration among government, private sector, and community organizations. While more focused A&R programs are needed, large household programs are supporting adaptation founders.

Mitigation-Focused Programs Outnumber A&R Programs 15:1

11	150+
A&R Climate Tech Programs	General (Mitigation) Climate Tech Programs

Internationally, A&R climate tech accelerators are launching in developing countries.
For Example: Climate KIC's ClimAccelerator in Tanzania, World Bank's InfoDev Program with 35 centers in 7 countries, The Catalyst Fund's accelerator for climate resilience in Africa, and The Lightsmith Group and Village Capital's Adaptation SME Accelerator.

In a survey of accelerators that looked at adaptation companies supported by volume, **TechStars, Cleantech Open, SOSV, MassChallenge, and gBETA rose to the top** with an average of 17 adaptation companies supported between 2019 – 2023. TechStars took the lead having supported 40 companies over that period.

Adaptation-Focused Programs:

- **Elemental Impact:** Cohort 11 awarded 5 startups in Climate Resilience
- **IDEO:** Awarded 13 companies through the Climate Resiliency Challenge
- **RISE Resilience Innovations:** Community resilience, flooding, and coastal resilience accelerators
- **NOAA's Ocean-Based Climate Resilience Accelerators** (USD60 M commitment)
- **Twilio.org Impact Fund:** Climate Tech Prize
- **QBE AcceliCITY Resilience Accelerator:** Global accelerator focused on B2G urban resilience innovations
- **Urban Future Lab:** Launched a prize track explicitly focused on climate adaptation and resilience, the Future Resilience Prize
- **X-Prize Wildfires:** X Prize Wildfire is a 4-year, USD11 M competition incentivizing the innovation of firefighting technologies

Source: Tailwind Analysis

Supply: Successful Business Models

Tailwind

A&R startups often rely on creative sales channels to overcome challenges with limited customer budget, lack of awareness or buyers' procurement constraints.

Lesson 1: Product benefits sell (…not adaptation itself).
Customers are interested not necessarily on being 'more resilient' but in the benefits of A&R products such as the following:

Food & Water Access	Energy Reliability	Positive Health Outcomes	Reduced Business Risk	Positive Safety Outcomes

Lesson 2: The end user is not always the customer.
Target users or beneficiaries of an A&R solutions can be hard to reach, less inclined to try new solutions or not able to afford them.

Lesson 3: Innovation brokers and channel partners matter!
Reaching government, private sector, and consumer customers requires creativity and engagement with the right partners. B2G models are especially hard – working with partners experienced with public procurement and with the right technical expertise can open more doors. *Don't be afraid to be a subcontractor!*

Business Model	Example A&R Channels
B to **G**	Engineering firms, government contractors
B to **B**	Distributors, engineering firms, consultants, OEMs
B to **C**	Distributors (ex. home improvement), banks

Metalmark

Metalmark works with distributors and building system integrators to get their high performing air filter product into private and government HVAC systems.

Pano AI

Pano AI detects wildfires thanks to their cameras in remote areas. They sell their services to utilities, who provide the data to local fire departments, shortening the time to suppression for everyone's benefit.

NatrX

NatrX partners with engineering firms to integrate its novel bio-material into local governments' and corporate customers' coastal infrastructure projects.

Supply: The Role of Large Corporations

Tailwind

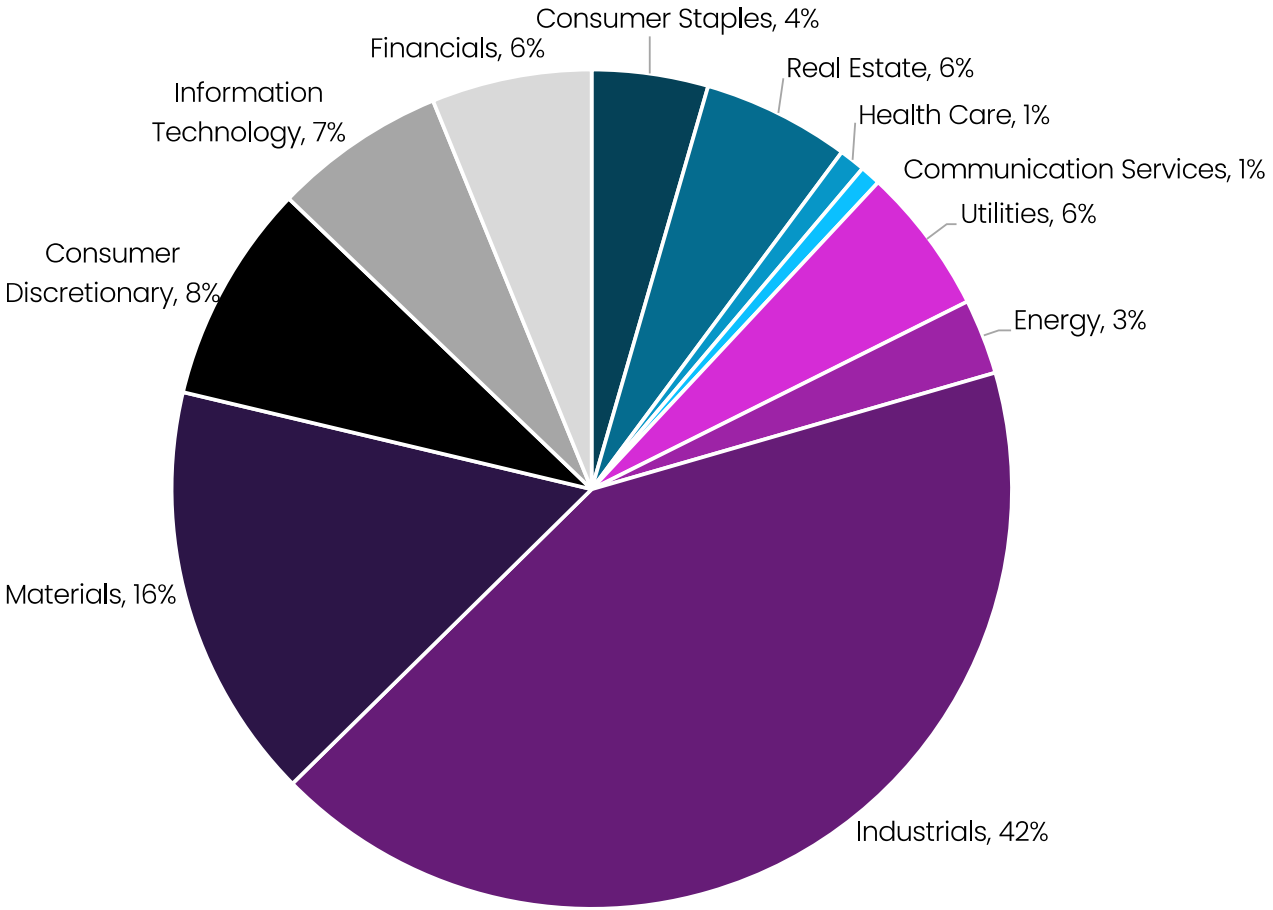
One in ten large corporations has an 'adaptation play', meaning they sell products and services bound to be in greater demand because of climate change.

Large corporations also play a key role in bringing new A&R products and services to the market. A recent analysis by MSCI and GARI found **one in ten companies (827) had A&R products and services**, in a universe of almost 8,000 publicly listed companies (GARI 2024). Amongst these, Industrials and Materials made up over half of the company count.

Separately, our analysis of corporate disclosures shows that sectors where innovation is core to the business are best positioned to leverage their R&D teams to develop A&R solutions. **Bright spots include pharmaceuticals, food & beverage, IT, and materials/chemicals.**

Examples of A&R solutions developed by large corporations include:

- Kraft-Heinz in the past five years has focused millions of R&D dollars into its HeinzSeed research center in California, as it develops tomato seeds that can better withstand hotter and drier growth environments.
- Dell and Doosan partnered in 2018 to build "PreVision," a fault detection and diagnostic platform, to minimize equipment maintenance and replacement, and avoid shutdowns by improving the resilience of power plants using Doosan equipment.
- 3M featured cool roofing granules as part of its climate-forward solutions portfolio in 2022.



Source: GARI

Supply: Insurance Industry's Role in Innovation

Tailwind

The insurance industry struggles with accelerating climate risks, but efforts pave the way for innovation.

With mounting risks facing the global insurance industry, insurers are doubling down on programs they hope will enable them to weather coming storms. These programs are important, but both internal and external innovation will be needed to ensure the insurance industry can keep up with mounting climate hazards.

Insurer / Insurer-Funded Program	Role	Example
CSAA	Accelerator and Prize Program Funder	CSAA, in partnership with AON, Arch Reinsurance and RenaissanceRe, funded an IDEO-lead program called the 'Resiliency Challenge' where they selected 13 winners and awarded $1 million in prize dollars.
American Family Insurance	Carrier-linked VC Firm	American Family Insurance's VC arm has invested in climate adaptation tech companies like Burnbot and Earth Force Technologies.
Factory Mutual	Insurer with Research and Engineering-Driven Underwriting Practices	Factory Mutual develops breakthrough engineering solutions for commercial property insurance risks that allow policyholders to reduce premiums as they finance solutions.
IBHS	Testing Center and Standards Authority	IBHS is a nonprofit scientific research center and communications organization supported by property insurers, reinsurers, and affiliated companies. IBHS unearths risk data on the performance of building hardening products.

"It is the agile and innovative insurance startups and entrepreneurs who stand the best chance at delivering new products, distribution mechanisms, and financing approaches for climate risk insurance and transforming this industry."

Charlie Sidoti, Executive Director of InnSure

Supply: Innovation Opportunities in Insurance

Tailwind

Insurance innovation is needed to both properly price risk, and finance risk reduction and adaptation solutions.

New insurance products (ex. micro, parametric insurance), new distribution mechanisms (ex. community-embedded insurance), and new financing approaches (ex. public and private financing) are starting to transform the insurance industry.

FloodFlash

FloodFlash offers a parametric flood insurance product that enables policyholders to leverage a claims-free process to recover from flooding.

Their process sets an agreed-upon trigger depth with their customers. When that level of flooding occurs, they use sensors to verify, allowing policyholders to receive an immediate payout.

Product

City of Isleton (CA) Flooding Initiative

Spearheaded by the CA Department of Insurance and funded by the CA Department of Water Resources, this community-based parametric flood insurance initiative allows for Isleton to, in the event of a flood of pre-determined depth, provide payouts to Isleton residents.

This program has been funded by a two-year, $200,000 grant.

Distribution

California Wildfire Fund

California's Wildfire Fund leverages public and private funds to address financial risks posed by utility-caused wildfires. The program helps cover claims from catastrophic fires linked to their equipment.

The program aims to ensure rapid compensation for victims while stabilizing utility finances and incentivizing utilities to invest in fire prevention and safety measures. It is funded through contributions from utilities, ratepayers, and the state.

Capital Stack

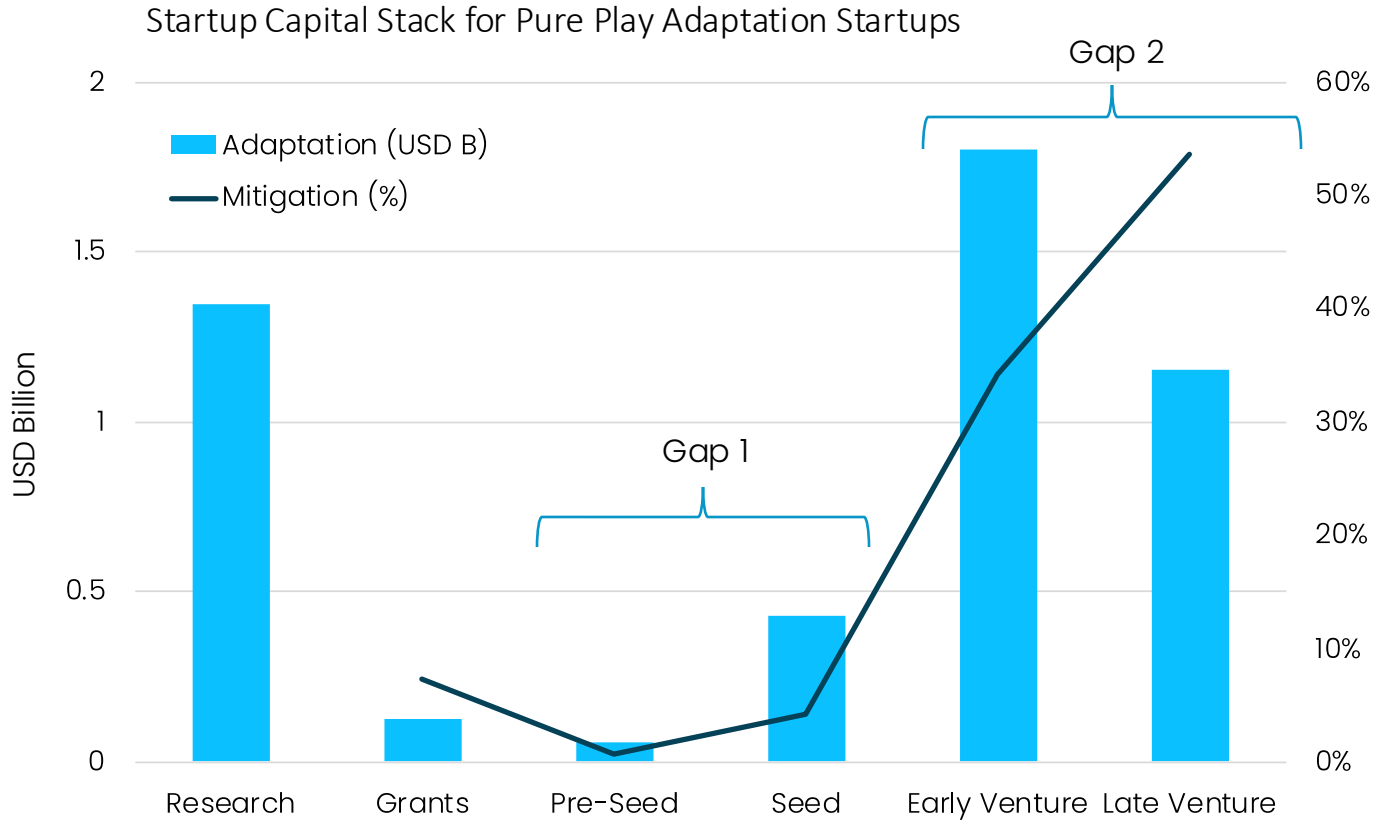
CAPITAL STACK

Capital Stack: Startup Capital Needs

Tailwind

A&R innovation investment remains glaringly low for innovators at all stages, with a huge gap for startup formation (pre-seed) and product development (seed) and insufficient capital for all venture rounds.

Our findings on capital availability between 2019 and 2023 reveal that there is very little capital for innovators translating research into new businesses. Once products have been tested, venture funding can be hard to come by.



**Research dollars are for 2023 only, while funding stages numbers are cumulative for 2019-2023*
Percentages apply to the sum of equity rounds and grants, excluding debt.

Investment Trend Lines:

- **Capital Gap 1**: Like the initial capital gap in climate tech 1.0, we see a **dire need for more funds at the pre-seed and seed stages. This represents the most serious capital gap for A&R companies.**

- **Capital Gap 2**: While the early **venture and late venture** funds available trend upward from the pre-seed and seed funding gap, **they are relatively much smaller** compared to a 'healthy' capital stack, illustrated by the mitigation percent funding. Late-stage rounds are particularly limited.

VIBRANT DATA LABS

Source: Tailwind and Vibrant Data Labs analysis

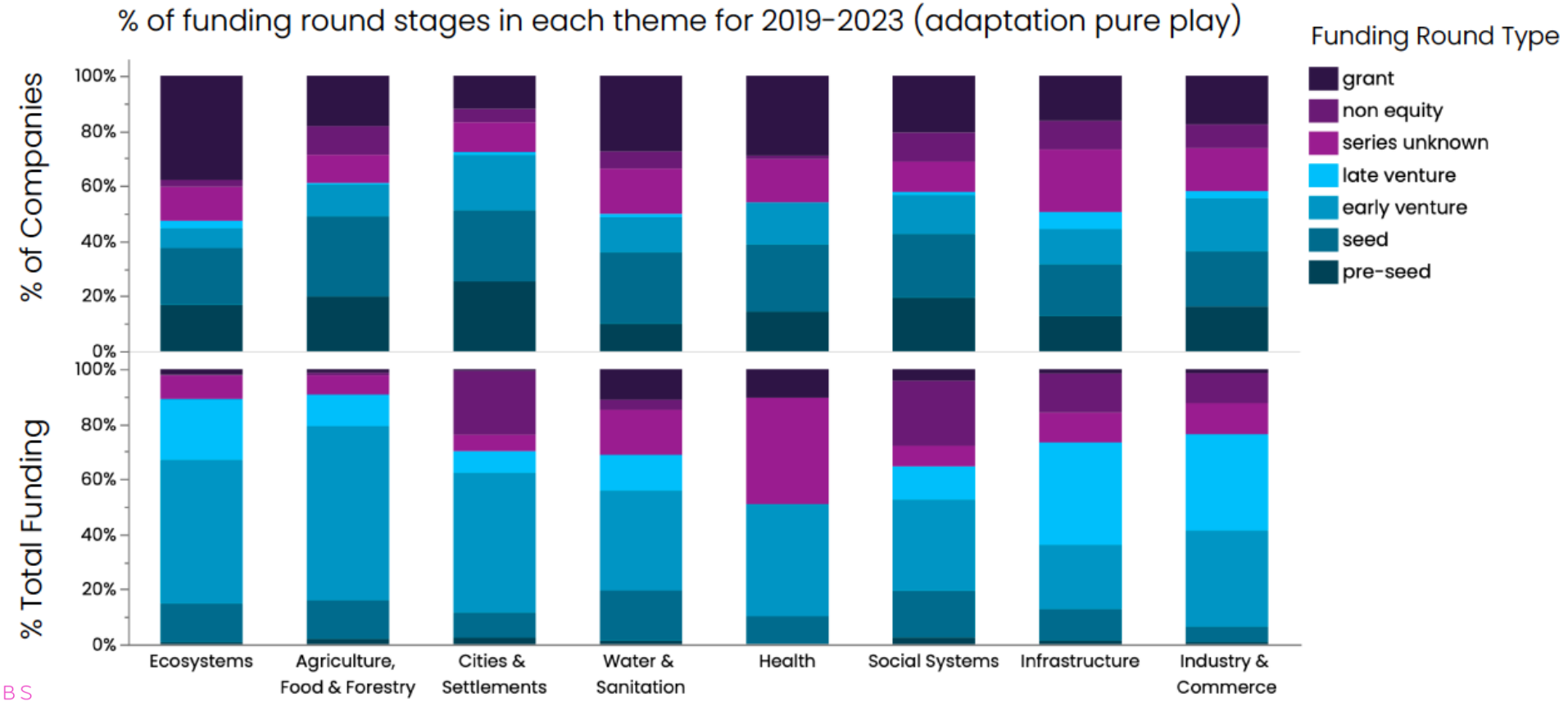
Capital Stack: Pure Play Startups

Tailwind

Pure play startups receive almost no late-stage venture funding, and seed capital is desperately lacking.

A closer look at funding by sectors and by stage for pure play startups shows similar trends. In particular:

- Insufficient grant funding for Cities & Settlements, Agriculture, Food & Forestry, and Infrastructure
- Insufficient early-stage venture capital available for Infrastructure
- Insufficient late-stage venture capital available for almost every theme but especially for Health, Cities & Settlements, Water & Sanitation, and Social Systems with some bright spots in Infrastructure and Industry & Commerce



VIBRANT DATA LABS

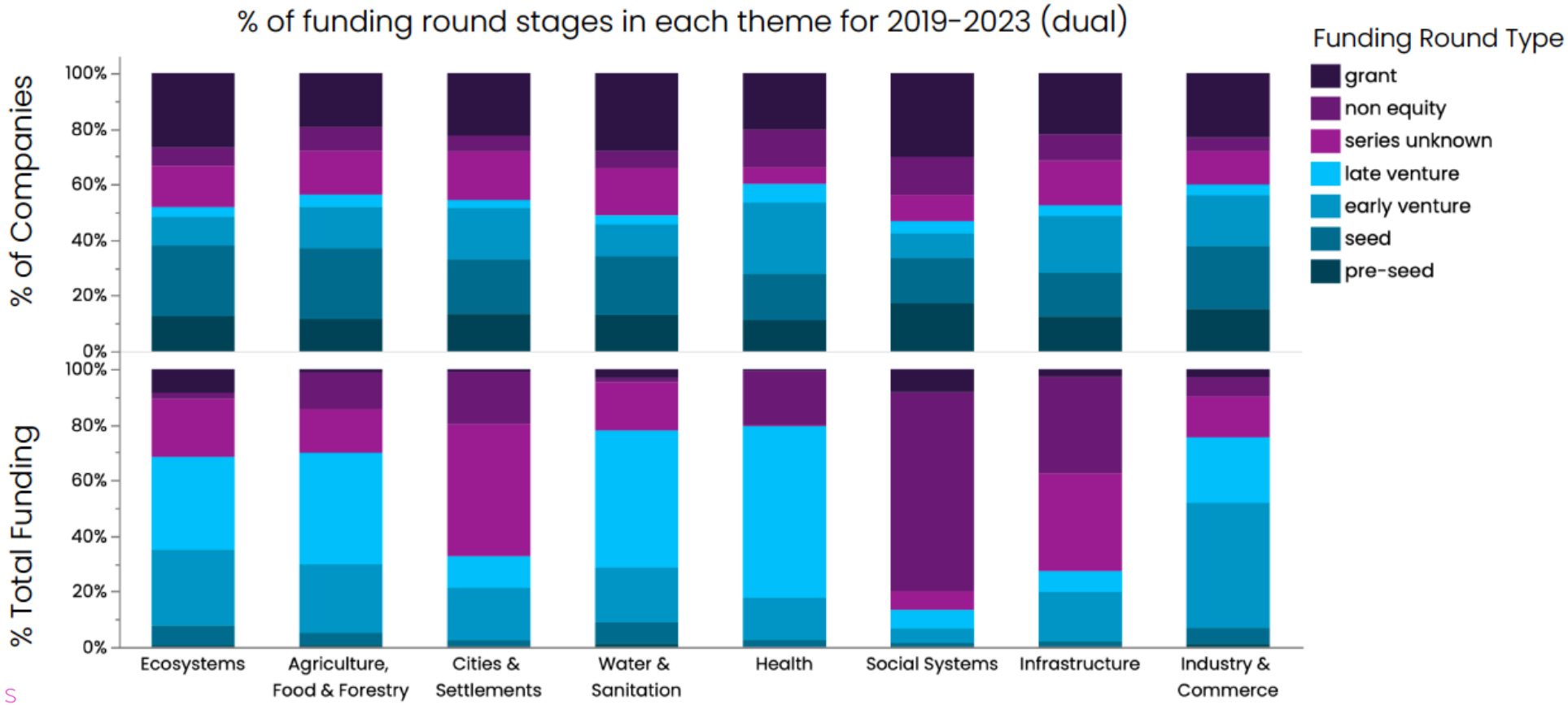
Capital Stack: Dual A&R Startups

Tailwind

Dual A&R startups also suffer from a chronic funding gap.

Dual benefit startups see slightly more late venture funding in Water, Health, and Agriculture but seed funding is equally lacking across the board. Other trends include:

- Insufficient grant funding for every area but Ecosystems and Social Systems
- Insufficient early-stage venture capital available for Social Systems and Cities and Settlements
- Insufficient late-stage venture capital available for Cities & Settlements, Social Systems, and Infrastructure



VIBRANT DATA LABS

Capital Stack: Top Pure Play A&R Investors

Tailwind

Specialized A&R VC funds are emerging with a focus on climate hazards (fire tech, water tech).

We reviewed the top investors and funders by number of pure play adaptation deals and found the following results:

Average median check sizes in this sample were USD4 M for private investors and USD319 K for public investors. The top 10 private investors have 21% pure play deals in their portfolios while public investors have 29%.

Top 10 Private Funders	Top 10 Public Funders
Convective Capital	National Science Foundation
Alumni Ventures	Department of Energy
Echo River Capital	Department of Agriculture
Mazarine Ventures	U.S. Environmental Protection Agency
MassVentures	NOAA
Gaingels	US Department of Commerce
Urban X	Maine Technology Institute
Sand Hill Angels	California Department of Food and Agriculture
Third Sphere	Small Business Innovation Research (SBIR)
Lowercarbon Capital	Massachusetts Clean Energy Center

Standouts

Over the last five years, several boutique firms focused on adaptation have emerged. The following two represent the firms with the highest % of adaptation deals (relative to portfolio size) in our study.

1. **Convective Capital**: Founded by Bill Clerico in 2022, Convective is a venture firm focused on investing in firetech with portfolio companies including Pano and Overstory.

2. **Mazarine Ventures**: Launched in 2018, Mazarine Ventures is focused on investing in early-stage technology companies with innovations that address risks relating to water and/or wastewater. Portfolio companies include Flume Water and WaterClick.

Capital Stack: Top Dual A&R Investors

Tailwind

Many climate tech funds are 'accidental' A&R investors, who hold portfolios with A&R benefits even if they are not explicitly a part of their investment theses.

We reviewed the top investors and funders by number of dual benefit A&R deals and found the following results: Average median check sizes in this sample were USD12 M for private investors and USD652 K for public investors. The top 10 private investors have 32% dual deals in their portfolios while public investors have 51%.

Top 10 Private	Top 10 Public Funders
SVG Ventures	National Science Foundation
Breakthrough Energy Ventures	Department of Energy
S2G Ventures	Department of Agriculture
Alumni Ventures	Maine Technology Institute
Cavallo Ventures	Massachusetts Clean Energy Center
Innova Memphis	California Department of Food and Agriculture
IndieBio	ARPA-E
Prelude Ventures	California Energy Commission
Lowercarbon Capital	Iowa Economic Development Authority
Fall Line Capital	New Jersey Economic Development Authority

Standouts

We found the standout private investors in this category with the highest % of dual deals in their portfolios were overwhelmingly focused on agriculture within their funds. Three of the top five were affiliated with a corporation.

SVG Ventures
- AUM: USD50 M - USD75 M
- Number of Investments: 215
- Portfolio focus: Agtech
- Strategic Investor?: Yes (Kagome Co. Ltd.)

Cavallo Ventures
- AUM: Unknown
- Number of Investments: 53
- Portfolio focus: Agtech
- Strategic Investor?: Yes (Wilbur—Ellis, Inc.)

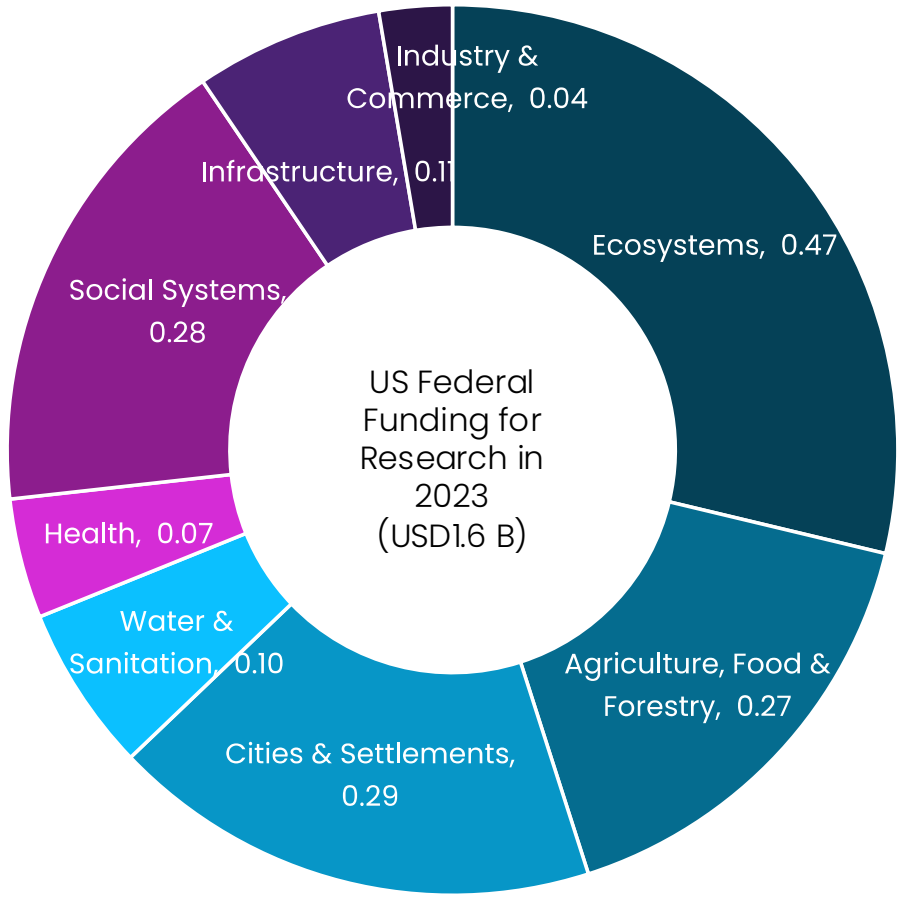
S2G Ventures
- AUM: USD2 B+
- Number of Investments: 167
- Portfolio focus: Agtech
- Strategic investor?: No, but linked to the Walton Family / Walmart

Capital Stack: US Federal R&D Funding

Tailwind

US Federal funding for research totals USD1.6 B in 2023, often as part of larger programs like the IRA or CHIPS acts.

- Our analysis of US Federal research programs that mention resilience shows a tot of USD1.6 B worth of A&R research in 2023.
- Key funders include:
  - Department of Interior (DOI): USD560 M
  - National Oceanographic and Atmospheric Agency (NOAA): USD390 M
  - National Science Foundation (NSF): USD167 M
  - Department of Homeland Security (DHS): USD157 M
  - US Department of Agriculture (USDA): USD148 M
  - Department of Human Health Services (DHHS) via ARPA-H: USD75 M
  - Environmental Protection Agency (EPA): USD53.4 M
  - Department of Defense (DOD): USD23 M
- US federal funding is often included as part of broad policies and programs that may not be obviously A&R-focused. For example, the CHIPS and Science Act, though focused on semiconductor manufacturing industry resilience, sets aside billions of dollars to fund research on climate mitigation and adaptation.
- Key, recent non-monetary federal initiatives include the White House Climate Resilience Framework, Climate Resilience Game Changers Assessment, the PREPA Call to Action, and Executive Order 14008.
- Grants focused on small businesses (SBIR), which are a very popular source of non-dilutive funding for startups, totaled USD80 M. More than half came from the NSF, with DOE, USDA, DHS, EPA contributing the remaining amount.



Source: Tailwind Analysis

Building Up the A&R Capital Stack

Tailwind

Public and private funders need to work in lockstep to increase funding across the capital stack.

To scale A&R companies, **we need more capital at every stage of startup funding, but especially at the pre-seed and seed stages**. Making sure sufficient pre-seed and seed stage funding exists will enable us to catalyze companies into subsequent venture stages. In the chart below we outline which funders we believe have a primary responsibility to fund at a given stage and which funders can help advise those funders.

Funder Type	Research & Development	Pre-Seed	Seed	Early Venture	Late Venture
Government	**Funding role** – Government is the largest funder of R&D and must continue to ramp up directed A&R R&D funding.	**Funding role** – Non-dilutive government grants are essential to A&R companies' growth. Public money for accelerators and incubators is essential.	**Consultative role** – Public funders have unique insights into what needs funding that can inform use of other types of capital and ensure long-term impact. The public sector is often also a buyer of A&R solutions, meaning they will fund projects as they exit the late venture stage. This makes private sector collaboration with government essential, as technologies scale.		
Philanthropic	**Consultative role** – Philanthropic funders have unique insights into what needs funding that can be used to inform use of public funds.	**Funding role** – Philanthropic funders can provide non-dilutive grants to catalyze companies and incubator or accelerator programs.	**Funding role** - Philanthropic capital has a critical role to play in the creation of impact and market rate funds investing in A&R.		
Private Investment	**Consultative role** – Private investors (especially those who may be eventual buyers) can advise R&D spending to maximize the venture's success.	**Consultative role** – Private investors can support public and philanthropic investors by providing insight into where private capital will and won't fund startups and programs.	**Funding role** – Private investors have the right resources and mandate to cover all venture phases of the capital stack.		

INNOVATION ROADMAP

Innovation Roadmap: Bright Spots

Tailwind

Sectors with proven demand and high investment levels provide the best opportunities for venture capitalists ready to write larger checks.

We see a few areas where innovation is maturing the **most rapidly** to meet demand.

Water Infrastructure: Solutions enabling efficient water sourcing, distribution, and utilization, and which enable resilient sanitation infrastructure.

Agriculture, Forestry & Food: Solutions driving the resilience of crop production, livestock production, forest products, and food systems.

Infrastructure (Electric): Solutions enabling grid resilience and reliability, as well as solutions enabling power reliability.

Information Technology: Climate risk analytics startups have seen a series of acquisitions, most recently Fathom's acquisition by Swiss Re.

Cities & Settlements: Solutions enabling building cooling and thermal efficiency (HVAC, building equipment like windows, thermal insulation).

Note: Some areas identified as bright spots are very broad, and while bright spots exist within them, additional innovation is needed. See the 'Hidden Gems' and 'Blind Spots' slides for more.

What is needed?
We need continued technological and cost improvement in these areas as well as **more capital providers funding these solutions at the early and late venture stages**.

What makes a Bright Spot?

Dimension	Rating
Demand	High
# Active Startups	High
$ VC Invested	High
# Acquisitions / Exits	High

Noteworthy Deals

- **A&R Unicorns:**
  - Planet Labs USD2.8 B IPO
  - Bear Robotics USD250 M acquisition by John Deere
- **Large Rounds**
  - Aquaria, an air water capture company, raised USD112 M mixed equity and debt in November 2024
  - Climate X, a climate risk analytics company, raised USD18 M in Series A in July 2024
  - Arable, a digital crop intelligence platform for enhanced productivity, raised USD40 M in Series C

Innovation Roadmap: Hidden Gems

Tailwind

Sectors with strong demand but limited access to capital and stunted innovation ecosystems require pre-seed / seed capital and more ecosystem support.

We see a few areas where innovation activity is **maturing, but not fast enough** to meet mounting demand.

Cities & Settlements: Flood tech solutions for buildings, coastal resilience solutions, and other building hardening solutions against hurricanes, wildfires, etc. in the residential and commercial real estate sectors.

Infrastructure (Transportation): Solutions that can enable the resilience of ground, maritime, and air transportation assets and systems.

Industry & Commerce: Insurtech solutions for all sectors. Earth observation and sensor data for early warning systems.

Agriculture, Forestry & Food: Solutions that improve soil and microenvironmental health.

Ecosystems: Solutions for wildfire prevention, detection and suppression. Solutions that can protect terrestrial ecosystems from wildfire.

What is needed?
We need **continued research funding** for these areas and **more capital providers funding these solutions from the pre-seed to late venture stages**. We also need **accelerators** to bridge companies from inception to revenue.

What makes a Hidden Gem?

Dimension	Rating
Demand	High
# Active Startups	Med
$ VC Invested	Low
# Acquisitions / Exits	Low

Noteworthy Deals

- **Deals**
  - Rain, aerial fire fighting tech, raised a USD9.7 M seed in September 2023
  - Floodbase, satellite data for floods, raised a USD12 M series A in January 2023
- **Examples**
  - Hohonu, low-cost flood sensors for flood prediction and management
  - FutureProof, AI based insurtech firm
  - ThermoShade, passive cooling shade panels for urban and industrial uses

Innovation Roadmap: Blind Spots

Tailwind

Sectors where expected climate impacts have not yet translated as budget or a strong demand signal. Innovation is driven by the fundamental need but lacks funding.

We see a few areas where innovation activity **lags behind** expected demand.

Health:

- Solutions to predict and treat respiratory, cardiovascular, and other negative health related outcomes to heat, fire, and other climate hazards
- Solutions to predict, alert, track and treat disease transmission of vector and waterborne illnesses
- Solutions for body cooling (such as wearables and cool patches)

Social Systems:

- Early warning systems and solutions for post-disaster recovery
- Temporary shelters and pre-fabricated / resilient housing
- Services for migrants, immigrants, residents being resettled
- Resilient green jobs

Ecosystems: Restoration and preservation – for its intrinsic value but also for tourism and risk reduction.

Water Infrastructure: Solutions to enable air water capture and water access in areas of drought.

What is needed?
We need catalytic capital from governments and philanthropy alongside creative investment vehicles that can bridge companies to revenues. We also need substantial **public funding for research and development.**

What makes a Blind Spot?

Dimension	Rating
Demand	High but Latent
# Active Startups	Low
$ VC Invested	Low
# Acquisitions / Exits	Low

Noteworthy Examples

- Cryogenx – Core body cooling medical device to treat heat stroke and heat illnesses
- Eztia Health – Novel cooling patches and garments for workers
- Azul Bio, Probiotics for coral reef restoration
- TinyBox – Low cost, efficient, fireproof tiny houses for housing and post disaster recovery

Innovation Roadmap: Landscape

Tailwind

We need to scale up existing technology and develop new solutions to make sure society has the innovative tools it needs to face the climate impacts already here and the ones headed our way. Tailwind's Innovation Roadmap highlights key technologies across 8 adaptation themes where we feel innovation is needed.

Stage	Ecosystems	Agriculture, Food & Forestry	Infrastructure	Water & Sanitation	Health	Cities & Settlements	Social Systems	Industry & Commerce
Mature Solution(s) available; further scale needed.	Drones for Tree Planting and Reforestation, Dikes and Seawalls	Cold Chain Solutions, Water Efficient Irrigation Solutions	Advanced Energy Storage Solutions, Coastal Erosion Solutions	Smart Water Meters, Water Recycling and Reuse Systems	Rapid Diagnostic Tests, Efficient Air Conditioning	Removable Flood Defenses, Shade Structures	Community Integrated Microgrids, Backup Power Systems, Temporary Shelters	Remote Sensing and Satellite Imagery, AR/VR Planning Tools
Growing Some solutions available; still requires further development and support.	Bio and Artificial Materials for Coral Reef Restoration, Sediment and Nutrient Management Technologies	Wildfire Early Warning Systems, Solutions for Herd Health Immunity	Physical Grid Hardening Solutions, AI-Enabled Grid Management Tools, Cool Pavements, Grid-Integrated Charging	Air Water Capture Technology, Stormwater Management Materials, Efficient Irrigation Solutions	Early Warning Systems for Vector-Borne Illnesses, AI Driven Drug and Vaccine Discovery	Low-cost Modular Housing Solutions, Climate Risk Prediction Tools	Early Warning Systems, Misinformation / Disinformation Management Tools	Air Quality Monitoring Systems, Drone Monitoring Systems
Early Stage Few solutions exist; significant innovation and funding required.	AI/ML powered Storm Prediction Models, Smart Sensors for Real-Time River Flow Analysis, Detection and Prevention Solutions for invasive Species	Drought-Resistant Crops, Breeding of Climate Resilient Livestock Species, Precision and Regenerative Agriculture, Advanced Agricultural Biotechnologies	Advanced Weather Monitoring and Prediction Tools, Reconductoring Solutions	Advanced Desalination and Water Recycling, Hydrological Forecasting Systems, Drought Management Solutions	Wearable Cooling Devices, Advanced Air Filtration Solutions, Climate Integrated Health Records, Vaccines for New Diseases	Fire Resilient Building Materials, High Albedo Materials, Low Cost (Multi-Hazard) Retrofit Solutions	Advanced Fire Suppression Systems, Biometric Identification Systems	Synthetic Precious Metals, Parametric Insurance, Innovative Risk Transfer Solutions for Insurance

Source: The Lightsmith Group, CPI, Oxford, Tailwind, The White House

RECOMMENDATIONS

The Path Forward

Tailwind

To have the solutions needed to adapt to climate change, we need to dedicate time, talent, and resources towards the right challenges.

- Our research indicates that entrepreneurs, funders, corporations, and policymakers can come together to address capital and innovation gaps in this space if there is adequate awareness and communication about what investments, technologies, programs, and policies are needed.
- The following slides outline our recommendations to these stakeholders, recognizing that priorities will change as this field continues to rapidly grow.
- We also highlight 'Enablers of Change', key issues and areas where additional tools, guidance, standards or research will help the market direct its dollars in the most effective and impactful way.
- These recommendations represent Tailwind's perspective on how time and resources can be best spent to enable a resilient society and economy through innovation.

Enablers of Change

Avoiding Maladaptation

Impact Metrics

Community Engagement

Recommendations

Funders

Entrepreneurs

Corporations

Policymakers

Enablers of Change: Preventing Maladaptation

Tailwind

Raising awareness of and addressing maladaptation risks unlocks successful adaptation.

Maladaptation refers to actions that unintentionally increase vulnerability to climate change and make a system more susceptible to climate-related risks.

Overview

- Maladaptation unintentionally creates harm, but often results from intentional adaptation policy and planning decisions.
- It does not necessarily occur in the geographic space or within the targeted group; it can extend social/geographic boundaries.
- Adaptation actions taken today can be maladaptive in the future.
- Maladaptation disproportionately harms marginalized groups (ex. low-income households, Black and Indigenous communities).
- Maladaptation risks are highly specific to the use-case, depending on socio-cultural factors, geography, unique ecosystem needs, etc.

Maladaptation
Towards more vulnerable, inequitable adaptation that increases risk for humans and ecosystems, has mitigation trade-offs

Successful Adaptation
Towards equitable and effective adaptation with human, ecosystem and mitigation co-benefits

Sources: Adapt Now: A Global Call for Leadership on Climate Resilience (Global Commission on Adaptation), IPCC AR5 Report , IPCC 2014 Chapter 14

Types of Maladaptation

- Increased or shifted vulnerability to climate change impacts
- Increased or new socially inequitable outcomes, especially for disadvantaged communities
- Increased climate-related impacts on ecosystems and ecosystem services
- Causes additional greenhouse gas emissions

"Without careful planning, adaptation investments could lead to widespread maladaptation, resulting in billions of dollars wasted, increased vulnerability for many communities, and unintended environmental harm. The scale of future adaptation needs is immense, and poorly designed interventions could exacerbate risks rather than reduce them." - Global Commission on Adaptation

Enablers of Change: Community Engagement

Tailwind

Solutions providers and funders must embed community engagement into the planning, deployment, and monitoring of effective adaptation solutions.

Community Engagement is a critical part of the planning, deployment, and monitoring of effective adaptation solutions. Equitable partnerships with local stakeholders help ensure that adaptation solutions serve the needs of communities most vulnerable to climate impacts, improve project design by integrating local knowledge, and increase the likelihood for successful adaptation outcomes in the short-and long-term.

Current State of Community Engagement

There is a pressing, recognized need for adaptation solutions, which are highly-localized, to be participatory, context-specific, and transparent for impacted stakeholders. Current best-practices for community engagement move beyond simply informing and consulting with local stakeholders to be equitably collaborate and give decision-making authority to impacted communities. *See the below visual of MSC and Facilitating Power's framework for community engagement.*

"Traditionally, local actors are often involved in adaptation solutions as the customers or recipients but rarely in decision-making, including about how funding is allocated or leadership roles throughout project life cycles" (WRI).

Frameworks & Best-Practices:

- World Resource Institute's Locally-Led Adaptation Program
- Greenlining Institute's Guidebook: Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs
- Climate Smart Communities' Inclusive Community Engagement Primer
- California Air Resources Board's Best Practices for Community Engagement

Sources: World Resources Institute (WRI), Global Center on Adaptation (GCA), Facilitating Power, Movement Strategy Center (MSC)

Enablers of Change: Measuring Impact

Tailwind

Selecting effective A&R metrics depends on the A&R purpose, sector, and scale of its application

"Start with the purpose, not the metrics… The choice of metrics depends on the purpose and requires careful consideration of what one intends to measure or achieve, the types of decisions the metric will be used for (e.g., allocation of funding versus learning), its meaningfulness to its audience, and the scale at which it will be communicated." – UNEP-CCC

International Adaptation Frameworks:

Various frameworks exist to measure adaptation impact. None of these frameworks are dedicated to private investors but all offer insights into measuring project-level impact.

- **World Bank:** MDB Common Approach to Measuring Climate Results
- **UNEP FI:** Adaptation & Resilience Impact: A Measurement Framework for Investors (ARIC)
- **GIZ:** Adaptation Monitoring and Evaluation Toolbox
- **Climate Investment Fund:** PPCR Monitoring and Reporting Toolkit
- **IIED:** Tracking Adaptation and Measuring Development (TAMD) framework
- **GIIN:** Climate Adaptation & Resilience Metrics

Cross-Theme Measurement Approaches: Examples

Climate Value at Risk (CVaR)

- Measures climate-related financial impacts at an asset-level. No single method exists to measure CVaR, but popular calculation tools exist from MSCI and WTW to do so. *Note: There is no clear and universal consensus on how to calculate this metric and no economic metric alone can be used to calculate adaptation impact.*

Adaptive Capacity

- Is the potential or ability of a system, region, or community to adapt to the effects or impacts of climate change. Adaptive capacity is an important measurement of impact. *Note: At present there are various methods to measure it., such as WRI's NAC framework and ACCRA's LAC framework.*

Theme / Project-Specific: Examples

- **Social Systems:** Number of people reached through early warning systems (GIIN)
- **Health:** Climate-related mortality and morbidity rates (UNEP)
- **Infrastructure:** Number of businesses using climate-resilient infrastructure provided through the investment (UNEP)
- **Water Infrastructure:** Number of people adopting water efficient equipment or practices due to the investment (UNEP)
- **Agriculture, Food & Forestry:** Number of livestock brought under sustainable management practices (GIIN)

Sources: UNEP-CCC, GIIN, UNEP FI

Recommendations: For Funders

Tailwind

We need visionary funders to step up and ensure that the programs and funding exist to make the necessary adaptation innovation and impact possible.

The data is clear, we need more capital going into adaptation and resilience companies, especially the ones translating research into businesses and building products at the earliest stages. Our 'Building up the A&R Capital Stack' slide lays it out, but here is the summary of what we think different funders can do to grow this space.

All Funders

- We need more sector-focused **accelerators and incubators**. These programs de-risk capital by making it more likely that companies succeed and make it to their next funding source. Funders can come together across capital types to support these programs.
- We also need better **tools for measuring the impact** of solutions in this space, establishing **clear metrics frameworks** for the private sector, and making sure they **prevent maladaptation** outcomes.

Recommendations to Funders by Capital Gap:

Capital Gap	Necessary interventions
#1: Pre-Seed to Seed	We need **philanthropy** and **government** to provide grants and concessionary capital vehicles to pre-seed and seed stage companies.
#2: Early Venture to Late Venture	We need **private investors** to a) increase ambition in this space, and b) increase capital allocation to adaptation companies.

Recommendations: For Entrepreneurs

Tailwind

We need visionary founders to step up and ensure that adaptation companies are created to help humanity become resilient to climate change.

New companies are needed to make communities and the economy resilient to climate hazards. Here is what we need from the people who will build those companies:

1. **Focus on Hidden Gems and Blind Spots** – In this report we outline where there is high and mounting customer demand but not enough innovation and company creation happening. We encourage entrepreneurs to look at these places carefully and apply energy accordingly. For example:

Bright Spots = Places to improve on existing tech (medium need)	**Hidden Gems** = Places to create and scale new businesses (medium need)	**Blind Spots** = Places to create and scale new businesses (high need)
Ex. Improving upon existing indoor cooling technologies	Ex. Creating solutions that make ground transport resilient	Ex. Creating new solutions for post-disaster recovery

2. **Get Creative with Capital and Business Models** – As more money comes into this space to fill capital gaps, we encourage entrepreneurs to engage a broad coalition of capital partners and channel partners to fund product development and bridge the gap to customers. Look at what successful companies in this space are doing, then build your own path to market.

3. **Get the Right Help** – Whether its lining up customer discovery interviews with experts in a field unfamiliar to you or bringing in a policy expert to help understand sales to governments, we encourage founders to seek insight from those closest to the problem you're trying to solve. This includes engaging communities to make sure what you are building for people will be effective and accessible to them.

Recommendations: For Corporations

Tailwind

Corporations need to invest in risk reduction solutions for themselves and the communities where they operate.

Corporations hold massive risk related to climate change that threatens to upend business as usual in many industries. We think about opportunities for corporations in two major buckets: 1) What are you doing to **protect your business** from climate hazards? 2) What are you doing to **remain competitive** in a world that needs adaptation and resilience products and services? Here is our advice on these 2 fronts:

<table>
<tr><th>Protect Your Business</th><th>Remain Competitive</th></tr>
<tr><td>Make sure you have a climate adaptation and resilience plan within your business informed by a quantitative risk assessment, estimates of costs, and risk mitigation measures.</td><td>Join the 827 publicly traded companies developing their own adaptation products for their customers. Leverage internal innovation resources to make this happen.</td></tr>
<tr><td rowspan="2">Invest in physical risk reduction solutions and enhanced insurance coverage for your assets and operations, as well as for your workforce, local infrastructure and your broader value chain.</td><td>Engage in external innovation to find adaptation technology providers who can work with you to build new solutions and improve your existing technology offerings.</td></tr>
<tr><td>Invest in adaptation solutions relevant to your industry so you can take advantage of this growing market while growing the success of strategic investment activities.</td></tr>
</table>

Recommendations: For Policymakers (1/2)

Tailwind

We need the public sector to step in and provide funding that can start and scale climate adaptation solutions to protect both communities and the economy.

Regulation

We need robust policies and plans to enshrine resilience and adaptation goals into law. This is the most direct way to ensure the protection of communities and the economy and to ensure that climate adaptation innovation will be funded by the public sector. Here are a few examples of policies we'd like to see at each level of government that could stimulate the climate adaptation innovation ecosystem.

- **Global:** We need a 'First Movers Coalition' type initiative for adaptation and resilience to bring the private sector together to fund A&R innovation.
- **Federal:** We need a National Adaptation Plan and a whole-of-government approach to tackling climate hazards.
- **State:** We need all states to have robust adaptation and resilience plans and plans for individual hazards where needed (such as heat, fire, flooding, etc.).
- **City:** We need cities to pass local policies that ensure adaptation and resilience action and funding.

Standards and Definitions

We need governments to work with and guide the private sector by defining standards for what good adaptation solutions should look like and how they should be evaluated:

- **Definitions:** We need standard definitions and taxonomies for climate resilience and adaptation solutions integrated into policies and funding programs.
- **Metrics:** We need funding and consensus building on metrics and measurement approaches to evaluate solutions' impacts.
- **Climate Risk Standards:** We need best practices and standards for climate risk assessment and modeling.
- **Maladaptation Guidance:** We need requirements in public programs that ensure adaptation projects are designed and executed in a way that minimizes maladaptive impacts.
- **Insights into Community Needs:** We need publicly available data that gives insights into which communities are most acutely impacted by climate hazards. We also need clear community engagement standards for government contractors.

Recommendations: For Policymakers (2/2)

Tailwind

We need the public sector to step in and provide funding that can start and scale climate adaptation solutions to protect both communities and the economy.

Publicly-Funded Research and Innovation Funding Programs

National, State, and City governments all play a role in funding innovation. The following types of publicly-funded resilience innovation programs are sorely needed in most places. These programs include:

(1) **Research Grants**: Funding university research that stimulates more innovative A&R solutions that can become companies.

(2) **Entrepreneurial Fellowships:** Funding programs that help researchers found companies and translate science out of the lab

(3) **Accelerators and Incubators:** Funding innovation programs that help researchers translate research into new A&R companies and validate potential product designs, value propositions, and business models.

(4) **Company Grants and Investments:** Funding pre-seed and seed-stage companies with both grant-based and investment-based funding vehicles. Funding venture stage and project stage companies through green banks and other economic development programs.

(5) **Piloting Programs and Demonstration Sites**: Funding programs and sites that allow A&R companies to test their solutions in the real world and collect data on their performance.

Example Public Sector Innovation Programs

The following publicly-funded climate innovation programs are examples of programs that, while currently mitigation-focused, could be effective at scaling adaptation solutions.

Funder	Program(s)
MassCEC	Catalyst, AmplifyMass, IncubateMass
ARPA-E	SCALEUP Program
US Navy	Elemental Impact Accelerator
US DOE	Activate Fellowship

APPENDIX

METHODS

Demand Methods & Data Limitations

Tailwind

We conducted the following research to assess corporate, consumer and government funding for adaptation. We acknowledge our findings are incomplete and support calls for better research, tracking and disclosures of adaptation spend globally in the public and private sector.

Government

- We did a global survey of national adaptation plans and planning processes as reported by UNEP
- We surveyed select developed economies and emerging economies, reviewing their adaptation plans and looking at their allocated resilience and adaptation budgets
- We reviewed literature related to developing economies and reviewed major publications by DFIs and MDBs
- We conducted desktop research of US federal and subnational resilience policies and programs
- We spoke to experts from the federal government and from the DoD about existing programs

We assigned budget to our Taxonomy sectors based available information about stated priorities (e.g. flood management) and expert judgement.

Consumers

- We leveraged data provided by the Climate Policy Initiative, who conducted an extensive review of consumer products likely to be used for adaptation. We benchmarked these estimates against other estimates of consumer spend based on consumer surveys in the US and globally.

Corporations

- We conducted a desktop review of 80 total corporations and analyzed the CDP reports of 75 of these corporations.
- We conducted 12 interviews with corporations from across industries to better understand their existing climate risks and resilience plans
    - Note: Some of these interviews were conducted in partnership with C2ES, who is a partner on this Playbook
- We conducted an extensive literature review on corporate climate risk and resilience planning

Supply Methods & Data Limitations

Tailwind

Tailwind partnered with Vibrant Data Labs to train a large language model (LLM) to identify A&R startups in Crunchbase and map them to the Tailwind Taxonomy (published in May 2024). This effort allowed us to develop the first detailed analysis of investment trends and bright spots for A&R in the startup ecosystem by sector and funding stage over time. We also used this data to identify investors most active in A&R (see Capital Stack section).

The analysis looked at companies that received funding in 2019-2023, including equity and non-equity financing, which includes debt and/or grants. We filtered for companies marked 'active' (still in business as of today). Crunchbase data includes US companies only.

We trained the model to identify 'climate tech' companies and to tag them as mitigation, dual, or adaptation. In reality, however, we think of these categories as a continuum rather than discrete categories. Analysts may draw the line differently as to what counts as 'dual' vs. pure play adaptation or mitigation. For example: tech innovation in agriculture and food systems are generally good at reducing emissions and addressing impacts of climate change, but individual companies may lean more towards one or the other use case. Similarly, many innovations in energy efficiency, energy storage, microgrids and grid resilience receive funding because of their GHG reduction impacts, but they are also very valuable from an A&R standpoint. We erred on the side of being a little more inclusive of dual benefit companies, and therefore acknowledge that many companies captured in our dataset are not explicitly focused on A&R, even if their activities have A&R features or positive A&R impacts.

Data limitations and uncertainties:

- The source data we used may have inaccuracies. We noticed and removed a number of non-profit organizations and government agencies (e.g. regional water districts) that were included in the source dataset, but some may have escaped our QA process.
- Some private market companies in the database are not VC-backed startups but rather consulting or engineering firms. Because startups can also be service providers, or service providers can become providers of technology-based solutions, we did not attempt to remove those from the data.

Methodology from Vibrant Data Labs

Tailwind

A multi-step process was developed to identify and categorize companies working on climate change adaptation. An intentionally broad Crunchbase search used nearly 800 climate-related terms to minimize false negatives, despite yielding many false positives.

A fine-tuned GPT-4o-mini model (OpenAI) filtered out irrelevant entities, creating a "climate-relevant" set. A fine-tuned ClimateBERT model then classified these companies based on their focus on adaptation, mitigation, or dual-purpose work. For adaptation-relevant companies, a taxonomy mapping technique categorized their activities within Tailwind's climate adaptation taxonomy by calculating cosine similarity between embedding representations of company descriptions and taxonomy categories.

OpenAI's GPT-4 model reviewed the resulting best matches using a few-shot approach. Finally, manual reviews identified errors and informed iterative updates to taxonomy categories and descriptions. This iterative tagging process allows for continual improvements and accommodates emerging insights in climate adaptation.

For more information, please contact info@vibrantdatalabs.org.

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Building a Resilient Future

Emilie Mazzacurati
+1.415.420.0074
emilie@tailwindclimate.com

Katie MacDonald
+1.339.927.1543
katie@tailwindclimate.com

www.tailwindclimate.com
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