Grant Thornton

Quantification of climate risks and opportunities

Climate risk is financial risk – there is no other way to spin the story

Every extreme weather event carries a cost – directly or indirectly. For many, the impact is relatively minor, such as travel delays or temporary disruption, but these effects still represent real economic and social costs.

For those less fortunate, the consequences can be far more severe, ranging from minor disruption to the complete write-off of assets. Destroying lives and livelihoods.

However, climate risk is not solely about damages and losses; the ability to mitigate, adapt to, or avoid climate risks also creates climate-related opportunities. According to the Climate Policy Initiative (CPI), it was estimated that investments into global climate finance came in at approximately USD 1.5 trillion in 2022 and USD 1.9 trillion in 2023. This scale of investment mirrors the growth in sustainable and green funds, where assets under management expanded from well under USD 1 trillion in 2016 to approximately USD 3.9 trillion by the end of 2025 – a compound annual growth rate (CAGR) of nearly 20% over the last 9 years!

With significant risks and opportunities at stake, stakeholders increasingly expect asset owners to be transparent about climate-related exposures.

Why quantifications matter – the old adage of "you cannot change what you don't monitor"

The push from within to be better…

As with any form of risk management, the decision of how to manage those risks depend on the magnitude of impact. Without quantification, organisations risk under-preparing or over-investing in misaligned responses.

Quantification enables the integration of climate risk into financial planning and capital allocation. It also supports more effective investment prioritisation, particularly as climate-related investments typically require significant upfront capital and involve long payback periods.

Finally, quantification strengthens organisational resilience by enabling organisations to anticipate change and respond effectively, rather than reacting under pressure.

The pull from regulators and investors…

Quantifying climate risk remains challenging, requiring both climate science literacy and financial analysis – capabilities that are still developing within many organisations.

At the same time, investor expectations are rising. As capital flows into sustainable assets, stakeholders increasingly demand transparency around climate-related risks. Over time, initiatives such as the Carbon Disclosure Project (CDP), the Task Force on Climate-related Financial Disclosures (TCFD), and more recently the International Sustainability Standards Board (ISSB) have aimed to improve the quality and consistency of disclosures – particularly disclosures that are decision-useful for financial stakeholders.

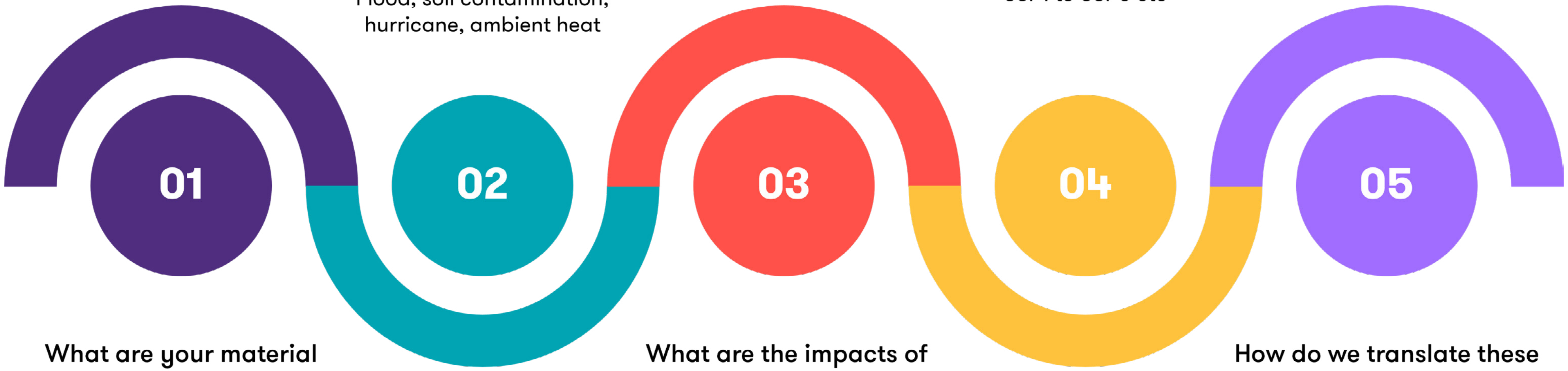
What began as largely voluntary, activist-driven initiatives has increasingly been embedded within regulatory frameworks.

In Singapore, this evolution has been progressive. The Singapore Exchange (SGX) introduced sustainability reporting in 2016 on a "comply or explain" basis. Climate-related disclosures aligned with the TCFD were subsequently mandated from FY2022 on a "comply or explain" basis for all issuers, before transitioning to mandatory requirements for selected industries in FY2023 and FY2024. In March 2024, SGX RegCo adopted the ISSB standards, following their endorsement by the Accounting and Corporate Regulatory Authority (ACRA) on 28 February 2024.

Some executives question the urgency given Singapore's relative insulation from certain physical climate risks; however, many Singapore-listed companies operate regionally and are exposed to diverse climate risks across Asia.

Climate disclosure is therefore not merely a compliance exercise. It is essential for maintaining transparency, investor confidence, and efficient capital allocation in an increasingly climate-exposed global economy.

How does one start to quantify climate risk?



What are your material climate topics?

Rainfall, soil use, wind, ambient temperature, etc

What are the risks associated to your identified climate topics?

Flood, soil contamination, hurricane, ambient heat

What are the impacts of these risks to your business?

Uncertainty in crop yield, land use restriction, etc

How do these impacts vary across climate scenarios?

Exacerbating heat stress from SSP1 to SSP5 etc

How do we translate these impacts into business impacts?

What are the losses associated with a variability in water supply

Step 1: What are your material climate costs?

The first step is awareness. Companies should assess which climate topics are relevant based on what they do, how they operate, and where they operate.

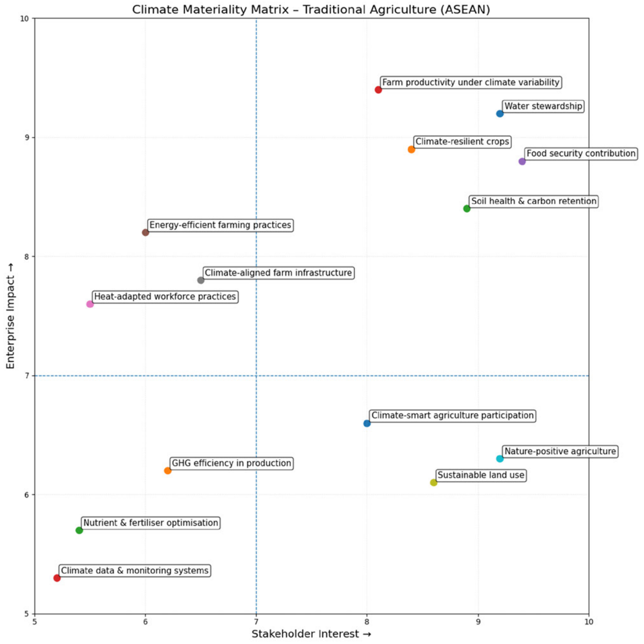
For example, a vertical farm in Singapore faces a very different risk profile compared to traditional farms elsewhere. While both operate in agriculture, their exposure to climate differs significantly.

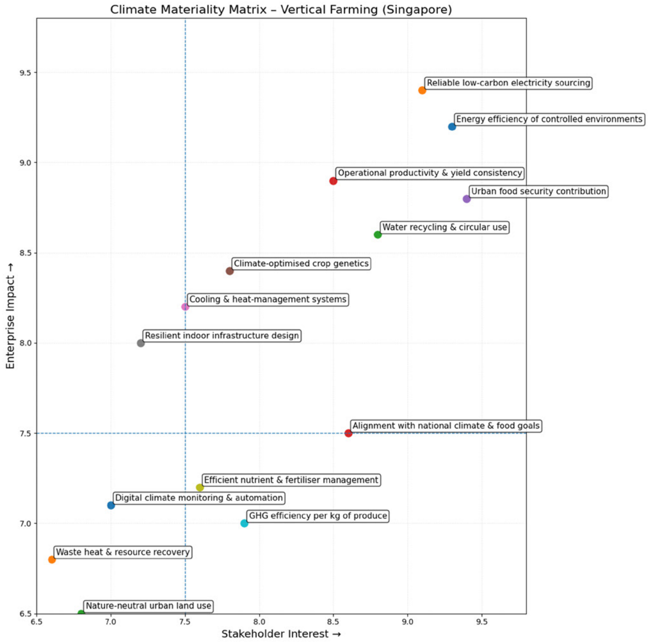
Traditional farms are directly influenced by weather patterns, making water availability, soil health, and climate variability highly material. In contrast, vertical farms operate in controlled environments, shifting materiality toward energy use, infrastructure efficiency, and system reliability.

This illustrates a key principle: climate materiality is not sector-wide, but highly dependent on business model and geography.

Generally, a climate materiality matrix can be developed via either through one or a combination of the below techniques:

- At the minimum, a climate materiality matric can be developed using internal expert judgement, where department heads and / or management teams assess climate topics based on their operational knowledge, financial exposure, and strategic priorities.
- Organisations can also construct one through broad stakeholder engagement, incorporating perspectives from investors, customers, regulators, employees, and supply chain partners to capture external expectations and perceived importance.
- For a more robust outcome, organisations may adopt a hybrid approach – starting with an internally generated long list of climate topics and preliminary scoring, and then refining and prioritising these through structured stakeholder consultations (e.g. surveys, interviews, or workshops). This combined method ensures that the matrix reflects both enterprise-level impact and stakeholder relevance, resulting in a more balanced, defensible, and decision-useful output.





Step 2: What are the risks associated to your identified climate topics?

Once material topics are identified, the next step is to map risks to each topic, recognising that different operating environments create fundamentally different risk exposures. Material climate topics can be such as rainfall, temperature, wind, or sea-level rise.

Once these topics are defined, the organisation can systematically associate specific risks to each topic by considering how changes in those climatic variables translate into tangible business impacts. For example, heightened rainfall intensity may give rise to flooding risks, while increased temperatures may drive heat stress, asset degradation, or higher cooling costs.

This approach helps anchor risk identification in physical climate realities rather than generic risk lists, ensuring that each identified risk is directly traceable to a material climate driver.

By structuring the process in this way, management can build a more coherent and defensible linkage between climate science and business impacts, which in turn supports more robust scenario analysis, risk quantification, and mitigation planning.

Step 3: What are the impacts of these risks to your business?

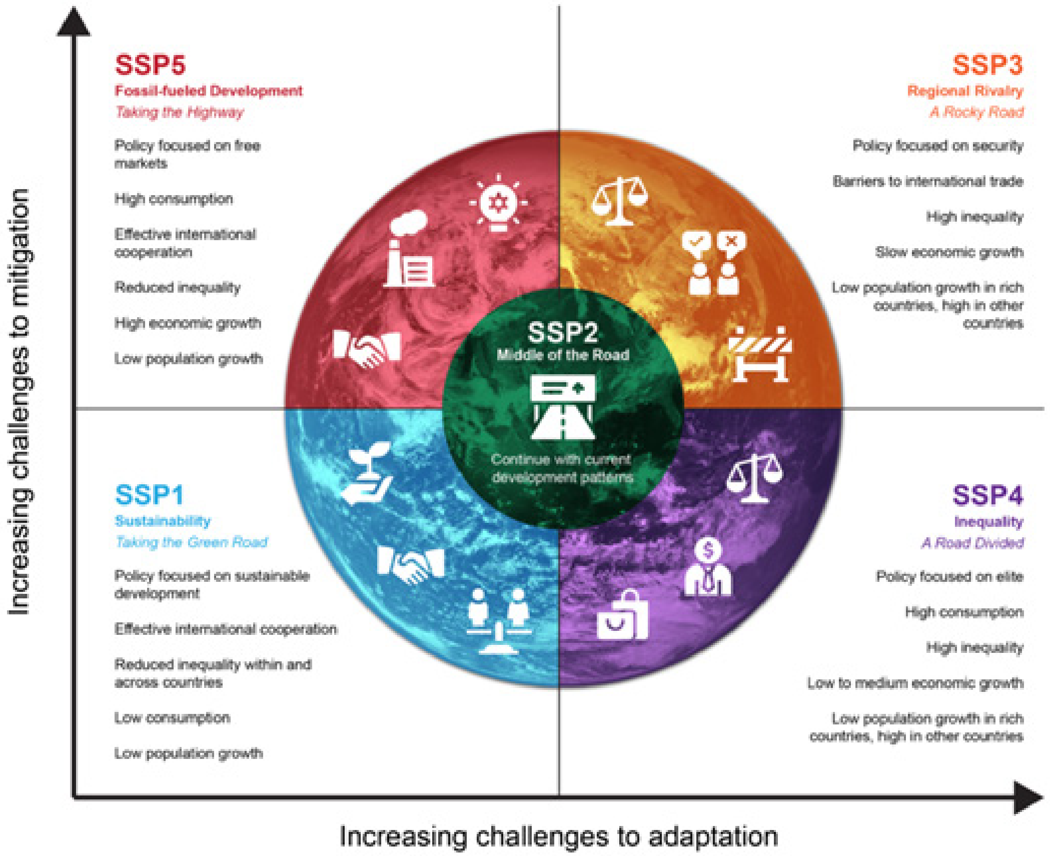
Each identified risk must be translated into operational and financial impacts, with clear impact pathways linking climate drivers to revenue, cost, and capital outcomes.

For traditional farms, rainfall variability associated to drought or flood will affect crop yields and revenue stability. For vertical farms, energy cost volatility directly impacts margins.

The key is to establish clear impact pathways, linking climate drivers to financial outcomes such as revenue loss, cost increases, or capital expenditure requirements.

	Material climate topic	Climate risk mapped to the topic	How the farming business is impacted
Traditional farms	Water stewardship and availability management	Increased rainfall variability, prolonged dry spells, and altered monsoon timing reduce water reliability, raising exposure to production shortfalls and irrigation constraints.	Uncertainty in irrigation availability leads to fluctuating yields, higher water management costs, and reduced ability to plan planting cycles, undermining revenue predictability.
	Climate-resilient crop and varietal selection	Rising temperatures and shifting precipitation patterns can render existing crop varieties less suitable, increasing yield volatility and replanting or transition costs.	Farming operations face declining productivity unless crop portfolios are adapted, increasing transition costs and lengthening payback periods for new varietals.
	Soil health and carbon retention practices	More frequent flooding, drought, and heat stress accelerate soil degradation and organic matter loss, undermining long term land productivity and increasing restoration costs.	Long-term land productivity declines, requiring higher input use, land restoration investments, or relocation of operations, increasing capital intensity.
	Farm productivity under climate variability	Greater frequency and intensity of extreme weather events disrupt planting, harvesting, and logistics, creating revenue volatility and higher operating risk.	Output volatility increases earnings variability, weakens supply commitments, and raises working capital and insurance requirements.
	Food security contribution across operating regions	Climate driven production shocks can reduce regional supply reliability, exposing the business to market volatility, export controls, and policy intervention during shortages.	Market volatility and regulatory responses (e.g. export controls, price stabilisation) affect pricing power, margins, and access to key markets.
Singapore vertical farms	Energy efficiency of controlled environments	Rising ambient temperatures increase cooling and lighting demand, heightening exposure to operating cost escalation in an energy intensive production model.	Operating costs rise in an energy intensive model, directly compressing margins unless offset by productivity or efficiency gains.
	Reliable low-carbon electricity sourcing	Dependence on grid electricity exposes operations to carbon intensity changes, electricity price volatility, and potential future carbon pricing or energy related regulation.	Cost of production becomes sensitive to energy market dynamics, affecting long term competitiveness and investment returns.
	Operational productivity and yield consistency	Climate driven stress on energy systems (e.g. heat waves increasing grid load) can affect uptime, system stability, and production consistency.	Any disruption to power or cooling systems can immediately halt production, impacting output consistency and customer supply commitments.
	Urban food security contribution	Climate-related disruptions to energy or cooling systems could constrain local production at precisely the time when import reliant supply chains are most exposed.	Reduced reliability of local supply undermines the strategic role of vertical farms in enhancing food resilience and weakens policy and stakeholder support.

Step 4: How do these impacts vary across climate scenarios?



Companies should utilise recognised climate scenario frameworks when assessing climate-related risks and opportunities. The most widely used are those developed by the Intergovernmental Panel on Climate Change (IPCC), including pathways such as SSP1-2.6 through to SSP5-8.5, which provide a foundational set of socio-economic and emissions trajectories.

These can be, but not required, complemented by more specialised frameworks, such as those developed by the Network for Greening the Financial System (NGFS), commonly used in financial risk analysis, and the International Energy Agency (IEA), which provides detailed energy sector transition scenarios.

Together, these scenarios describe a range of plausible future states shaped by differing levels of emissions, policy ambition and socio-economic development. They enable organisations to assess how the likelihood and severity of climate-related risks may evolve over time, recognising that impacts are often region- and hazard-specific.

Depending on the scenario, both the likelihood and severity of business impacts will vary. Higher emissions SSP pathways, along with the accompany climate data sets such as Singapore National Climate Change Study V3, generally increase both impact frequency and intensity of hazards, as adaptation and mitigation become more challenging.

	Material climate topic	How the farming business is impacted (impact pathway)	SSP1 (Sustainability / lower emissions)	SSP3 (Regional rivalry / fragmented, high challenges)	SSP5 (Fossil fuelled / highest emissions)
ASEAN traditional farms	Water stewardship and availability management	Water reliability drives irrigation stability → yield consistency → revenue predictability. Drier spells and rainfall variability increase cost of water access/storage and reduce planted-area reliability.	**Medium:** Physical stress rises but moderated; more orderly adaptation and planning reduce disruption.	**High: Physical stress plus constrained coordination/ technology diffusion increases operational disruption and cost volatility.**	**Very high:** Highest climate load amplifies drought/rainfall variability → most pressure on irrigation costs and yield stability.
	Climate-resilient crop and varietal selection	Shifting temperature/rainfall changes crop suitability → replanting cycles, R&D/seed costs, yield volatility, longer payback for varietal changes.	**Medium:** Transition can be planned; lower warming reduces rate of suitability loss.	**High:** Fragmented support and slower technology transfer raise adaptation cost and lag risk.	**Very high:** Rapid and severe warming accelerates variety obsolescence; higher spend needed to maintain yields.
Singapore vertical farms	Energy efficiency of controlled environments	Higher ambient heat → higher cooling load → higher electricity consumption → margin compression in an energy intensive model.	**High (but manageable):** Heat stress rises; energy burden increases but lower than SSP5; efficiency upgrades are more effective over time.	**High:** Heat stress rises and system level constraints may be harder to resolve under fragmented pathways.	**Very high:** Largest structural cooling burden and operating cost pressure.
	Reliable low-carbon electricity sourcing	Dependence on grid power → exposure to electricity price volatility, carbon intensity and future carbon related costs → competitiveness and investment returns.	**Medium:** Faster decarbonisation and clearer policy reduce carbon cost shocks; electricity remains material but more predictable.	**High:** Fragmented transition can mean more uneven price signals and reliability concerns, raising long run cost uncertainty.	**High–Very high:** Greater risk of abrupt cost adjustments; energy remains dominant cost driver.

Step 5: How do we translate these impacts into business impacts?

In practice, risks are managed by weighing likelihood against impact. Climate risk is no different, and this is typically summarised in a scenario-based risk table.

	Impact pathway	SSP1 – Lower-emissions pathway: estimated business impact likelihood and impact intensity	SSP3 – Fragmented pathway: estimated business impact likelihood and impact intensity	SSP5 – High-emissions pathway: estimated business impact likelihood and impact intensity
ASEAN traditional farms – Water stewardship and availability management	Water reliability drives irrigation stability → yield consistency → revenue predictability. Drier spells and rainfall variability increase the cost of water access/storage and reduce reliability of planted acreage.	**Estimated likelihood of material business impact over 10 years:** 40-55% (based on company translation of regional hazard-frequency data into business impact likelihood). **Impact intensity if materialised:** Moderate. A multi-country farm group with USD 120m annual revenue faces a two-season rainfall deficit affecting 35% of acreage. Yield declines 8–12% on affected acreage, resulting in USD 4.0–6.0m lost revenue. Mitigation measures, including temporary pumping, water trucking, overtime irrigation and agronomy interventions, add USD 1.0–1.5m. **Estimated financial impact:** USD 5.0-7.5m, equivalent to ~4–6% of annual revenue. **Illustrative expected value:** USD 2.0–4.1m.	**Estimated likelihood of material business impact over 10 years:** 60–75% (higher hazard frequency and weaker adaptation conditions increase business impact likelihood). **Impact intensity if materialised:** High. Water shortfalls are more persistent and harder to offset due to slower technology diffusion and weaker cross-border coordination. A comparable two-season shortfall affects 45% of acreage, with 12–18% yield decline on affected acreage, resulting in USD 6.5–9.5m revenue loss. Higher contingency spending for water access and infrastructure workarounds adds USD 2.0–3.0m. **Estimated financial impact:** USD 8.5–12.5m, equivalent to ~7–10% of annual revenue. **Illustrative expected value:** USD 5.1–9.4m.	**Estimated likelihood of material business impact over 10 years:** 75-90% (higher emissions pathway increases hazard intensity/frequency; business likelihood depends on exposure and adaptation capacity). **Impact intensity if materialised:** Very high. Higher emissions conditions intensify dry spells and rainfall variability, increasing irrigation stress. In a severe two-season sequence, 50% of acreage is affected. Yield declines 18–25% on affected acreage, resulting in USD 10–15m revenue loss. Emergency water sourcing and accelerated capex, including reservoir expansion, irrigation redesign and drought-resilient upgrades, add USD 3–5m. **Estimated financial impact:** USD 13–20m, equivalent to ~11–17% of annual revenue. **Illustrative expected value:** USD 9.8–18.0m.

	Impact pathway	SSP1 – Lower-emissions pathway: estimated business impact likelihood and impact intensity	SSP3 – Fragmented pathway: estimated business impact likelihood and impact intensity	SSP5 – High-emissions pathway: estimated business impact likelihood and impact intensity
Singapore vertical farms – Energy efficiency of controlled environments	Higher ambient heat → higher cooling load → higher electricity consumption → margin compression in an energy-intensive model.	**Estimated likelihood of material business impact over 10 years:** 30-45% (derived from projected heat-related hazard frequency and company-specific cooling sensitivity). **Impact intensity if materialised:** Moderate to high. A vertical farm with SGD 25m annual revenue and SGD 6m annual electricity cost sees sustained higher cooling demand, combined with moderate price pressure. Net electricity costs rise 10–15%, resulting in SGD 0.6–0.9m annual OPEX increase. If EBITDA margin is 12%, this cuts EBITDA by ~2–4 percentage points unless offset by efficiency improvements. **Estimated financial impact:** SGD 0.6-0.9m/year. **Illustrative expected value:** SGD 0.18–0.41m per year.	**Estimated likelihood of material business impact over 10 years:** 45-60% (higher heat stress and less favourable system conditions increase operating sensitivity). **Impact intensity if materialised:** High. Heat stress increases and wider system constraints make efficiency gains slower to realise. Electricity costs rise 15–25%, due to higher cooling runtime and less favourable price dynamics. This results in SGD 0.9–1.5m annual OPEX increase. Short, episodic downtime and wastage could add SGD 0.2–0.4m equivalent impact. **Total impact:** SGD 1.1-1.9m/year in a bad year. **Illustrative expected value:** SGD 0.50–1.14m per year.	**Estimated likelihood of material business impact over 10 years:** 60-75% (higher emissions conditions increase cooling-load stress; actual business impact depends on facility design, energy contracts and resilience measures). **Impact intensity if materialised:** Very high. V3-style heat stress escalation is most severe under high-emissions conditions, driving structurally higher cooling loads. Electricity costs rise 20–35%, resulting in SGD 1.2–2.1m annual OPEX increase. If the farm requires an unplanned cooling retrofit earlier than expected, an additional SGD 1.5–3.0m one-off capex shock may arise, with depreciation or finance costs thereafter. **Total impact:** SGD 1.2-2.1m/year plus potential SGD 1.5-3.0m capex shock. **Illustrative expected value:** SGD 0.72–1.58m per year, excluding capex; higher if retrofit capex is probability-weighted.

How to use the quantification table

In practice, the table is typically used for internal management reporting to assess a company's financial exposure to climate risk, or as part of external sustainability disclosures – particularly those aligned with ISSB requirements.

For illustrative purposes, the table above provides a hypothetical, scenario-based quantification of climate risk across different climate futures (SSP1, SSP3 and SSP5), showing (i) the likelihood of a material business impact over a 10-year horizon and (ii) illustrative financial consequences if the risk materialises.

The table traces a clear impact pathway from climate drivers (such as rainfall variability and rising ambient temperatures), through operational effects (including reduced irrigation reliability, yield volatility, or higher energy demand), and ultimately to financial outcomes, such as revenue loss, cost escalation, and potential capital expenditure.

By structuring the analysis across progressively more challenging climate scenarios, the table illustrates how both the frequency and magnitude of impacts increase under higher-emissions pathways. Do note that the numbers presented in the table are purely for illustration purposes and are not intended to be representative of reality.

This approach provides a decision-useful view of downside exposure under different climate conditions.

So how do we estimate the financial impact of climate risk?

As shown above, climate risk (both physical and transition) can be quantified using an Expected Value (EV) framework:

Expected Value = Probability of business impact × Financial impact

The Expected Value (EV) framework combines likelihood and impact to produce a single, decision-useful estimate over time.

This enables consistent comparison and prioritisation, supporting capital allocation under uncertainty.

The EV framework requires two key inputs:

1. Probability of business impact

Unlike many operational risks, climate risks and their business impacts cannot be assessed using historical data alone. Instead, organisations infer business-impact likelihood by combining inputs such as climate projections and historical trends.

- Climate projections (e.g. IPCC scenarios, national climate studies such as Singapore Climate Projections V3)
- Historical trends

IPCC scenarios are not probabilistic forecasts; they provide directional "what-if" pathways. Probabilities are therefore applied to business impacts, not to the scenarios themselves.

Companies should treat scenarios as stress tests: "If the climate evolves in this way, what does it mean for our operations, assets, costs and revenues?"

While IPCC scenarios are not assigned probabilities, they provide robust directional signals (e.g. hotter conditions, heavier rainfall, longer dry spells). Organisations can translate these into business-impact likelihoods by considering (i) signal strength, (ii) exposure and sensitivity, and (iii) relevant planning horizons. In this framework, probabilities apply to business impacts, not to the scenarios themselves.

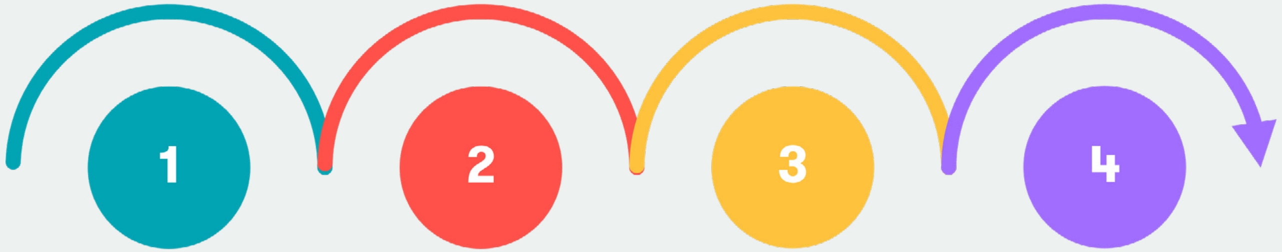
Directional signals (e.g. more frequent heat stress) can be translated into probability bands (low/medium/high) based on signal strength, exposure and sensitivity.

- Strength of the climate signal
- Degree of exposure
- Sensitivity of the business

2. Financial value of impact

Financial impact is typically estimated in a manner similar to corporate planning and stress-testing, assessing how different climate conditions could affect operations and financial performance over time.

This process generally involves several structured steps:



Establish base year
Base year operational and financial parameters

Defining climate-driven deviation from base year
Changes and their magnitudes

Translate impacts into operational impacts
Implications for actual operational performance

Convert into financial impacts
Converting operational metrics into financial impacts

Limitation of the Expected Value framework

While the EV framework is a useful starting point for prioritisation and capital allocation, climate risks are characterised by fat-tailed distributions, non-linear damage functions, and the potential for compounding and cascading impacts. As a result, relying on point-estimate EVs alone risks materially understating downside exposure.

In practice, EV-based assessments should be complemented by explicit consideration of tail outcomes, stress scenarios, and loss amplification mechanisms. This can be achieved by incorporating asymmetric probability weightings, modelling impact escalation beyond critical thresholds, and evaluating outcomes across severe but plausible scenarios rather than around a single mean.

Such an approach preserves the intuitive appeal of EV while ensuring that planning and risk responses are calibrated to the full distribution of outcomes, particularly for low-probability, high-severity events that can disproportionately affect financial performance and resilience.

An illustration

The example below illustrates how climate signals can be translated into EV using the farming examples.

1. Probability of business impact

A. Establish the relationship between climate condition, business impact and sensitivity

For example, higher ambient heat → higher cooling load → increased electricity consumption electricity use → margin compression in an energy-intensive model.

The next question is whether the persistence of this condition would materially affect costs, margins, or operational reliability. For a typical vertical farm, key sensitivities include:

- Cooling loads that increase non-linearly with higher temperatures
- Energy costs that are variable and market-linked
- Operating margins that are sensitive to increases in energy-related costs

Taken together, these factors indicate that the business is financially sensitive to sustained increases in heat stress. At this stage, three critical elements have been established:

- the relevant climate condition,
- the business's exposure, and
- its sensitivity to that condition.

B. Establish the directional shift in climate conditions

Using Singapore's Climate Projection V3 as an example, the report describes Singapore ambient heat development as "temperatures will rise under all emissions scenarios," "very hot days and warm nights will become more frequent," "extreme rainfall intensity is projected to increase," and "dry periods may become more severe".

These statements represent high-confidence directional signals. While they are not probabilities, they clearly indicate the direction in which the climate system is evolving. Directional signals provide an essential foundation for understanding where climate-related stresses are likely to intensify.

C. Establish the intensity of the climate condition vis-à-vis the baseline

Singapore Climate Projection V3 describes ambient temperature changes as follows: "Occurrences of high heat stress (WBGT ≥ 33 °C) are projected to become significantly more frequent by end-century under all emissions scenarios, with high heat stress days exceeding moderate heat stress days under the high-emissions scenario."

From this statement, it is reasonable to infer a baseline condition that Singapore's operating environment will be materially hotter for a greater proportion of the year.

D. Derive a business-impact likelihood band

In this example:

- the climate projection states that high heat stress becomes "significantly more frequent,"
- the language does not suggest the outcome is possible, rare, or highly uncertain, and
- the business exhibits both high exposure and high sensitivity to the projected condition.

Together, these factors support a qualitative-to-quantitative translation, allowing the company to assign a likelihood band to the probability of material business impact, even though the underlying climate scenario itself is not probabilistic.

In this instance, purely for illustration, we assume that the farm adopts a business impact likelihood band in the following table.

Likelihood band	Indicative range (10-year horizon)	How it should be interpreted	Typical climate context
Low	<20%	Possible but unlikely; requires multiple adverse conditions to coincide	Weak or mixed climate signals; high uncertainty; low exposure or strong buffers
Low–Medium	20–35%	Credible risk, not expected to materialise frequently	Directional climate signal present, but episodic or partially mitigated
Medium	35–50%	As likely as not over the planning horizon	Clear climate trend, moderate exposure and/or sensitivity
Medium–High	50–65%	Business impact is more likely than not; should be actively planned for	Strong, recurring climate signal; high exposure or sensitivity
High	65–80%	Likely to occur at least once in the period	Climate signal is strong, persistent, and robust across scenarios
Very high	>80%	Highly likely (inevitable without intervention)	Structural climate change with high exposure and high sensitivity

To get to an indicative range, map projection language to the likelihood bands to derive an indicative probability range.

V3 language on ambient heat	Business interpretation	Contribution to probability of business impact
"Becomes significantly more frequent"	Condition is likely to recur regularly (Strong)	High – 65-80%
"Under all emissions scenarios"	Low scenario uncertainty (Very strong)	Structural climate change with high exposure and high sensitivity
"Reversing today's pattern"	Structural, not episodic change (Strong)	

Consequently, for other risks such as rainfall flood where risk is expressed in less "severe" terms, the likelihood band is nearer to 20-35% to business impact based our business-impact likelihood table, which is essentially "Low-to-medium" likelihood that rainfall flood driven cost pressure will materially affect operations.

This exercise should be repeated across all material climate risk faced by the company within the time horizon that it has chosen as a time frame for reference.

2. Financial value of business impact

Next, estimate the financial value of that impact should the climate condition materialise.

For illustrative purposes, we focus on the financial impact of water supply variability of the ASEAN farmer featured earlier. In this scenario, water variability is expected to affect crop yields (assumed here to be grain), which in turn introduces volatility in production volumes and, consequently, revenue from grain farming.

Now, apply planning assumptions to translate climate variability into quantified financial impacts.

A. Establish base year (year 0)

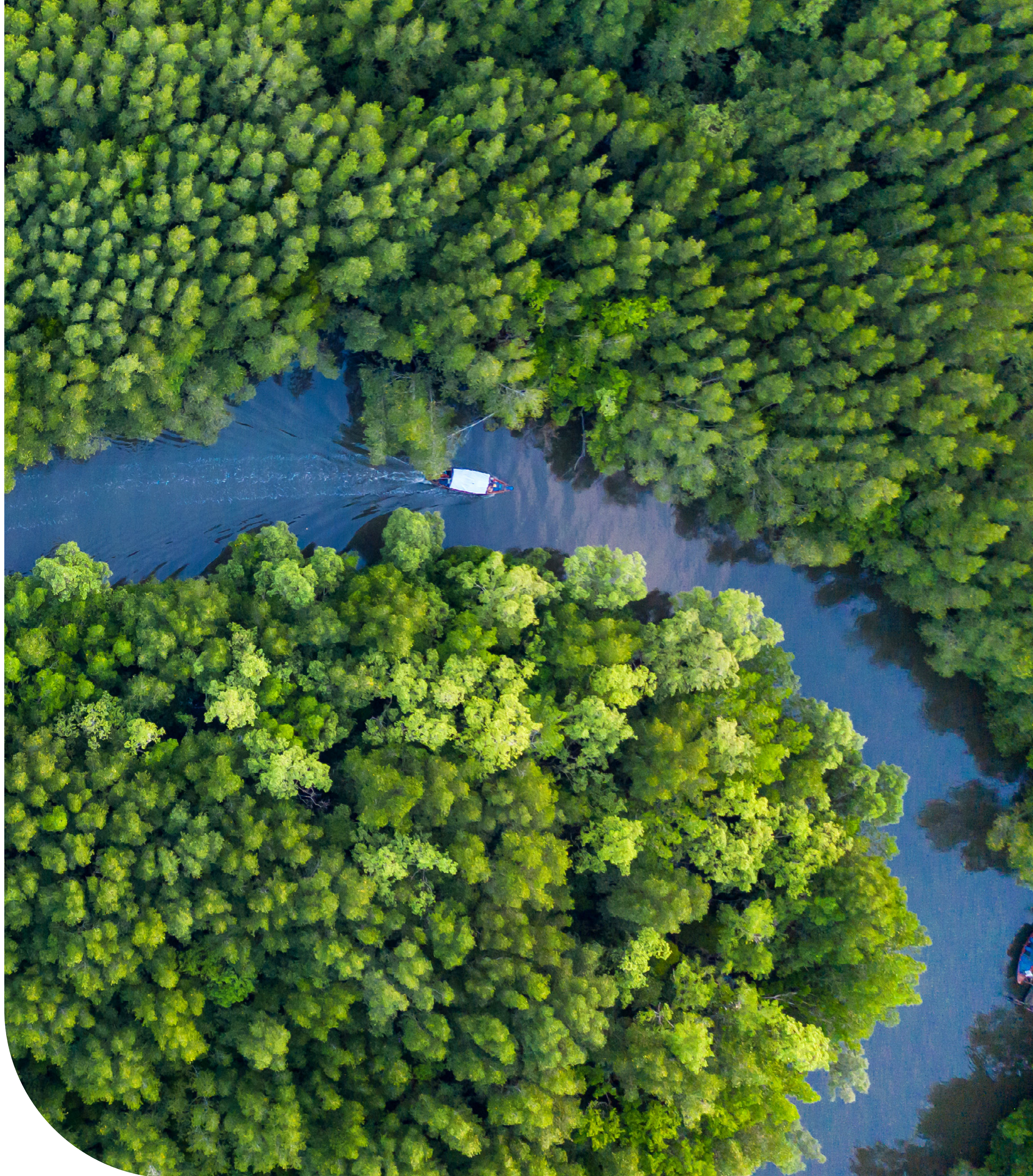
In this case, baseline metrics such as the amount of water supply, planted area, average crop yield, average crop price (revenue) and baseline cost structure can be used as a basis to extrapolate given the climate outcome (water supply) in the future.

Category	Assumption
Baseline water supply	100% (indexed)
Baseline planted area	100% of normal acreage
Baseline average crop yield	100% (e.g. tonnes per hectare)
Baseline revenue	100% (or absolute value, e.g. USD 100m)
Baseline price	Constant in real terms (price risk excluded)
Baseline cost structure	Held constant for this simulation (cost effects optional add on)

B. Ascertain the climate variability

In this case, water supply variability is the driver. From the regional climate data, we assumed, for the purpose of this study, we can get rainfall variability projection data – e.g. Sumatra and Java show an increase in dry-spell length "of up to 40%" in the near future.

Planning period	Water supply variability (vs baseline)
Years 1–5	±30%
Years 6–10	±40%



C. Translate climate variability into operational data

To translate climate varaibility into operational data, we often refer to peer-reviewed sources or internal expert data. In this instance, according to major studies, a 5% water shortfall is likely to result in a 3.5% in effective irrigation shortfall. The shortfall in turn will cause a 3.6% reduction in crop yield (assuming that yield response factor to irrigation shortfall is approximately 1.1×.

Effective irrigation shortfall (%) = Water supply variability (%) x Water-to-irrigation transmission factor

Yield reduction (%) = Effective irrigation shortfall (%) × 1.1

Item	Assumption
Water to irrigation transmission factor	70% A 5% water shortfall results in a 3.5% effective irrigation shortfall
Yield response factor	1.1× Every 1% effective irrigation shortfall causes 1.1% yield reduction

Period	Water variability	Effective irrigation shortfall	Yield reduction
Years 1-5	−30%	−21%	−23%
Years 6-10	−40%	−28%	−30%

Period	Area temporarily not planted / under-utilised
Years 1-5	1% Delayed planting, rotation shifts, water rationing
Years 6-10	2%

D. Translate operational data into financial impact

Revenue impact channels:

- Yield loss on planted area
- Lost production from unplanted area

Revenue impact (%) = (1–Yield reduction (%)) × (1 – Area loss) - 1

Period	Yield reduction	Area loss	Revenue impact
Years 1-5	−23.1%	−1.0%	~ −24%
Years 6-10	−30.8%	−2.0%	~ −32%

E. Summary impact

Assumptions are illustrative and should be replaced with crop- and region-specific coefficients. What this illustration strives to do is to provide guidance on how to approach translating climate risk to financial impact.

Assumption	Years 1-5	Years 6-10
Water supply variability	±30%	±40%
Irrigation transmission factor	70%	70%
Yield response factor	1.1×	1.1×
Yield reduction	−23%	−30%
Area reliability loss	−1.0%	−2.0%
Revenue impact (downside)	~ −24%	~ −32%

However, the above example is an example on how to model the financial impact of water variability on an ASEAN farm. Different climate risk had a different relationship with crop yield (e.g. wind, heat etc.) but most can be modelled reasonably using public / academic resources (e.g. yield response factor).

Key takeaways

As increasing capital and effort are directed toward new sustainable industries, as well as the sustainable transformation of traditional sectors, investors are seeking greater clarity on the climate-risk exposure of their investee companies and assets.

At the same time, regulators are progressively requiring companies to disclose their exposure to climate-related risks and to articulate how these risks are being addressed – whether through avoidance, mitigation, adaptation measures or others.

This represents a significant undertaking. It requires the integration of skillsets that do not typically coexist: an understanding of climate science, and the ability to translate climate-related hazards into meaningful financial and business impacts.

Adding further complexity, while the EV framework provides a broadly applicable foundation, the quantification of climate risks is not uniform across risk types. As illustrated in this paper, different hazards – such as ambient heat, wind, or rainfall – require distinct approaches to risk quantification.

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