Physical Climate Risk Assessment and Management

An investor playbook

October 2024

Prepared by:

Adaptation & Resilience Investors Collaborative

UN environment programme | finance initiative

Acknowledgments

Adaptation & Resilience Investors Collaborative

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British International Investment

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FinDev Canada

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FMO Entrepreneurial Development Bank

NDF Nordic Development Fund

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PLAYBOOK INTRODUCTION

This playbook gives investors a simplified step-by-step approach to integrating the identification, assessment and management of physical climate risks in the investment process. It focuses on how to assess physical climate risks and identify adaptation and resilience (A&R) opportunities in the context of corporate finance. The playbook is product agnostic, and can be applied to the provision of capital across both equity and debt instruments.

It should also be noted that investors should evaluate climate risks in their entirety, including transition risks, to ensure the investment has a positive climate impact overall. The coverage of climate-related risks is limited to physical climate risk in this guidance, given the geographical scope of ARIC members on more climate vulnerable countries and on vulnerable sectors such as agriculture.

It addresses three key questions:

- **What is physical climate risk?**
- **Why should investors assess and manage physical climate risks?**
- **How can physical climate risks be assessed and managed throughout the investment process?**

This playbook is a foundational step for investors engaging on adaptation and resilience, supporting further opportunity identification and impact realisation. Investors may refer to wider publications including the Climate Investment Playbook and the Adaptation & Resilience Impact: A measurement framework for investors report to understand cross-sector adaptation and resilience opportunities, and associated impact metrics for individual investments or aggregated portfolios.

1. AN INTRODUCTION TO PHYSICAL CLIMATE RISK

PHYSICAL CLIMATE RISK REFERS TO THE FINANCIAL RISKS (AND LOSSES) THAT CAN ARISE FROM THE ADVERSE EFFECTS OF CURRENT OR FUTURE CLIMATE CONDITIONS

Drivers of physical climate risks and opportunities

- Temperature variability
- Precipitation variability
- Flood
- Wildfire
- Drought
- Sea-level rise
- Water stress
- Extreme rainfall
- Extreme heat
- Cyclones (hurricanes and typhoons)

While these hazards are already drivers of risks to businesses, climate change will amplify their intensity and variability. Investors should employ scenario analysis to assess how these hazards will change under the influence of different climate scenarios. Additional resources in the Annex can give investors a more comprehensive understanding of physical climate risk drivers.

Examples of climate-driven impacts across sectors

Agriculture	▪ Decline in yields quality and/or quantity ▪ Crop loss ▪ Increased pest and disease occurrence	▪ Post-harvest loss increases ▪ Decreased livestock productivity	
Real Estate	▪ Devaluation of assets ▪ Increased operating costs due to higher energy demand for cooling	▪ Increased property damage/loss ▪ Higher temperatures reducing worker and machine productivity	
Manufacturing	▪ Inadequate water availability ▪ Increased energy costs for cooling ▪ Flood-induced damages	▪ Infrastructure damages ▪ Supply chain disruption	

THE PHYSICAL CLIMATE RISK EQUATION PROVIDES THE FRAMEWORK TO ASSESS PHYSICAL CLIMATE RISKS

The physical climate risk to a counterparty is a function of its dynamic exposure and vulnerability to climate-related hazards, either individual hazards or a combination of hazards. The 'physical climate risk equation' provides a consistent and complete framework to assess physical climate risk for investors.

Physical Climate Risk $= f($ **Climate hazards** $*$ **Exposure** $*$ **Vulnerability** $)$

Physical Climate Risk

Financial risks and losses that can arise from the adverse effects of current or future climate conditions.

Climate hazards

Potential occurrence of a climate-related event or trend that may cause damage and loss to physical assets, interruptions to counterparty operations and service provision (e.g., flood, drought) or affect worker productivity.

Exposure

Exposure is dependent on the geographic location of a counterparty's assets and value chain (upstream and downstream). It also encompasses the financial value of a counterparty's assets.

Vulnerability

Sensitivity

Predisposition of a counterparty to be adversely affected by climate hazard(s), which depends on the characteristics of its business activities and business model.

Adaptive Capacity

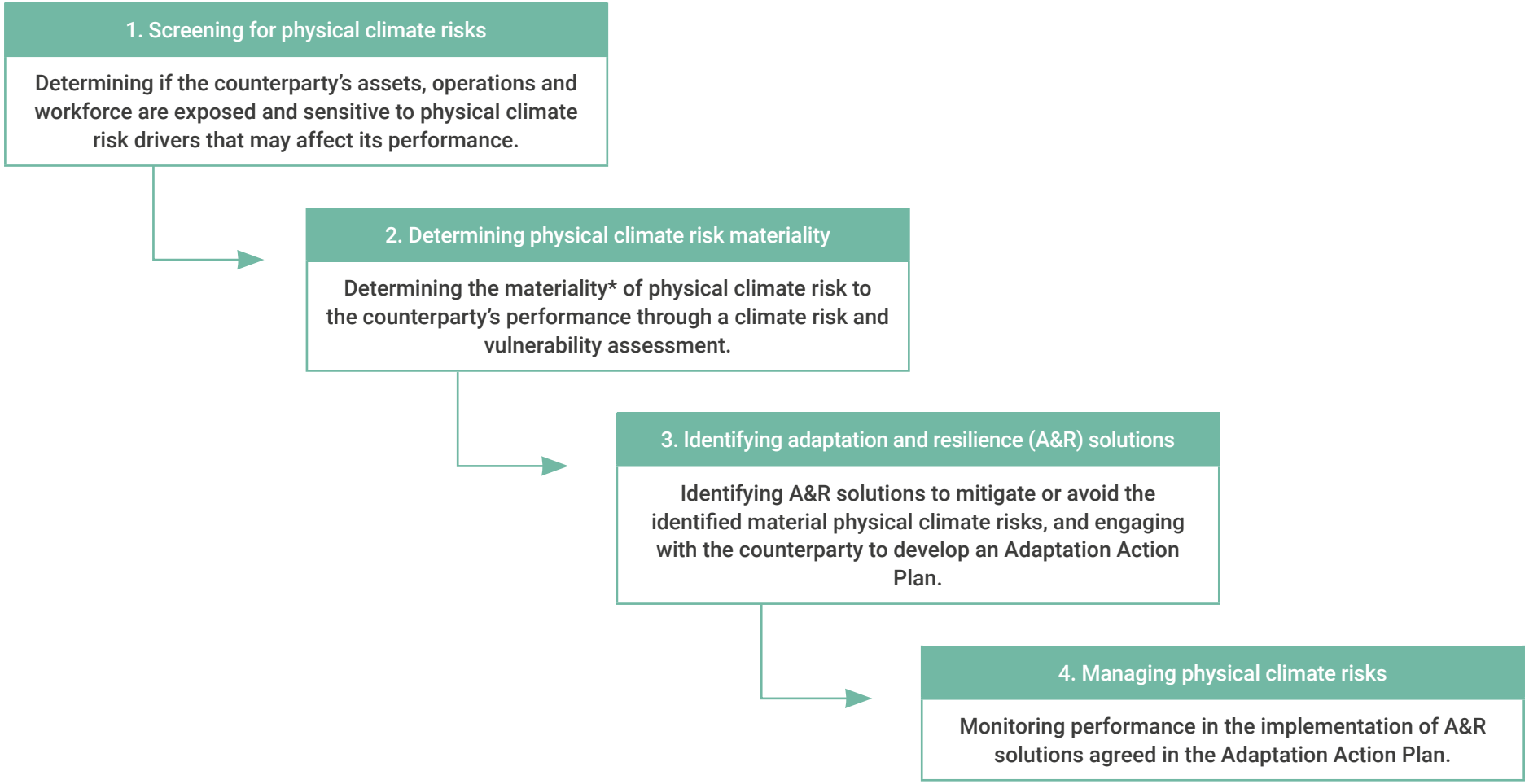
Ability of a counterparty to prevent, respond to and recover from climate hazard(s).

Evaluated through physical climate risk tools

Evaluated through direct engagement with a counterparty

Source: re-elaboration of the determinants of physical climate risks from the IPCC Fifth Assessment Report and its evolved version in the IPCC Sixth Assessment Report.

A STEPWISE APPROACH TO INTEGRATE PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT IN THE INVESTMENT PROCESS



*Materiality is defined as any climate hazard that may impact counterparty operations and financial performance.

PHYSICAL CLIMATE RISK PATHWAYS FOR INVESTORS AND THEIR COUNTERPARTIES

Understanding how physical climate risk drivers can impact a counterparty enables investors to evaluate and manage the potential financial and development impact implications and identify A&R opportunities.

Impact channels & pathways		
Direct	Counter-party's assets/ operations	The financial risks and associated impacts vary depending on frequency and severity of climate hazards and the climate resilience of a counterparty's assets, operations, workforce and business model.
Indirect	Supply chains	Financial risk can manifest through a corporate's supply chain, depending on factors such as the diversity and location of suppliers, and the natural resource intensity and shock resilience of its supplies.
	Markets of sale	Financial risks and impacts vary depending on climate-related events and climate-driven price shocks, and the company's capacity to shift customer base or pass through costs as appropriate/needed to customers.

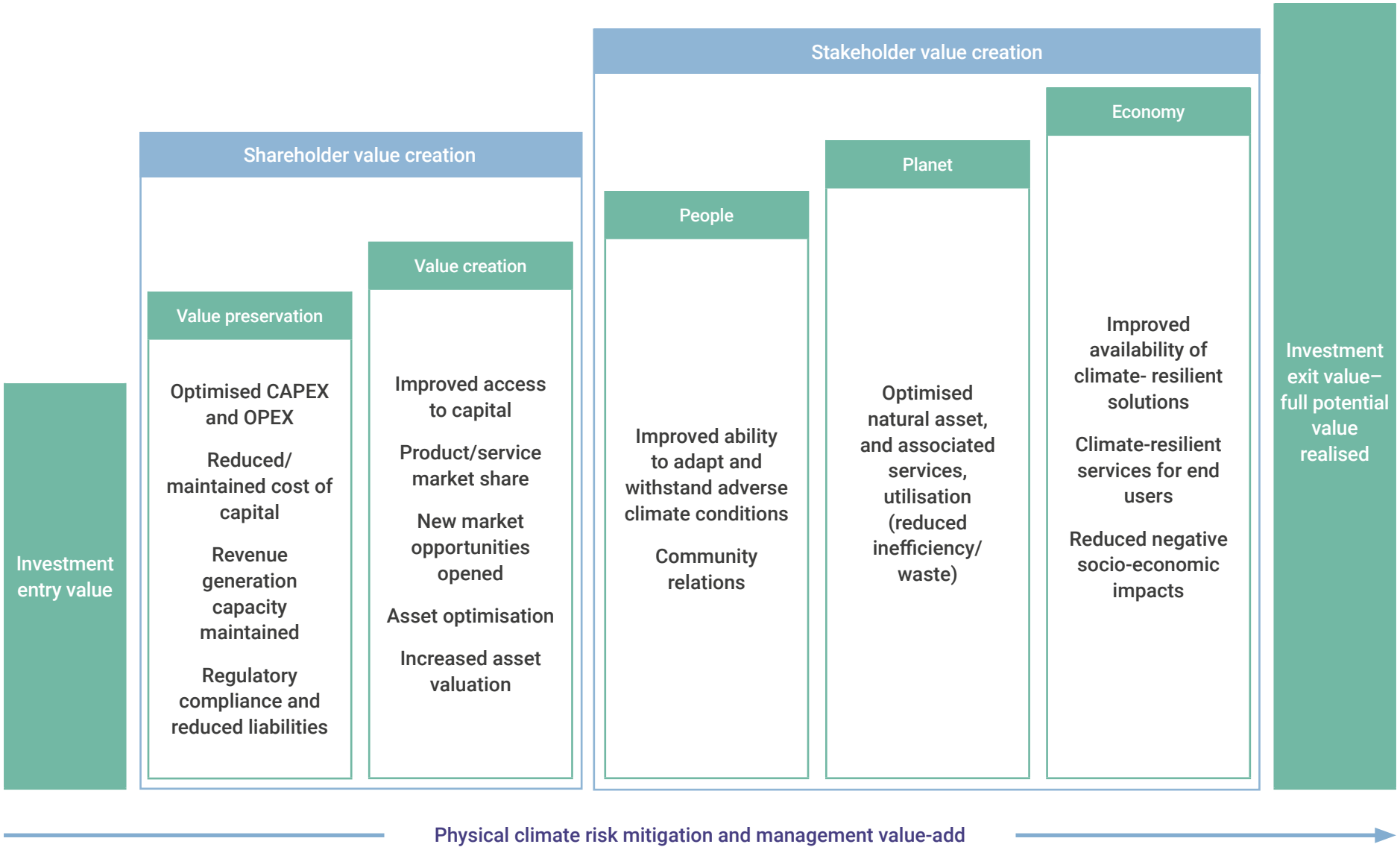
Risk to counterparty

- Revenue loss
- Cost increase
- Decreased asset and company valuation
- Increased cost of capital

Risk to investor

- Financial risk
- Impact risk
- Strategic risk
- Reputational risk

PHYSICAL CLIMATE RISK MANAGEMENT BRINGS VALUE TO BOTH SHAREHOLDERS AND WIDER STAKEHOLDERS ACROSS, AND BEYOND, THE INVESTMENT LIFETIME



2. INTEGRATING PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT IN THE INVESTMENT CYCLE

INTEGRATING PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT IN THE INVESTMENT CYCLE

The representative investment cycle below demonstrates how to integrate physical climate risk and A&R at each stage of the investment process in a proportional and risk-based manner.

Investment cycle	Key objective	Key output
Screening due diligence	Identify which physical climate risk driver(s) may affect the counterparty's assets and operations over their expected lifetime	Inherent physical climate risk rating[1]
In-depth due diligence	Gain an enhanced understanding of the counterparty's vulnerability to physical climate risk, the related implications, and identify required adaptation and resilience solutions	Residual physical climate risk rating[2] and Adaptation Action Plan
Investment decision	Make an investment decision informed by physical climate risk and identified adaptation and resilience opportunities	Physical climate risk informed investment decision
Investment legal agreement	Secure and formalise the commitment and resources required to increase a counterparty's resilience to climate change shocks and stressors	Adaptation Action Plan in place
Monitoring & reporting	Oversee and support the counterparty to implement adaptation and resilience solutions and build physical climate risk management capabilities	Monitoring performance in the implementation of the Adaptation Action Plan and updated residual risk rating
Exit with value-add	Enhance the counterparty's capability to withstand climate-related shocks and stressors, and longer-term delivery of climate-resilient development objectives	Successful exit and value realisation

Definitions

1. The level of risk for an investment in the absence of any actions taken to alter either the impact or probability of the risk itself. It does not include any adaptation measures implemented by the investor.
2. Level of risk remaining following the implementation of risk reduction efforts (adaptation and resilience interventions).

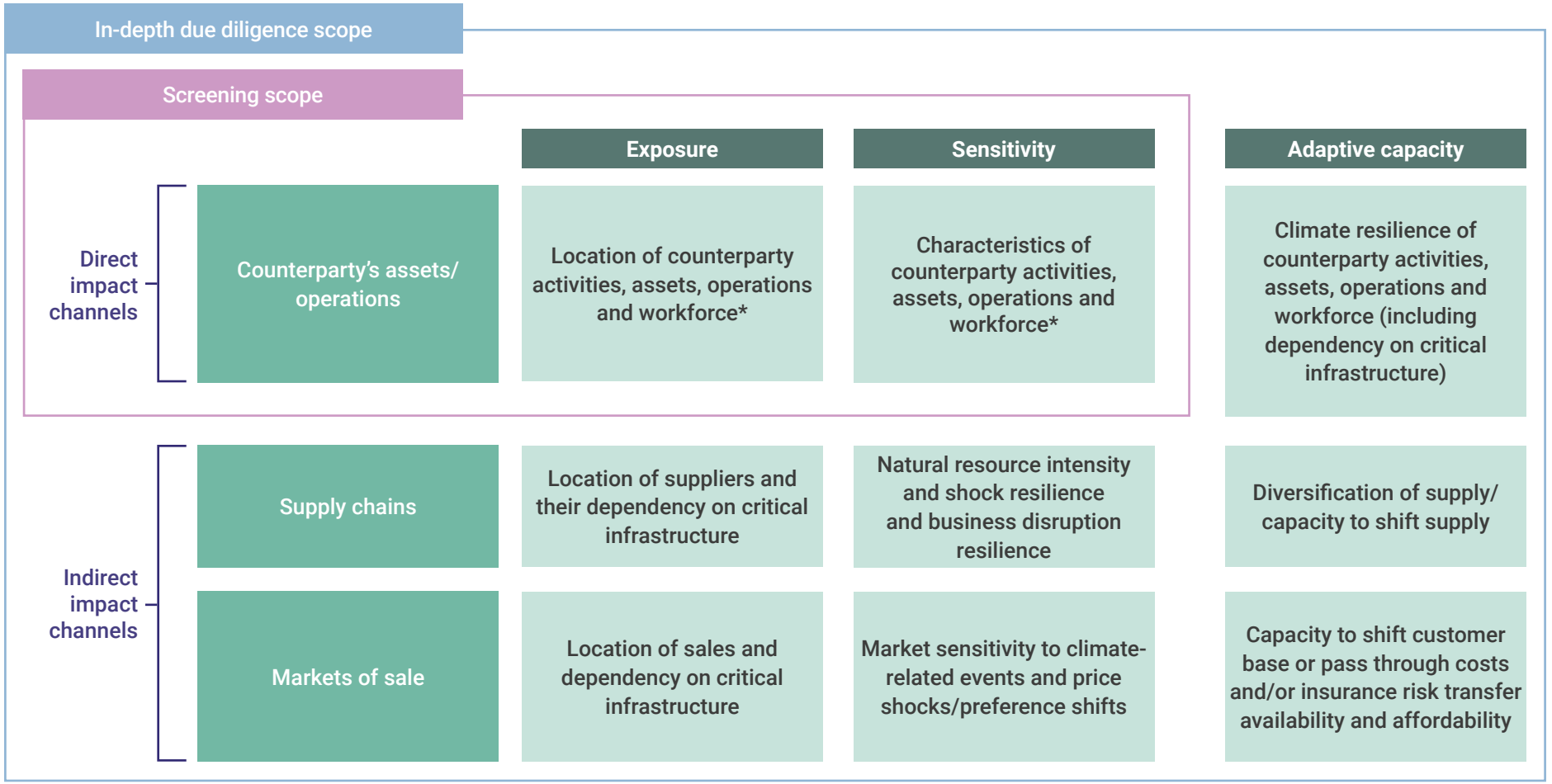
HIGH-LEVEL PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT ACTIVITIES THROUGH THE INVESTMENT CYCLE

The physical climate risk assessment requires a stepwise, risk-based and proportional approach. It is dynamic, evolving through the investment cycle as the understanding of the counterparty's risk profile improves, and as adaptation and resilience solutions are identified and implemented.

Invest. stage	Screening due diligence	In-depth due diligence	Investment Decision	Investment legal agreement	Monitoring & reporting	Exit with value add
Physical climate risk Activity	Identify physical climate risk drivers that may materially affect the counterparty's performance	Determine physical climate risk materiality by conducting a detailed physical climate risk assessment and develop Adaptation Action Plan	Integrate the outcomes of the due diligence and residual physical climate risk rating in the paper submitted to the investment committee	Formalise the Adaptation Action Plan	Engaging with the counterparty to implement adaptation and resilience solutions and evaluate performance against the Adaptation Plan	Demonstrate value-add (delta change in the physical climate risk rating)
Activity factors	Counterparty-specific business activity: Sector/sub-sector Characteristics of key revenue generating assets and operations Geographic location of assets and operations	Characteristics of key revenue generating assets, operations and workforce Geographic location of assets, operations and workforce Counterparty's adaptation capacity, commitment and track record, including business model	Agreement on the Adaptation Action Plan in collaboration with the counterparty		Performance against the Adaptation Plan Identification of material changes to physical climate risk drivers	
Output	Inherent physical climate risk rating	Residual physical climate risk rating and Adaptation Action Plan	Physical climate risk-informed investment decision	Adaptation Action Plan in place	Monitor performance in the implementation of the Adaptation Action Plan and updated residual risk rating	Successful exit and value realisation

THE SCOPE AND DEPTH OF THE PHYSICAL CLIMATE RISK ASSESSMENT IS PROPORTIONAL TO THE STAGE OF THE INVESTMENT CYCLE AND THE SEVERITY OF THE RISK FACED

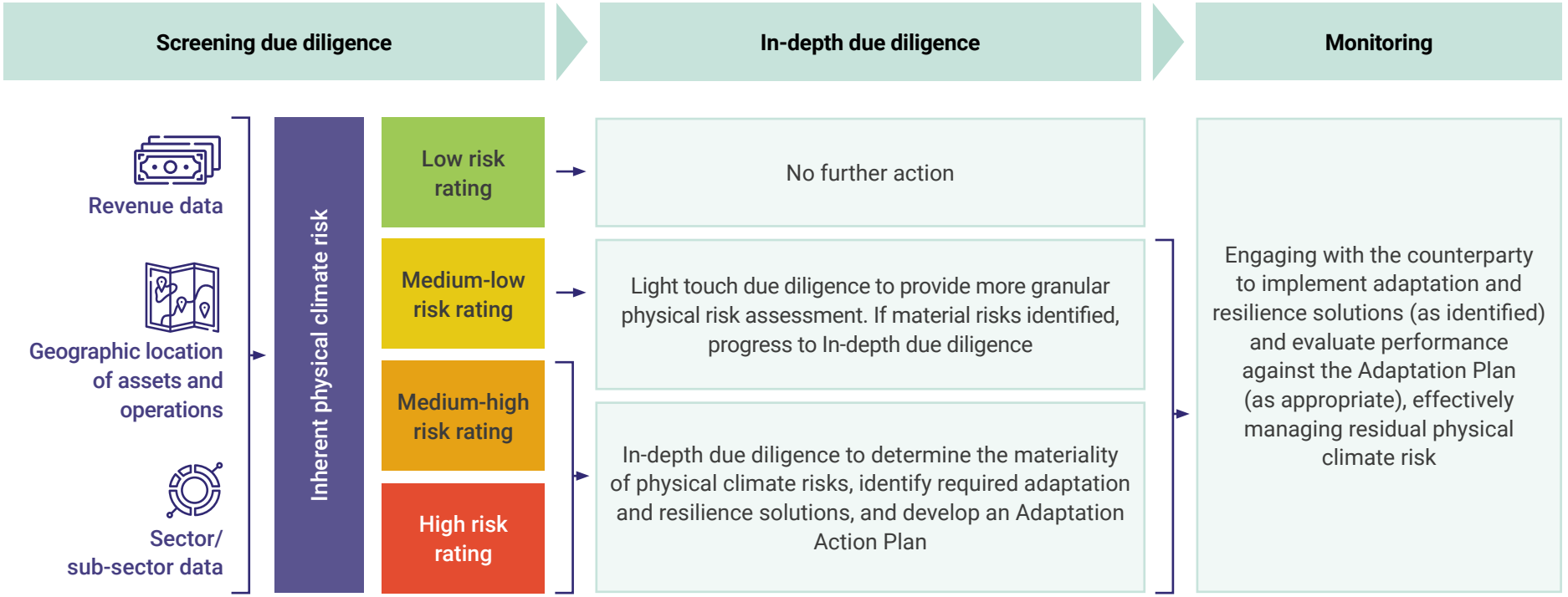
For counterparties identified as at higher physical climate risk, further analysis would be required during due diligence. At this stage, indirect drivers of physical climate risks through the value chain should be considered during the assessment. Effective counterparty and investor collaboration is a key factor in due diligence, supporting meaningful exposure, sensitivity and adaptive capacity assessment outcomes.



*Workforce assessment is not required at screening stage..

APPLYING A RISK BASED AND PROPORTIONATE APPROACH TO PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT

The scope and depth of physical climate risk assessment across the investment cycle should always be conducted in a material and proportional manner. It is recommended to build the physical climate risk profile incrementally over the investment cycle, increasing the scope and depth of analysis as the investment is qualified through the investment process—reducing unnecessary overheads and potential throwaway efforts for investors.



Note: Worked example on page 23 of this playbook, and additional resources in the Annex, support a more comprehensive understanding of physical climate risk assessment and management activities.

3. STEP-BY-STEP PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT

SCREENING DUE DILIGENCE

Screening due diligence assessment supports investors in determining the exposure and inherent predisposition of a counterparty's to be adversely affected by physical climate risk drivers, with the material physical climate risk drivers identified requiring in-depth due diligence assessment.

Invest. stage	**Screening due diligence**
Objective	**Identifying physical climate risk drivers that may materially affect the counterparty's performance**
Activity	▪ Determine the exposure and sensitivity of the counterparty's assets and operations to climate-related hazards that may materially affect its operational, financial and development impact performance (materiality defined as any hazard that may impact counterparty operations and financial performance) by leveraging climate risk tools: ▪ Capture key data inputs for the climate risk tool: type and geographic location of the counterparty's key revenue generation assets and operations as appropriate. ▪ Determine the hazard profile for the geographic context of operation of the counterparty by using climate risk tools or other scientifically-recognised sources (please refer to the Annex for a list of publicly-available tools). ▪ Leverage appropriate climate scenarios to identify potentially material drivers of physical climate risk to the counterparty over the relevant lifespan of its assets and operations. ▪ Based on the assessment's outcomes, define whether an in-depth physical climate risk and vulnerability analysis due diligence is required and its related scope and depth. This will depend on the investor's risk appetite.
Output	**Inherent physical climate risk rating**

IN-DEPTH DUE DILIGENCE

Performing a physical climate risk and vulnerability assessment to (i) determine the materiality of physical climate risk drivers on the counterparty's performance, and (ii) identify the A&R solutions required to reduce the identified physical climate risk.

Invest. stage	**In-depth due diligence**
Objective	**Conducting physical climate risk and A&R opportunity assessment**

Activity	▪ Evaluate:
	  ▪ The climate vulnerability profile of the counterparty's assets, operations and workforce leveraging appropriate climate scenarios and third-party technical expertise where needed;
	  ▪ For a counterparty with diversified or distributed assets (e.g. telecom providers or commodity traders), asset-level assessment is typically impractical. In these instances, investors may prioritise the assessment of the capacity of the counterparty to identify, assess and manage physical climate risk drivers, as this is the most meaningful and practical means of assessing physical climate risk and vulnerability.
	  ▪ Depending on the investment context, investors may also engage the counterparty around wider contextual risk (indirect vulnerabilities, e.g., logistics infrastructure, power supply, etc.) to fully explore and understand risk factors that may impact the investment. Additionally, investors may engage the counterparty to understand how planned adaptation solutions may impact the wider operating environment (e.g., water usage in a farming context and impacts upon wider community), collaborating with appropriate stakeholders to avoid maladaptation* risk for the wider operating environment.
	  ▪ The counterparty's capacity to identify, assess and manage physical climate risks across the four pillars of governance, risk management, strategy, metrics and targets.**
	▪ Identify potential adaptation and resilience solutions that may be required to strengthen:
	  ▪ The counterparty's assets, operations workforce's health and safety and value chain.
	  ▪ The counterparty's capacity to identify, assess and manage physical climate risks.

Output	**Residual physical climate risk rating and Adaptation Action Plan**

*Maladaptation risk is defined as the unintended consequence of adaptation action, leading to increased risk of adverse socio, environmental or economic outcomes (e.g., increased GHG emissions, reduced water access, increased flooding, etc.)

**These four pillars are central to the framework of the IFRS S2 Climate-related Disclosure Standard.

INVESTMENT LEGAL AGREEMENT

Formalising the Adaptation Action Plan (as part of the ESAP, if appropriate) to avoid and mitigate the risk of adverse climate-related impacts on the counterparty's performance.

Invest. stage	**Investment legal agreement**
Objective	**Formalising the Adaptation Action Plan**

Activity	▪ Formalise the counterparty's commitment to implement the Adaptation Action Plan, outlining the adaptation and resilience solutions required to avoid and mitigate the material physical climate risk drivers identified during due diligence.
	▪ Adaptation and resilience solutions can encompass:
	  ▪ Soft adaptation measures, including the following types:
	  ▪ Managerial (e.g., developing heat stress policy to manage workers' health and productivity during extreme heat conditions)
	  ▪ Strategic (e.g., commissioning new buildings with climate resilient design as part of planned urban building programme)
	  ▪ Temporary (e.g., using shading to reduce solar heat increases)
	  ▪ Technical (grey) measures, e.g., refurbishing buildings, enhancing physical flood defences, increasing capacity of sewage systems
	  ▪ Nature-based measures, e.g., implementing or expanding green infrastructure for water runoff management or microclimate moderation
	▪ Integrate the Adaptation Action Plan in the ESAP as appropriate, articulating the activities, indicators of completion, budget, role and responsibility and timeline.

Output	**Adaptation Action Plan formalised and in place**

MONITORING & REPORTING

Evaluating counterparty performance in the implementation of the adaptation and resilience solutions to avoid and mitigate the material physical climate risk drivers identified during due diligence.

Invest. stage	Monitoring & Reporting
Objective	**Evaluate performance in the implementation of the Adaptation Action Plan**
Activity	▪ Regularly evaluate performance in the implementation of the Adaptation Action Plan and climate-related impacts that may have affected the counterparty's operational and financial performance. ▪ Provide support to the counterparty as needed, e.g., where available, through technical assistance. ▪ Identify further adaptation and resilience opportunity areas in light of the evolving availability, maturity and accessibility of adaptation and resilience solution.
Output	**Monitoring performance in the implementation of the Adaptation Action Plan and updated residual risk rating**

EXIT WITH VALUE-ADD

Demonstrating the links between effective physical climate risk management, positive investment outcomes, and positive development impact outcomes. An investment's A&R strategy and management should also demonstrate an opportunity for positive future financial outcomes.

Invest. stage	Exit with value-add
Objective	Value demonstration

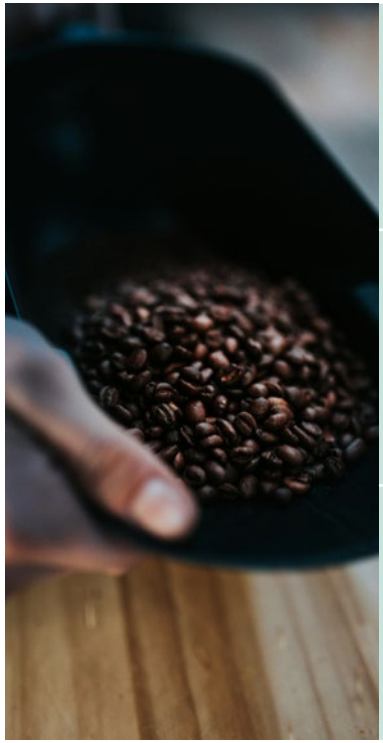
Activity	▪ Demonstrate shareholder value creation enabled by physical climate risk management:
	  ▪ Value preservation: CAPEX and OPEX, cost of capital, revenue generation capacity, regulatory compliance and liability exposure performance
	  ▪ Value creation: Market share and new market opportunities, asset optimisation, access to capital and asset value
	Investors may reference UNEP FI's 2023 Climate Risk Landscape report for further information on valuation approaches and tools in support of pricing physical climate risk
	▪ Demonstrate stakeholder value creation enabled by adaptation and resilience interventions.
	  ▪ People: Improved ability to adapt and absorb negative climate conditions, jobs created and improved community relations outcomes
	  ▪ Planet: Optimised natural resource and service utilisation
	  ▪ Economy: Climate resilient service provision for end users and reduced negative socio-economic impacts
	Investors may reference the ARIC measurement framework for further stakeholder value creation guidance

Output	Successful exit and value realisation

4. WORKED EXAMPLE: PHYSICAL CLIMATE RISK ASSESSMENT AND MANAGEMENT IN PRACTICE

WORKED EXAMPLE: ETHIOPIAN AGRIBUSINESS

ILLUSTRATIVE INVESTMENT CONTEXT



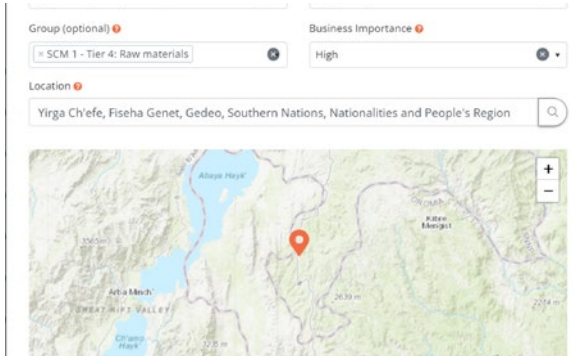
Investor overview	The investor is an agriculture-focused fund manager, with experience in coffee investment in Kenya. The investor is looking to expand to wider East African markets to diversify its portfolio and is planning an equity investment in a target company.
Investment target	The investment target is an agribusiness producing coffee in Ethiopia. The business has a wide variety of offtakers for the washed coffee beans it produces, but has a key dependency on its inputs with a single supplier agreement in place across its input requirements (fertiliser, etc.).
Investment geography	The agribusiness owns and operates its coffee farm in Jimma-Limu, Ethiopia.

WORKED EXAMPLE: ETHIOPIAN AGRIBUSINESS—SCREENING DUE DILIGENCE

Invest. stage	**Screening due diligence**
Objective	**Identifying physical drivers that may materially affect the counterparty's performance**

Activity

- The investor screens the agribusiness company's farm for its exposure and sensitivity to physical climate risk drivers using the Water Risk Filter tool (further/wider tool availability is included in the Annex).
- The initial assessment highlights that drought and flood may materially affect the company's operations. Droughts can stress coffee plants and make them more susceptible to diseases, while floods can damage crops and wash away soil nutrients.
- Based on these findings, the investor undertakes a physical climate risk and vulnerability assessment during the next due diligence stage.

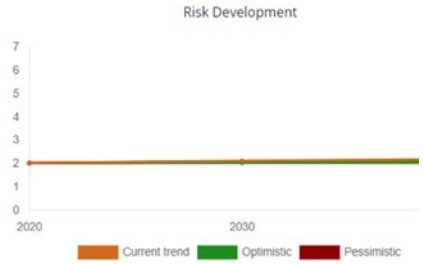


riskfilter.org/water/explore/

Hazard	Risk tier
Drought	Med-high
Flood	High

Risk tiers trigger a physical climate risk and vulnerability and adaptive capacity assessment

Scenario analysis



Output	**Inherent physical climate risk rating High**

WORKED EXAMPLE: ETHIOPIAN AGRIBUSINESS—IN-DEPTH DUE DILIGENCE

Invest. stage: In-depth due diligence

Objective: Conducting physical climate risk and vulnerability assessment

Activity:

- The investor performs a climate risk and vulnerability assessment at two levels to determine risk materiality and identify the required A&R solutions to formalise in the Adaptation Action Plan, which forms part of the ESAP.

Company's assets, operations and workforce vulnerability

Dimension	Guiding questions	Response
Addressing flooding risk	Which measures are in place to avoid or reduce the adverse effects of flooding and droughts on the coffee plantations, if any?	Drainage
Addressing drought		Solar irrigation

Company's capacity, commitment and track record to manage physical climate risk

Dimension	Guiding questions	Risk rating
Governance	Has the company allocated roles and responsibilities for the identification, assessment and management of physical climate risks?	**Adequate**
Strategy	Is the company's business model concentrated or diversified in terms of suppliers or customer base? Has the company developed an Adaptation Plan?	**Inadequate**
Risk management	Is the identification, assessment and management of physical climate risks integrated in the company's risk management system? Does the company have a track record in identifying, assessing and managing physical climate risks? Has the company contracted an insurance policy to cover the adverse consequences of climate-related events?	**Inadequate**
Metrics and targets	Does the company have metrics in place to measure its operational and financial performance in relation to physical climate risk and resilience and, where set, progress towards any climate-related targets?	**Inadequate**

Output: Residual physical climate risk rating **Med-high**

Risk rating determined by the investor. The investor may also incorporate financial materiality assessment based residual climate risk rating

WORKED EXAMPLE: ETHIOPIAN AGRIBUSINESS - INVESTMENT LEGAL AGREEMENT

Invest. stage	**Investment legal agreement**					
Objective	Formalising the Adaptation Action Plan					
Activity	**Risk dimension**		**Adaptation solution**	**Implementation timeframe**	**Budget**	**Responsibility**
	Company assets, operations and workforce	Addressing flooding risk	Installation of of an effective nature-based drainage facility	6 months from capital receipt	USD 5,000	CEO
		Addressing drought	Installation of a solar irrigation capability	1 year from capital receipt	USD 35,000	CEO
	Company capacity	Governance	Maintenance of existing governance structures and processes – quarterly Exco review	Immediate upon capital receipt	N/A	COO
		Strategy	Refresh of risk management procedures to reflect physical climate risk management	Immediate upon capital receipt	N/A	COO
		Risk Management	Climate resilient training for employees on procedures and processes around climate-related events/ shocks	6 months from capital receipt	USD 300	HR Lead
		Metrics and targets	Integration of physical climate risk metrics into performance monitoring and reporting e.g. management KPIs	6 months from capital receipt	N/A	COO
Output	**Adaptation Action Plan formalised and in place**					

WORKED EXAMPLE: ETHIOPIAN AGRIBUSINESS—MONITORING & REPORTING

Invest. stage	Monitoring & Reporting
Objective	Evaluate performance in the implementation of the Adaptation Action Plan

Activity

- The investor performs a climate risk and vulnerability assessment at two levels to determine risk materiality and identify the required A&R solutions to formalise in the Adaptation Action Plan, that could form part of the ESAP.

Risk dimension	Adaptation solution	Implementation timeframe	Indicator for completion	Budget	Responsibility
Addressing flooding risk	Nature-based drainage facility	6 months from capital receipt	# trees planted	USD 5,000	CEO
Addressing drought	Solar irrigation capability	1 year from capital receipt	Off-grid kW capacity	USD 35,000	CEO
Governance	Quarterly Exco review	Immediate upon capital receipt	# Exco reviews held	N/A	COO
Strategy	Risk management procedure refresh	Immediate upon capital receipt	% procedures reviewed	N/A	COO
Risk management	Climate resilient training	6 months from capital receipt	% employees trained	USD 300	HR lead
Metrics and targets	Physical climate risk metrics integration	6 months from capital receipt	# metrics reported	N/A	COO

Output	Residual physical climate risk rating **Low**

Investors should additionally consider counterparty reporting on climate hazard-related business disruption and impacts to support comprehensive Monitoring & Reporting, and the identification of further adaptation and resilience needs/solutions as appropriate.

WORKED EXAMPLE: ETHIOPIAN AGRIBUSINESS—EXIT WITH VALUE-ADD

Invest. stage	**Exit with value-add**
Objective	Value demonstration

Activity

- Demonstrating the positive investment and development outcomes as a consequence of A&R strategy and management.

Outcome	Shareholder value creation		Stakeholder value creation		
	Value preservation	Value creation	People	Planet	Economy
Reduction in farm vulnerability	✓	✓		✓	
Reduced/ maintained cost of capital	✓	✓			
Increased sales volume due to enhanced brand reputation		✓	✓		✓
Asset valuation increase		✓			
Improved management of natural assets for adaptation and resilience			✓	✓	✓

Output	Successful demonstration of financial, and wider, value creation within the investment, and long-term benefit realisation due to the implementation of A&R solutions

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ANNEX

SUPPLEMENTAL GUIDANCE: HAZARDS

UNDERSTANDING CLIMATE-RELATED HAZARDS

Hazard context	The effects of extreme weather and changing climate differ across regions and countries due to various factors, including topography, local weather patterns, land cover, and proximity to waterways, amongst others. Climate hazards are the key drivers of physical climate risks. They can be acute such as floods and droughts, or slow in their onset, such as sea level rise.
Utilising hazard data	Hazard data is available from publicly-available data portals or proprietary data providers, alongside scientifically-recognised sources, such as academic journals and IPCC reports. UNEP FI has developed a database of both open-source and proprietary tools for physical and transition risk assessments for financial institutions across different use cases. Investors should refer to the UNEP FI risk centre for the latest data provider information and insight, with further information on selected providers included in this document.
Climate scenario analysis	Climate scenarios demonstrate different possible climate and socio-economic futures, based on expert peer-reviewed projections. The scenarios used for physical climate risk assessment come from IPCC and the AR6 report, defined by Shared Socioeconomic Pathways (SSPs) and carbon emission pathways (Representative Concentration Pathways [RCPs]—for further details, see Carbon Brief), with financial institutions often using the scenarios produced by the Network for Greening the Financial System (NGFS). It is important to note these scenarios are **not** forecasts but are designed for investors and companies to test their business resilience against a range of different future states to inform strategic decision-making. Under all climate scenarios, an increase in the magnitude and frequency from climate and weather events due to the historic anthropogenic GHG emissions is expected. The future-looking scenarios can support investors in assessing current climate-related hazard risks to an investment, alongside how these hazards are expected to change over time. Investors should ensure their investment is resilient to the current levels of physical climate risk, as well as being resilient to the future levels of hazard, based on the implemented adaptation measures over the investment lifetime. Investors should also consider potential indirect impacts in their broader environmental and social risk assessments. For further reading, investors may reference this NGFS report.

THE USE OF PHYSICAL CLIMATE HAZARD INDICATORS VARIES DEPENDING ON THE INVESTMENT CONTEXT AND INVESTOR PREFERENCE

Various metrics are used to evaluate the level of risk of climate-related hazards. An investor should choose the indicators most relevant to the counterparty's assets, operations and workforce for physical climate risk assessment. The table below shows a non-exhaustive range of indicators that may be employed to evaluate each climate hazard.

Hazard group	Illustrative hazard indicators	
Temperature	Average annual temperature (in °C) Maximum of daily temperatures (in °C) Number of days per year exceeding 35°C/ 38°C per year Number of days with Wet-Bulb Globe Temperature exceeding 25°C per year Absolute heat wave: annual count of three-day periods with high temp >35°C and low temp >24°C	Days per year with temperature <-10°C Absolute cold wave: annual count of three-day periods with average temp <-5°C
Wind	Maximum 1-minute sustained wind speed (in km/hr) experienced at the 100-year return period Average annual wind speed (in km/h) Max/min wind speed (in km/h) for the year	
Flooding	Mean flood depth and associated frequency (e.g., depth of the water (in meters) at the 100-year return period) Annual accumulation of rainfall in the 99th percentile Consecutive number of extremely wet days (CWD) with over 20mm of rainfall Maximum daily rainfall over five consecutive days	Total annual precipitation Average largest one-day precipitation Average largest five-day precipitation Precipitation percentage change
Drought	Months per year where the rolling three or six-month average Standardized Precipitation Evapotranspiration Index is below -2 Maximum number of consecutive dry days (daily precipitation under 1mm)	Maximum daily total water equivalent precipitation (in mm) experienced at the 100-year return period
Wildfire	Annual number of wildfires Annual probability of wildfire Combination metric: Max number of consecutive dry days, number of hot days (Tmax >40°C)	
Sea level rise	Annual depth of the water (in meters) in coastal areas due to high tides	

Indicators sourced from the World Bank Climate Change Knowledge Portal and the ClimInvest Factsheets.

CLIMATE SCENARIOS: AN OVERVIEW OF THE INTEGRATED SHARED SOCIECONOMIC PATHWAYS (SSP), AND REPRESENTATIVE CONCENTRATION PATHWAYS (RCP) SCENARIOS

The IPCC SSP-RCP (SSP X-Y) scenarios combine the Shared Socio-economic Pathways (SSP) and Representative Concentration Pathways (RCP) into a common set of five scenarios with different narratives and emission trajectories through to 2100. The RCP provides the pathway for emissions and greenhouse gas concentration outcomes through to 2100, with the SSP outlining the socio-economic conditions that will drive or realise the RCP outcomes.

THE SSP X-Y SCENARIOS

SSP1-1.9 SUSTAINABILITY—'TAKING THE GREEN ROAD'

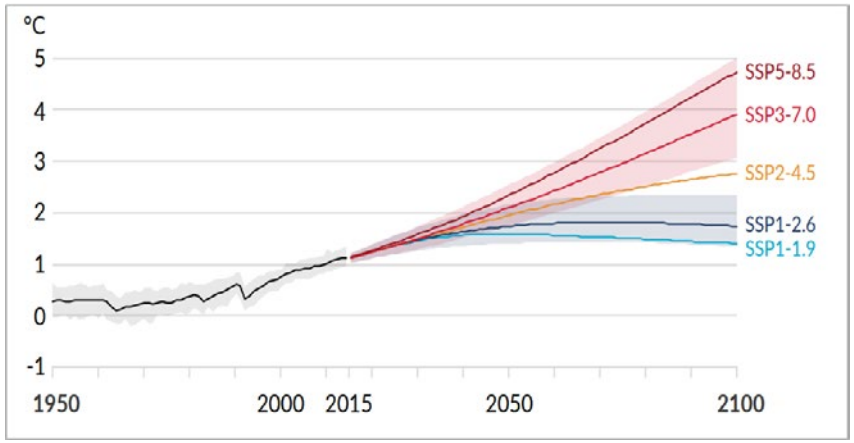
The IPCC's most optimistic scenario, this describes a world where global CO2 emissions are cut to net zero around 2050. Societies switch to more sustainable practices, with focus shifting from economic growth to overall well-being.

SSP1-2.6—'MIDDLE OF THE ROAD'

In the next-best scenario, global CO2 emissions are cut severely, but not as fast, reaching net-zero after 2050. It imagines the same socioeconomic shifts towards sustainability as SSP1-1.9. But temperatures stabilise around 1.8°C higher by the end of the century.

SSP3-7.0 – 'A ROCKY ROAD'

On this path, emissions and temperatures rise steadily and CO2 emissions roughly double from current levels by 2100. Countries become more competitive with one another, shifting toward national security and ensuring their own food supplies. By the end of the century, average temperatures have risen by 3.6°C.



Global surface temperature change relative to 1850-1900 under different climate scenarios. Source: IPCC AR6 Working Group report 2021

SSP2-4.5—'A ROAD DIVIDED'

This is a "middle of the road" scenario (current trajectory). CO2 emissions hover around current levels before starting to fall mid-century, but do not reach net-zero by 2100. Socioeconomic factors follow their historic trends, with no notable shifts. Progress toward sustainability is slow, with development and income growing unevenly. In this scenario, temperatures rise 2.7°C by the end of the century.

SSP5-8.5 FOSSIL-FUELLED DEVELOPMENT—'TAKING THE HIGHWAY'

This is a future to avoid at all costs. Current CO2 emissions levels roughly double by 2050. The global economy grows quickly, but this growth is fuelled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a scorching 4.4°C higher.

Note—Investors may also consider the potential or likelihood of 'tipping points' across climate scenario modelling. Tipping points are critical thresholds that, if exceeded, would lead to large, accelerating and often irreversible changes in the climate system , such as unprecedented weather, extreme temperatures and increased frequency of droughts and forest fires. Investors can refer to the IPCC AR6 WG1 Technical Summary, Carbon Brief's tipping point summary, Nature Communications tipping point and scenario study and the associated Carbon Brief report for further information on tipping points.

PUBLICLY-AVAILABLE DATA SOURCES FOR CLIMATE HAZARD INDICATORS AND SCENARIO MODELLING

A representative set of data providers providing climate hazard indicator data and scenario tooling. This listing is non-exhaustive and investors should refer to the UNEP FI risk centre for the latest data provider information and insight.

Data provider	Geography	Scenarios	Timeframe	Climate hazards considered	Sources based on
Resilient Planet Data Hub—The Global Resilience Index	Global	RCP, SSP	Baseline–2100	Coastal and river flooding, extreme heat and drought, tropical cyclones, seismic risk	WRI Aqueduct Floods Hazard Maps, Lange et al 2020, ISIMIP, STORM Tropical Cyclone Maximum Wind Speeds, Present and Future climate, IRIS tropical cyclone model, GEM Global Earthquake Hazard Map
Climate Change Knowledge Portal — World Bank	Country level (subnational regions for some countries)	SSP	Baseline (present–2100	Sea-level rise, Heatwaves, Floods, Wildfire, Drought, Cold wave, Changing temperatures, Changing precipitation	Observational data is sourced from the Climatic Research Unit (CRU) of the University of East Anglia. Climate projection data is modeled data, derived from the Coupled Model Inter-comparison Projects (latest version CMIP6)
Copernicus	Global Regional Predominantly EU	RCP, SSP	Baseline–2100	Heatwaves (EU), Cold spells, Flooding (EU),	Several including: Coupled Model Intercomparison Project (CMIP-6) and Coordinated Regional Climate Downscaling Experiment (CORDEX)
European Environment Agency	Europe	RCP2.6, RCP4.5, RCP8.5	Baseline–2100	Drought, Flash flooding, Wildfire, Heatwaves, Sea-level rise	Intergovernmental Panel on Climate Change (IPCC)
Aqueduct (WRI)	Global	RCP4.5, RCP8.5, SSP2, SSP3	Baseline–2080	Flooding (Riverine, coastal) Drought, Water Stress	Intergovernmental Panel on Climate Change (IPCC)
Water Risk Filter (WWF)	Global	RCP2.6, RCP 4.5, RCP6.0, RCP 8.5, SSP1, SSP2, SSP3	Baseline–2050	Water scarcity, flooding, water quality, ecosystem services status, Regulatory environment, Reputational risks	Intergovernmental Panel on Climate Change (IPCC)
World Climate Research Programme (WCRP)	Global 14 Regions	RCP2.6, RCP4.5, RCP8.5	Baseline–2100	Wind Speed	Earth System Grid Federation (ESGF) Coordinated Regional Climate Downscaling Experiment (CORDEX)
Think Hazard	Global Regional District Province	Baseline (present) state and qualitative discussion on evolution of risk	Baseline	Flooding (Coastal, river, urban), Cyclonic wind, Heatwaves, Drought, Wildfires	World Bank Climate Change Knowledge Portal (Climate indicators) Global Administrative Unit Layers (Spatial data)
Cotton 2040	Global Regional	RCP8.5 (2031–2050)	2031–2050	Flooding (Coastal, fluvial), Drought, Heat stress, Wildfire, Storms	European Centre for Medium-Range Weather Forecasts (ECMWF) Reanalysis 5th Generation (ERA 5), Coupled Model Intercomparison Project (CMIP-5), Global Fire Data, World Resource Institute Aqueduct flood

SUPPLEMENTAL GUIDANCE: EXPOSURE

UNDERSTANDING EXPOSURE TO CLIMATE-RELATED HAZARDS

Exposure context	A counterparty's exposure to climate-related hazards is a function of its geographic location and the financial value of its physical assets.
Geographic analysis	When looking for climate-related data to complete physical climate risk assessment, investors should look at asset-level geographic data where possible. If asset-level data is unavailable, country or province-level data can inform trends to pinpoint where to undertake further analysis in physical climate risk assessment.
Value chain analysis	To fully understand exposure (and vulnerability), it is relevant to consider in the assessment the upstream (e.g., inputs) and downstream (e.g., logistics/retail) value chain dependencies. Incorporating a counterparty's value chain enhances the robustness of the physical climate risk assessment and management.

ILLUSTRATIVE SECTOR VALUE CHAIN AND ASSET EXPOSURE SCOPING

Sector	Example activities	Example asset types
Food & Agriculture	Production, storage, processing, treatment, packaging, transport	Fodder, land, equipment, machinery, buildings, infrastructure connectivity (e.g., water, waste, power), vehicles
Energy	Basins, reservoirs, mines, solar/wind farm, turbines, equipment, machinery, pipelines, vehicles, power plants, transmission networks	Exploration, development, material production, mining, quarrying, transportation, refining, generation, transmission, distribution
Construction & Real Estate	Purchasing and financing of land, material sourcing, planning and design, construction, property management, end-of-life	Machinery, equipment, buildings, infrastructure connectivity (e.g., water, waste, power)
Manufacturing	Warehousing, material sourcing, I inventory control, production, processing, assembly, printing, logistics and transport, recycling	Buildings, machinery, equipment, distribution centres, vehicles, infrastructure connectivity (e.g., water, waste, power)
Water Management	Facility construction, operation, maintenance, treatment, distribution, consumption, wastewater collection and treatment	Buildings, machinery, equipment, distribution and sewer networks, treatment plants, pipes, infrastructure connectivity

Note: This is not an exhaustive list. Depending on the nature of the investment, assets and activities may be similar and overlap across sector value chain

SUPPLEMENTAL GUIDANCE: VULNERABILITY

UNDERSTANDING A COMPANY'S VULNERABILITY PROFILE

Vulnerability context	The vulnerability of the counterparty determines the damage or loss given the identified climate-related hazard magnitude and frequency risk.
Value chain analysis	A counterparty's sensitivity varies by sector/sub-sector/asset types. Within the Food & Agriculture sector for instance, the 'storage' stage in the value chain is more susceptible to floods, but less so to droughts, while the 'production' stage is susceptible to droughts, wildfires and floods. In a food and beverage processing context, companies are typically water-intensive and, if operating in drought-prone contexts, these companies face a higher risk of drought than companies operating in non-water-intensive sectors. These food and beverage companies are also highly-dependent on agricultural inputs, and the availability of these inputs (quality and quantity) may be impacted by climate hazards. The nature of a company's value chain (e.g., a diversified/concentrated supplier profile for key inputs), significantly impacts its vulnerability. As a consequence, understanding the counterparty's value chain, its materiality, and its sensitivity to climate-related hazard exposure, is a key step in assessing vulnerability.
Adaptive capacity	A counterparty's ability to adjust to current and expected climate conditions, and its ability to moderate harm or take advantage of beneficial opportunities, determines its adaptive capacity. The IPCC recognises three different types of adaptive capacity, and all three should be considered when assessing how equipped a counterparty is to actively manage physical climate risk on, and implement adaptive measures; ▪ Capacity to anticipate and prepare for risk ▪ Capacity to respond to a given risk ▪ Capacity to recover and change
Identifying adaptation and resilience measures	Adaptation and resilience measures and actions can be classified as as either **soft, technical, or nature-based**. Investors should evaluate the counterparty's existing and planned adaptation measures, how these measures are integrated to business strategy, and the counterparty's capability to identify and manage physical climate risk on an ongoing basis. The measures identified in the due diligence stage should be developed into comprehensive adaptation and resilience planning and integrated into the investment's ESAP where appropriate to reduce the climate-related financial risk for both the counterparty and the investor.

ADDITIONAL RESOURCES AND REFERENCES

PHYSICAL CLIMATE RISK ASSESSMENT RESOURCES

ARUP (2024), Universal Taxonomy for Natural Hazard and Climate Risk and Resilience Assessments

How to perform a robust climate risk and vulnerability assessment for EU taxonomy reporting (including translation matrix for climate hazards across IPCC/EEA to EU Taxonomy classification)

Equator principles (2023) Guidance Notes on Climate Risk Assessment

EBRD (2019), advancing TCFD guidance on physical climate risks and opportunities

ISO Standard 14091:2021 Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment

British International Investment: TCFD Implementation toolkit

UNEP-FI: Climate Risk Landscape Report 2024

SECTOR GUIDANCE RESOURCES

Infrastructure—Technical Guidance on Climate Proofing Infrastructures (European Commission, 2021)

Infrastructure—IIGCC PCRAM (Physical Climate Risk Assessment Methodology) in Practice: Outputs and insights from climate resilience in action

Energy Hydropower Sector Climate Resilience Guide (Hydropower.org)

Transport Climate Risk and Ports: A practical guide on strengthening resilience (IDB Invest)

Water Resilient Water Infrastructure Design Brief (World Bank)

PHYSICAL CLIMATE RISK SCREENING TOOLS

UNEP FI Climate Risk Tool Dashboard

Water-related risks: WWF's Water Risk Filter Tool; WRI's Aqueduct

Wildfire risks: ESA's World Fire Atlas

Sea Level risks: NASA IPCC Sea Level Projection Tool—NASA Seal Level Portal

Multi-hazard: NGFS's Climate Impact Explorer by Climate Analytics

Multi-hazard: OS-C, Open-source Climate: Physical and Resilience tools

ARIC Adaptation & Resilience Impact: A measurement framework for investors

GLOSSARY

Term	Description	Reference
Adaptation	In human systems, adaptation is defined as the process of adjustment to actual or expected climate and its effects in order to moderate harm or take advantage of beneficial opportunities. In natural systems, adaptation is the process of adjustment to actual climate and its effects; human intervention may facilitate this. An adaptation plan sets out concrete steps to implement those interventions required to prevent and reduce physical risks while harnessing associated opportunities. It is integral to an entity's strategy and risk management framework; its delivery should be integrated into the entity's organisational processes for business and financial planning, and for governance. It should include details about resources, and timelines. An adaptation plan should be dynamic, and responsive to new information and relevant external developments (e.g. latest climate science and/or adaptation and resilience solutions). It should be regularly reviewed and updated.	IPCC (2022)
Adaptive capacity	The ability of physical or natural assets, people and businesses to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.	IPCC (2022)
Climate resilience	Climate change resilience is the ability of a system to withstand climate-related shocks or stressors. It is the capacity of a system to cope with, or recover from, those effects, while retaining its essential original components. [The IPCC defines resilience as the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation].	IPCC (2022)
Environmental & Social Action Plan	The ESAP details how the gaps identified in the due diligence will be actioned by the investee (counterparty) throughout the investment to meet the investor's requirements. A good ESAP should be specific, measurable, achievable, realistic and time-delimited (SMART). Please refer to BII's guidance for more detail.	BII ESG Toolkit for Fund Managers
Exposure	Exposure is defined as the presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected.	IPCC (2022)
Hazards	The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.	IPCC (2022)
Inherent risk	The level of risk for an investment in the absence of any actions taken to alter either the impact or probability of the risk itself. It does not include any adaptation measures implemented by the investor.	IPCC (2022)
Impact	The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards, exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure.	IPCC (2022)
Physical climate risk	Financial risks (and losses) that can arise from the adverse effects of current or future climate conditions.	BIS (2021)

Term	Description	Reference
Physical climate risk drivers	Increasing severity and frequency of: Extreme climate change-related weather events (or extreme weather events) such as heatwaves, landslides, floods, wildfires and storms (i.e., acute physical climate risks) Longer-term gradual shifts of the climate such as changes in precipitation, extreme weather variability, ocean acidification, and rising sea levels and average temperatures (i.e., chronic physical climate risks or chronic risks) Indirect effects of climate change such as loss of ecosystem services (e.g., desertification, water shortage, degradation of soil quality or marine ecology)	BIS (2021)
Residual risk	Level of risk remaining following the implementation of risk reduction efforts (adaptation and resilience interventions).	IPCC (2022)
Risk	Risk refers to the exposure of an investment to activities or events that may cause damage or loss. Key risks have potentially severe adverse consequences for humans and social-ecological systems resulting from the interaction of climate related hazards with vulnerabilities of societies and systems exposed.	IPCC (2022)
Scenarios	Scenario analysis is a well-established method for developing strategic plans that are more flexible or robust to a range of plausible future states. They are hypothetical constructs, not forecasts, predictions or sensitivity analyses. Scenarios are intended to highlight central elements of a possible future and to draw attention to the key factors that will drive future developments. In the context of climate change, scenarios look at possible climatic projections into the future under varying socio-economic pathways. Financial regulators working together under the NGFS, developed a set of scenarios to provide a reference point for understanding how climate change (physical climate risk) and climate policy and technology trends (transition risk) could evolve in different futures.	TCFD
Sensitivity	Sensitivity refers to the physical pre-disposition of human beings, infrastructure, and environment to be affected by a dangerous phenomenon due to a lack of resistance and predisposition of society and ecosystems to suffer harm as a consequence of intrinsic and context conditions, making it plausible that such systems, once impacted, will collapse or experience major harm and damages due to the influence of a hazard event.	IPCC (2022)
Supply chain/ Value chain	Upstream and downstream dependencies of the investee company (counterparty). Supply chain is the upstream element of a company, where it does not have direct control over but purchases the goods and/or services.	PRI (2017)
Vulnerability	Vulnerability is defined as the propensity or predisposition to be adversely affected and encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.	IPCC (2022)

The Adaptation and Resilience Investor Collaborative (ARIC) is an international partnership of development finance organisations (DFIs) working together to accelerate and scale up private investment in climate adaptation and resilience in developing countries. To unlock investment in climate adaptation and resilience, we build know-how, tools and join forces to develop pipelines of bankable investments.