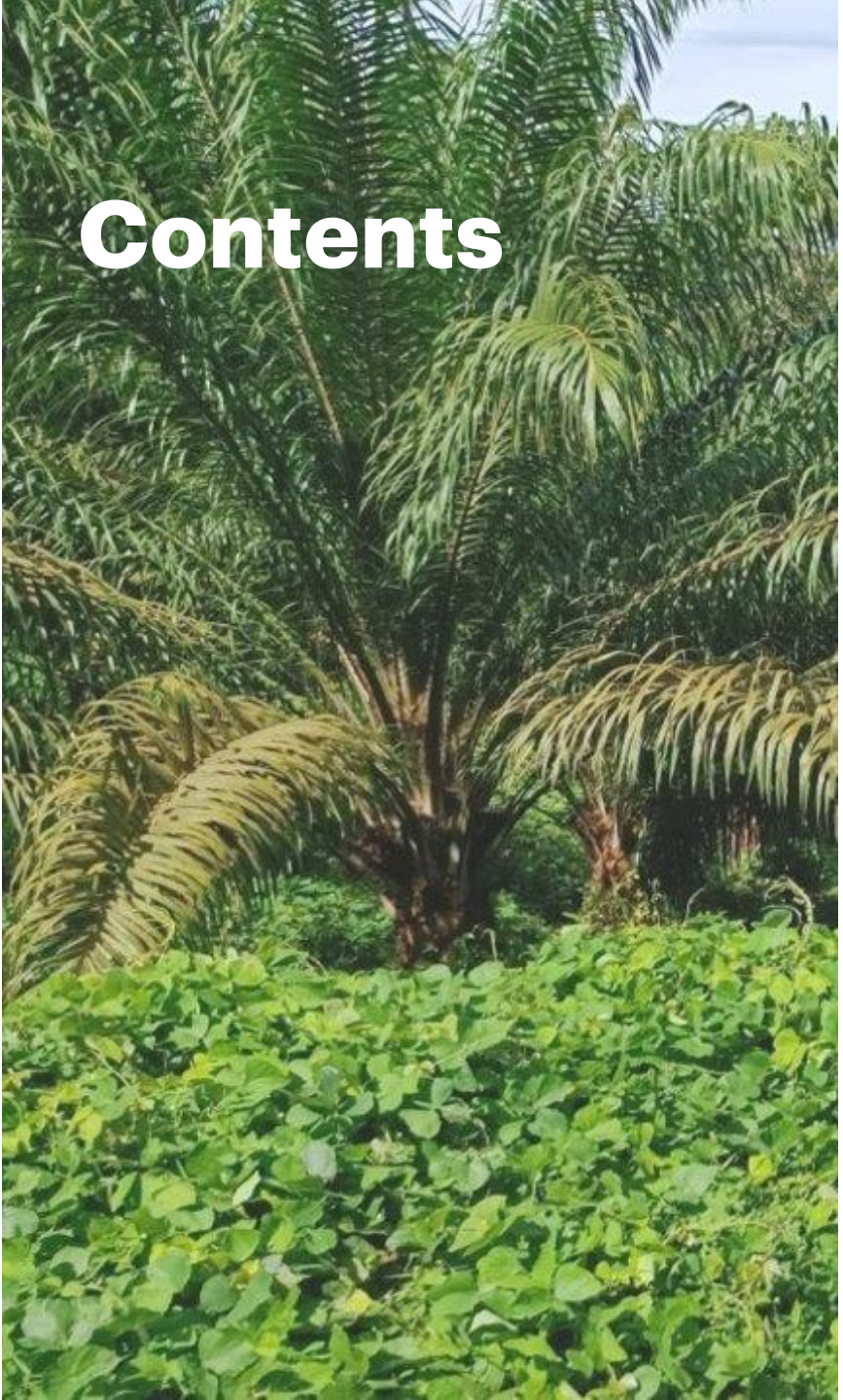
Accelerating Climate Resilience at AEP

Climate Scenario Analysis

December 2023



Contents

1

Executive Summary

Summary of Findings

This report summarises the process and findings of scenario analysis conducted for 5 (2 transition and 3 physical) strategically important climate and nature risks for AEP. Transition risks are the highest in Orderly and Disorderly scenarios, whereas physical risks are most pronounced in the Hot house scenario.

Transition risks emerge primarily from increasing expectations re: climate and nature performance (from both regulators and customers) and *non-compliance* with those expectations would create a High level of risk in both the Orderly and Disorderly scenarios in the long-term.

Projections for drought and flood risk at AEP's sites are reassuring, even under a Hot house scenario. No discernible trend in drought is projected for any of AEP's sites through to 2050; and although projections suggest flood risk at AEP's sites will increase slightly, AEP is already operating – without any significant disruption – within areas that are categorized as having high flood risk. Nevertheless, palm in Malaysia/Indonesia *is* vulnerable to the El Niño/La Niña cycle, which is not well-captured in climate projections. AEP should monitor ongoing research into how climate change could influence this cycle. The aggregated impacts of climate change as temperatures rise have the potential to significantly impact palm yield in the long-term, particularly in the Disorderly and Hothouse scenarios (in which the potential financial impact on AEP is deemed High by 2050).

An additional high-level exploration of systemic risk flagged the possibility that climate and nature risk might emerge more rapidly, and/or have more fundamental impacts, than suggested by the scenario analysis.

Accenture's analysis suggests that AEP has a good degree of resilience, at least in the short term, to the risks identified. It is currently managing drought and flood risk effectively and is making progress on traceability and emerging expectations around climate and nature. AEP's decision to pursue RSPO certification, and its efforts to align with the traceability requirements of the EU Deforestation Regulation (EUDR), are likely to provide short-term resilience within a rapidly-evolving regulatory landscape.

AEP's key climate transition & physical climate risks: summary of financial impact assessment

Climate Scenario	Orderly			Disorderly			Hot House		
Time horizon	Short (2024-25)	Med (2025-30)	Long (2030-50)	Short (2024-25)	Med (2025-30)	Long (2030-50)	Short (2024-25)	Med (2025-30)	Long (2030-50)
Regulation/ Policy	Low	Moderate	High	Moderate	Moderate	High	Low	Low	Moderate
Customer Expectations	Low	Moderate	High	Low	Moderate	Moderate	Low	Low	Moderate
Flood	Low	Low	Low	Low	Low	Low	Low	Low	Low
Drought	Low	Low	Low	Low	Low	Moderate	Low	Low	Moderate
Temperature	Low	Moderate	Moderate	Low	Moderate	High	Low	Moderate	High

Low	Would result in small decline in revenue (<1%), limited impact on operations, or small reputational impact in local or niche media
Moderate	Would result in moderate decline in revenue (1-5%), moderate impact on operations, or moderate reputational impact in mainstream media
High	Would result in serious decline in revenue (>5%), severe impact on operations, or severe reputational impact in mainstream media

Key Findings 1

AEP engaged Accenture to conduct scenario analysis of strategically important climate and nature risk. Scenario analysis is a process of examining risk trajectory in different plausible scenarios across multiple time horizons. It is used to understand long term risk exposure, strengthen strategic decision making and empower businesses with a wider view of how climate and/or nature may impact their operations and/or revenue. This process entailed identifying a long list of climate and nature risks relevant to AEP and selecting the most strategically important ones for scenario analysis.

AEP's current resilience. Our research suggests that AEP has a good degree of resilience, at least in the short term, to the risks identified in this research. It is currently managing drought and flood risk effectively and is making progress on traceability and emerging expectations around climate and nature. The ways in which physical climate and nature risk might manifest in the future is uncertain, but climate change is likely to pose challenges to yield over longer timeframes – especially in scenarios in which action on climate change/nature stalls. AEP's decision to pursue RSPO certification, and its efforts to align with the traceability requirements of the EU Deforestation Regulation (EUDR), are likely to provide short-term resilience within a rapidly-evolving regulatory landscape, but the company should be aware that regulatory and customer expectations around climate and nature could change rapidly.

Risk Category	Key Project Findings
Systemic Risk • A step-change in climate/nature action • A climate-instigated economic shock • A breakdown in ecological processes	Systemic risk – which concerns the potential destabilisation and/or breakdown of the underlying physical and socio-economic systems that all economic activity relies on – is very hard to project or to plan for. Nevertheless, the possibility that the climate and ecological crises, and/or the societal response to both, might result in rapid, disruptive change cannot be discounted (particularly in the long-term). AEP should therefore consider the possibility that disruptive change might occur more rapidly than projected as part of its planning process – and be ready to react to a rapidly changing regulatory environment and/or marketplace. Whilst unlikely within the timeframes considered in this project, systemic risks become more likely the warmer the planet gets and are more likely to manifest if climate change isn't tackled at a global level. AEP should therefore seek to leverage its influence with key external stakeholders (especially governments, but also peers and sectoral bodies) to help ensure global warming is kept as low as possible. Managing its own performance well, and being able to demonstrate leadership across climate and nature issues, will increase AEP's effectiveness as an advocate for wider change.

Key Findings 2

Risk Category	Key Project Findings
Transition Risk • Regulation/ Policy • Changing Customer Expectations	A wide range of climate- and/or nature-related regulation has been adopted, is in consultation, or has been proposed in different jurisdictions around the world, especially within the EU. Given its historic associations with tropical deforestation, the palm sector is often a specific focus of emerging regulation on nature – notably the EU Deforestation Directive (EUDR). Additional regulation (and related standards) covering a wide range of related topics, from carbon pricing and trading schemes; emissions reporting; risk and resilience reporting; transition planning; corporate alignment with national, and other science-based, targets around climate and nature; etc are also adding complexity to AEP's operating context. A number of AEP's most important customers – and their customers – are also increasingly vocal about their efforts to tackle climate change, protect biodiversity and, increasingly, to promote carbon-smart or regenerative agriculture practices. There is considerable uncertainty as to how regulations and expectations might play out over time, and no guarantee that they will strengthen, but in scenarios that limit warming to 1.5C – and/or in which concern about nature/biodiversity continues to grow – it is highly likely that expectations of palm growers will tighten significantly. RSPO remains the voluntary certification scheme of choice for FMCG companies in Europe and North America, and in our Orderly scenario it becomes an *essential* component of market access not only in these markets but globally. The risks of non-compliance are very high in this scenario, but the costs of compliance are relatively low (although by no means insignificant) given international alignment and widespread support mechanisms. This contrasts with the Disorderly scenario, in which expectations from certain markets/customers also increase, but where expectations vary and no one certification scheme meets the needs of all customers. Compliance costs – for palm growers that continue to seek to sell into all markets – therefore grow significantly. Even in scenarios in which governments hesitate or step back from further action on climate and/or biodiversity, it is likely that expectations from some FMCGs and investors in Europe and North America in particular will continue to tighten. The role of the RSPO becomes less certain in these scenarios, and some growers might choose to voluntary exclude themselves from certain markets, but improved performance across certain metrics is still likely to be critical in enabling access to certain markets.

Key Findings 3

Risk Category	Key Project Findings
Physical Risk • Flood • Drought • Temperature	Projections for drought and flood risk at AEP's sites (using the WWF Water Risk Tool) are reassuring, even under a Hothouse scenario (systemic risk notwithstanding). No discernible trend in drought is projected for any of AEP's sites through to 2050; and although projections suggest flood risk at AEP's sites will increase slightly, AEP is already operating – without any significant disruption – within areas that are categorized as having a high risk of flooding. Nevertheless, palm in Malaysia/Indonesia *is* vulnerable to the El Niño/La Niña cycle, with El Niño being associated with drought conditions that significantly impact yield, and La Nina being associated with wetter conditions that can disrupt operations. Prior El Niño's have been associated with annual yield reductions of some 15%, and the Malaysian government has warned that the ongoing 2023/2024 El Nino event could impact at a similar level of magnitude. Research into climate change's impact on the El Nino cycle is emergent/dynamic, but projections suggest an increase in both frequency and intensity are likely. These changes are not yet factored into models used to explore drought and flood risk, and thus projected impacts likely underplay both the risks of drought impacting yield and flooding impacting operational efficiency. Projections that consider the potential combined/aggregated impacts of climate change on the palm sector in Indonesia and Malaysia are not consistent across all studies. Paterson, 2023, for example, suggests that Malaysian palm yield will not be negatively impacted by climate change through to 2030, and that yield could even *increase slightly* by 2050 in response to climate change. Other research (e.g., Sankar et al, 2020), however, has suggested that the aggregated impacts of climate change as different temperature thresholds are crossed will indeed have a negative impact on palm yield – and modelling based on Sankar et al's findings suggests that, in the Disorderly, and especially the Hothouse, scenarios AEP's potential exposure crosses into our categorisation of High risk by 2050. The uncertainty across different studies with regard to this risk is a frustrating finding for any company seeking to understand its exposure to climate risk, but scenario analysis isn't intended to resolve uncertainty, but to reveal it. And AEP should factor in the possibility of significant impacts over longer time horizons into its strategic planning.

Summary of scenarios used to assess risk

For physical risk analysis, temperature alignment was used to differentiate scenarios. For transition risk, bespoke scenarios – based on standard archetypes – were created based on policy and consumer trend research.

Archetype	Orderly	Disorderly	Hot House
Temperature alignment (2100)	**~1.5°C**	**>2°C**	**>4°C**
External Data Alignment	RCP 2.6 (IPCC) Optimistic (WRI/WWF) Net Zero 2050 (NGFS)	RCP 6.0 (IPCC) Current/Business as Usual (WRI/WWF) Delayed Transition (NGFS)	RCP 8.5 (IPCC) Pessimistic (WRI/WWF)
Summary	Strong, sustained and internationally-coordinated action on climate results in net zero emissions being achieved globally by 2050. Nature rapidly emerges as a key issue for companies and governments alike through the 2020s.  **Inter-governmental harmonisation**  **Green growth & nature regeneration**	Climate and nature action is divergent across countries and sectors. Differing, and sometimes competing regulations, incentives and climate/nature 'solutions' are embraced in different regions.  **Mixed/delayed signals from Governments**  **Disputed 'solutions'**	Governments fail to build on current policies and action is insufficient to keep warming below 2°C by 2050. Progressive investors and companies attempt to drive continued action and activism becomes increasingly unpredictable and extreme.  **Radical activism**  **Extreme weather**
Associated 'what if' questions	• *What if all current and proposed climate- and nature- regulation is adopted and scaled globally?* • *What if customers demand best-practice on both climate and nature?*	• *What if a complex/conflicting regulatory landscape emerges, with differing regional priorities and/or differing emphases on nature/climate?* • *What if key customers impose differing demands on growers re: climate and nature?*	• *What if no new regulation is introduced to drive climate action and progress on nature stalls?* • *How might customers – and other stakeholders – respond if governments backtrack?*

Risk summary

NB. For Physical Risks, AEP's 'potential exposure' is primarily informed by the financial modelling that has been undertaken (although the ranking of drought risk in the long-term has also been informed by additional qualitative analysis). For Transition Risks, AEP's ranking has been informed by qualitative assessment.

	Risk	Potential Impact	Scenario	Potential Exposure (by Time Horizon)			Notes / Rationale
				Short (2025)	Med (2030)	Long (2050)	
Transition Risk	Regulation	Increasing climate and nature regulation could increase compliance and reporting costs, require changes in growing practices and, if compliance is not achieved, limit market access.	Orderly	Low	Moderate	High	Risk is low in short-term as the EU resolves concerns about the implementation of the EUDR, granting a grace period for smallholder performance and implementing support mechanisms to help growers meet requirements. Risk grows over time however, with significant reporting and implementation costs emerging over time as climate and nature regulation escalates. Global reporting and performance requirements align over time, helping to limit the costs of compliance, but ever-increasing obligations across a range of sustainability criteria require continual investment by growers. Effective international and national financial support helps growers manage these costs.
			Disorderly	Moderate	Moderate	High	Risk is moderate, even in the short-term, as the EUDR is rigorously enforced in 2025 and implications flow through the global palm market. Risks grow over the medium- and long-term as regulation is developed and enforced in other markets. Different expectations and frameworks apply in different geographies; and there is a lack of alignment between climate and nature policy. Reporting and compliance costs are very high for companies seeking to access all markets.
			Hothouse	Low	Low	Moderate	Low in the short- and medium-term as no new climate/nature regulation is introduced or enforced. Risk increases in the longer-term as a result of protectionism and associated export bans. Reporting and compliance costs are low, although expectations grow over time to demonstrate climate/nature *resilience* and an ability to provide secure supply.
	Changing Customer Requirements	Increasing customer expectations regarding climate and nature could increase administrative and reporting costs, require changes in growing practices, and impact sales.	Orderly	Low	Moderate	High	Low in short-term; but escalates rapidly as leading FMCGs push ever-more stringent demands down their supply chains – raising compliance costs and the prospect of lost sales if compliance/excellence cannot be demonstrated (the risk of lost sales as a result of non-compliance are very high in this scenario). In the medium- to long-term, strong performance across the palm sector makes it hard for any company to charge a premium for certified palm products; although certain FMCG brands are willing to pay more for 'carbon-positive' palm.
			Disorderly	Low	Moderate	Moderate	Low in the short-term; medium in mid- term as leading European and North American FMCGs push demands down their supply chains (with global buyers following in the long-term). The percentage of sales at risk from 'non-compliance' is moderate/high. Entry requirements to the EU market are very high; and individual brands demand pristine supply chains, but alternative markets/buyers are still available (and the Indonesian government is highly supportive of 'home grown' palm oil). Conversely, strong and demonstrable climate and nature performance can help ensure access to all markets – and to access premiums paid for exemplary performance. Additional uncertainty arises through a relatively capricious market – with individual FMCG companies changing their sourcing policies in response to responding/reacting to campaigns.
			Hothouse	Low	Low	Moderate	Low in the short- and medium-term, although customers that are *already* pushing carbon and nature disclosure and performance improvement continue to do so. The percentage of sales at risk from 'non-compliance' is low, but sales *are* at risk from protectionism (both from Indonesia/Malaysia restricting exports and overseas markets promoting domestic alternatives to palm). Additional uncertainty arises from volatile activism, and how customers will respond if targeted.

Risk summary

NB. For Physical Risks, AEP's 'potential exposure' is primarily informed by the financial modelling that has been undertaken (although the ranking of drought risk in the long-term has also been informed by additional qualitative analysis). For Transition Risks, AEP's ranking has been informed by qualitative assessment.

	Risk	Potential Impact	Scenario	Potential Exposure (by Time Horizon)			Notes / Rationale
				Short (2025)	Med (2030)	Long (2050)	
Physical Risk	Drought	Palm yield is negatively impacted by drought/water stress. If climate change increases drought conditions and/or water stress it will have a negative impact on yield and revenues.	Orderly	Low	Low	Low	The exposure ratings for drought, based on the WWF water scarcity metric, indicate that AEP's level of drought risk is low in the Orderly scenario, and does not change across the 2030 and 2050 time horizons, relaying minimal (<0.1%) impact on AEPs revenue.
			Disorderly	Low	Low	Moderate	In the Disorderly and Hothouse scenarios, the WWF water scarcity metric also indicates that AEP's level of drought risk changes imperceptibly and remains low across the 2030 and 2050 time horizons, relaying minimal (<0.1%) impact on AEPs revenue. This is an important, and reassuring finding for AEP. However, given uncertainties in drought projections, and emerging science that suggests El Nino events will become more frequent and intense as a result of climate change, we have escalated AEP's exposure to drought risk in the long-term to Moderate.
			Hothouse	Low	Low	Moderate	
	Flooding	Heavy rainfall/flooding can disrupt operations, both on- and off-site. If climate change increases the frequency and intensity of heavy rainfall/flooding events it will negatively impact operational efficiencies and costs.	Orderly	Low	Low	Low	AEP is already operating – without any significant disruption – within areas that are categorized (using the WWF Water Risk Tool) as having high flood risk. Projected changes to baseline flood risk was assessed on the assumption that increased exposure would impact on revenue via operational disruption. Despite increases in flood risk across a number of AEP's sites, the resultant risk to revenue is <1% in all scenarios across all time horizons, relaying low risk to the business.
			Disorderly	Low	Low	Low	
			Hothouse	Low	Low	Low	
	Aggregated impacts at temperature thresholds reached	Palm yield is negatively impacted as temperature thresholds are crossed. As regional temperatures increase, yield of fresh fruit bunches will decrease accordingly and impact AEP's revenue.	Orderly	Low	Moderate	Moderate	The potential impact of climate change on the palm sector in Indonesia and Malaysia is an active area of research, and projections are not consistent across all studies. Paterson, 2023, for example, suggests that Malaysian palm yield will not be negatively impacted by climate change through to 2030, and that yield could even *increase slightly* by 2050 in response to climate change. Other research (e.g., Sankar et al, 2020), however, has suggested that the aggregated impacts of climate change as different temperature thresholds are crossed will indeed have a negative impact on palm yield. Given that an explicit purpose of climate scenario analysis is to explore uncertainty, we have modelled the potential impacts associated with the findings of Sankar et al (2020). The risk rankings here reflect those results and illustrate that, in the Disorderly, and especially the Hothouse, scenarios AEP's potential exposure crosses into our categorisation of High risk by 2050.
			Disorderly	Low	Moderate	High	
			Hothouse	Low	Moderate	High	

Recommendations to Build Resilience

Category	Recommendation	Risk Area
Fully integrate climate and nature risk into global risk management	Improve climate and nature risk management through greater alignment with global risk management processes. Define risk management thresholds (materiality thresholds based on those adopted by other companies were used in this work, but AEP's own risk tolerance should dictate these in future).	All
	Incorporate climate and nature risk into expansion planning to minimize future exposure (e.g., consider whether expansion areas are likely to be high-risk or controversial, and/or the focus of regional efforts to improve biodiversity or carbon sequestration)	Physical risk
Strengthen governance	Strengthen governance of climate and nature risk management by clarifying management and board level oversight and review channels.	All
Site level management plans	Develop and maintain (with local partners) site-level resilience plans to minimize future exposure to climate/nature risk (e.g., consider alignment with regional efforts to improve biodiversity or carbon sequestration; set aside flood-prone areas for conservation; maintain natural forested corridors within plantations - not only for biodiversity, but to improve water flow/reduce flood risk (maintaining natural vegetation on slopes can help with both).	Physical risk
	Manage logistics routes to reduce the possibility of transportation disruption between plantations and mills. Long logistics routes are particularly vulnerable to disruption during flooding.	Physical risk, especially flood
	Explore possibilities for water storage on site to withstand drought events when they occur.	Drought risk
Government engagement on regional resilience	Engage with local and national government to promote investment in road infrastructure such that it remains resilient to future storm/flood events.	Physical risk
El Nino planning	Despite uncertainties, the El Nino/La Nina cycle is relatively forecastable at a seasonal scale, and AEP should consider factoring such forecasts into plantation renewal and planting cycles (given the particular vulnerability of young plants to both drought and flood events).	Physical risk
Institutional Engagement	Involvement with research to create and adopt temperature/drought-tolerant palm varieties which maintain yield.	Physical risk, especially drought
	Partner with local research institutions or universities to better understand the potential impact that flood, temperature and drought could have on yield/revenue to enable informed decision making about management strategies.	Physical risk
	Monitor ongoing research into potential impacts of climate change on South-East Asia palm growth.	Physical risk
Competitor, industry body and government engagement	Both physical and transition risks increase the warmer the planet gets. AEP should become a vocal proponent of governmental action on climate, set carbon reduction targets in line with Net Zero by 2050 and advocate that peers/industry bodies/government do the same.	All
	Proactive engagement with any emerging regional biodiversity/restoration schemes.	Physical risk
Customer engagement	Engage customers on an ongoing basis to understand developing expectations around climate and nature, both to gain advance understanding of potential future requirements and to increase chances of transition support/joint investment.	Transition risk, esp. changing customer requirements
RSPO	Accelerate efforts to obtain RSPO certification. In scenarios in which concern and action on climate and nature escalates, there is a strong chance that RSPO certification becomes essential to access key markets.	Transition risk

2

Introduction

The global financial impacts and risks linked to climate change and nature loss are growing

Global recognition of the threat climate and nature pose to economic and human wellbeing is growing; and institutions, governments and businesses who are failing to act are increasingly viewed as laggards.

Global financial and economic stability are under threat

$640bn

Losses due to natural disasters intensified by climate change between 2017-2019

Munich RE (2020)

$313bn

Losses due to natural disasters worldwide in 2022

Statista (2023)

>$1 trillion

Global stranded assets as present value of future lost profits in the upstream oil and gas sector

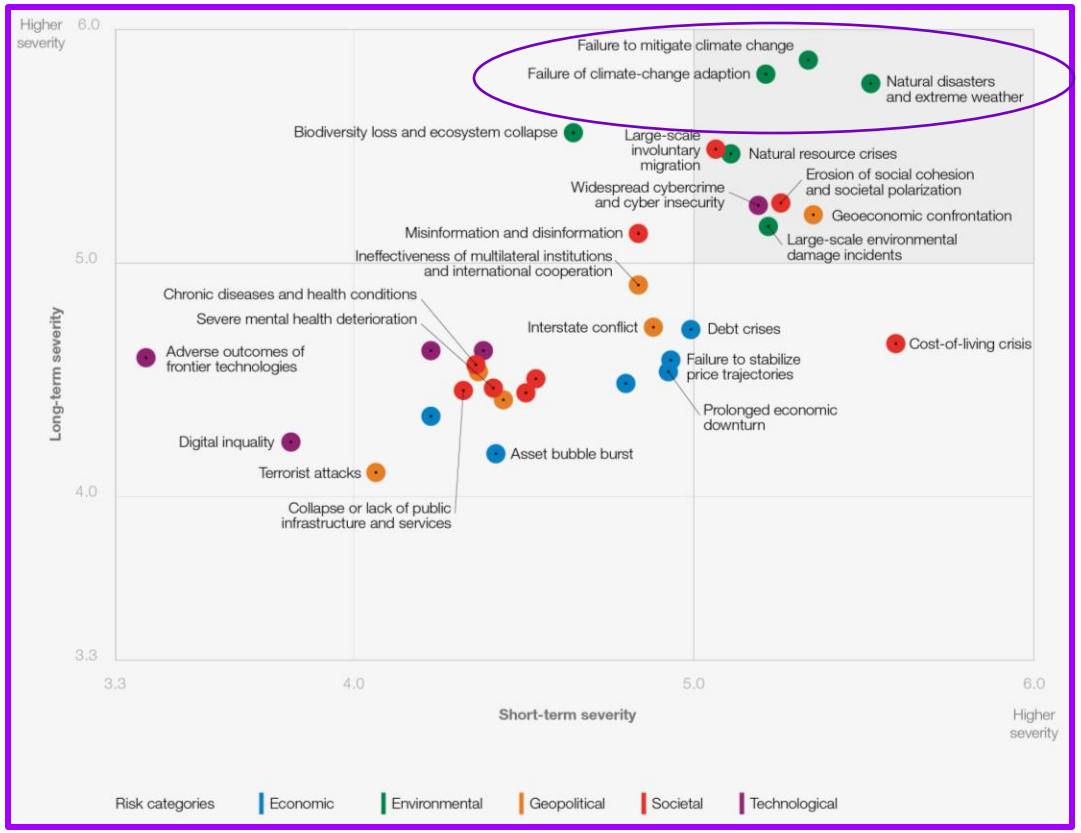
Nature (2022)

31,000 fatalities

Fatalities due to natural disasters in 2022

Statista (2023)

The World Economic Forum's 2023 top 3 global risks likely to materialise in 2-10 years are all related to climate and nature



Top 9 global risks in terms of likelihood and impact, according to the WEF*:

- **Natural disasters and extreme weather**
- **Failure to mitigate climate change**
- **Failure of climate-change adaptation**
- **Natural resource crises**
- Erosion of social cohesion and societal polarisation
- Geoeconomic confrontation
- Large scale involuntary migration
- **Large scale environmental damage incidents**
- Widespread cybercrime and cyber insecurity

*Source: www3.weforum.org/docs/WEF_Global_Risks_Report_2023.pdf

Aligning with the TCFD/TNFD enhances AEP's resilience

Scenario analysis is a methodology used to examine how risks may manifest and impact businesses in different possible futures. It enhances company ability to make informed strategic decisions and guard against forthcoming risks. Reporting the results of climate scenario analysis allows external stakeholders to better understand how companies manage material climate and nature risks.

TCFD/TNFD alignment requires using scenario analysis to examine the range of ways that climate and nature risk may manifest in the decades ahead. Full, best practice TCFD/TNFD alignment involves a long-term, iterative process of risk identification and scenario analysis. Risk management and controls should be implemented, monitored and disclosed.

Compliance & readiness

Prepare for mandatory disclosure requirements by assessing gaps in conformance to TCFD framework and identifying TCFD/TNFD synergies

Complete (2022-2023)

Risk management

Identify and evaluate risks to your company across the value chain

Strategic planning

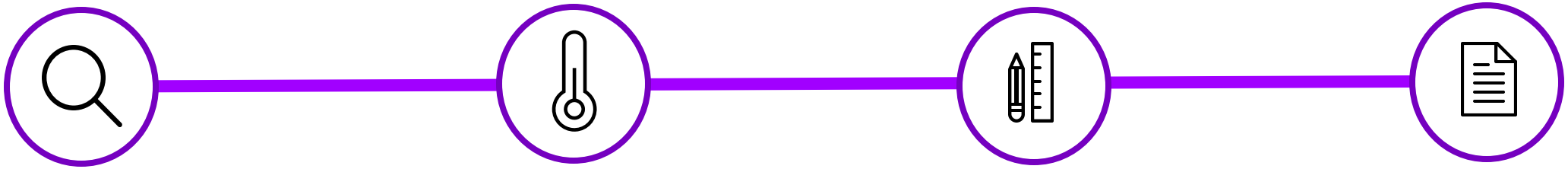
Account for the changing business environment using scenario analysis

Current Scope (2023)

Embedding Climate Risk

Create mitigation/adaptation strategies and embed climate and nature risk into global risk management. Enable informed decisions on where and when to allocate capital and detail how AEP will transition to low carbon economy ways of working

A four-step process was taken to conduct AEP's climate scenario analysis



RISK AND OPPORTUNITY IDENTIFICATION

PROCESS

- Desk research, peer review and AEP's prior work on climate risk informed the creation of a long list of climate and nature related risks and opportunities. (See Appendix 2 for long list.)
- 4 material/strategically important risks were confirmed with AEP stakeholders to take forward for scenario analysis, with 'systemic risk' to be considered separately as a high-level 5th risk.
- Over the course of the project, an additional physical risk – the aggregated impacts of climate change at different temperature thresholds – was added.

OUTCOME

- 5 risks signed off to be taken forward for analysis.

SCENARIO DEVELOPMENT

PROCESS

- Agreed use of the WWF Water Risk Tool as the basis for exploring flood and drought risk at AEP's plantations and mills.
- This analysis was supplemented with insights gained from using the WRI Water Risk Tool and academic research into the potential impacts of climate change on palm yield in Malaysia.
- Developed bespoke scenarios to analyse transition risk, based on different levels of governmental and customer engagement with climate and nature.

OUTCOME

- Agreed set of scenarios to be used to explore AEP's potential future exposure to climate/nature risks and opportunities.

IMPACT ANALYSIS

PROCESS

- Qualitative assessment of transition risk (consumer and policy risks) and quantitative assessment of physical risks (drought and flooding) was conducted under the agreed scenarios.
- Additional insights based on projections of how Malaysian palm yield will change under different levels of warming were added.
- High level examination of systemic risk documented

OUTCOME

- Qualitative and quantitative analysis of 5 strategically important climate and nature risks.
- High level exploration of systemic risk

RESULTS

PROCESS

- Results communicated and discussed with AEP.

OUTCOME

- Final report detailing outcomes of the scenario analysis.

Accenture worked with AEP to agree a shortlist of priority risks to be considered via Scenario Analysis – alongside a high-level consideration of 'Systemic Risk'

The risk and opportunity prioritisation process was as follows:

1) Accenture reviewed AEP's prior disclosures regarding climate risk* and undertook desk research into identified and emerging climate and nature risks considered material to the palm sector (including a review of disclosures by peers and prominent buyers of palm oil). This enable the identification of a 'long-list' of risks and opportunities (see Appendix 2 for details).

2) This long-list was discussed with the AEP Project Team, and the following 4 risks were prioritised to be taken forward for further exploration through climate scenario analysis:
   - Policy/regulatory risk and opportunity
   - The risks and opportunities associated with changing customer expectations
   - Flood risk
   - Drought risk

3) Over the course of the project, an additional physical risk – the aggregated impacts of climate change at different temperature thresholds – was added.

4) In addition, given that the TNFD have built upon the TCFD's categorization of risk types to include *systemic* risk alongside *physical* and *transition* risk, a decision was made to explore, at a high-level, the possibility that systemic risk might rapidly change AEP's operating context.

* AEP had previously identified heavy rainfall/flooding, drought, fire, pests and disease as key physical risks; compliance with changing regulations, and changes in buyer preferences as key transition risks; and the development of new products, and biogas production as key transition opportunities.

3

Scenario Analysis Methodology

Choosing a coherent set of scenarios to test risks

Climate scenarios are tools to test different possible future worlds and their potential implications

To consider how climate and nature risks might impact AEP, we have built out three scenarios based upon well-established archetypes*:

- an **orderly** scenario in which society acts aggressively to limit warming to 1.5C;
- a **disorderly** scenario in which society takes action, but does so in an uncoordinated manner, with action divergent and/or delayed across different countries and sectors; and
- a ***hot house*** scenario in which governments take little further action.

The archetypes align with scenario groupings defined by the Network for Greening the Financial System (NGFS), which provide a high-level view of different climatic and socio-economic futures. We have applied the themes that define these scenarios to nature as well as climate risk, and have embraced a 'what if' approach** as promoted by the TNFD to explore the potential implications for palm sector, and for AEP, under each of these scenarios.

Throughout the process, different external scenarios are relied upon and related back to these three core archetypes. For example, our physical risk analysis draws upon data from a number of different sources (WRI, WWF) whose scenarios are all ultimately aligned to the IPCC's *Representative Concentration Pathways (*RCPs). These RCPs express the warming associated with the chosen scenario archetypes.

The resulting scenarios are summarised on the following slide.

* See, for example, the Network on Greening the Financial System (NGFS) Scenarios Portal.

** The TNFD's Guidance on scenario analysis notes that; "...the Taskforce has deliberately sought to avoid an approach that is overly rigid, prescriptive or reliant on advanced analytic capabilities such as modelling...The exploratory nature scenarios outlined in this guidance therefore ask "what if?" questions that allow the user to identify and aggregate qualitative and quantitative supporting research and data to drive internal risk and opportunity assessment."

Summary of scenarios used to assess risk

For physical risk analysis, temperature alignment was used to differentiate scenarios. For transition risk, bespoke scenarios – based on standard archetypes – were created based on policy and consumer trend research.

Archetype	Orderly	Disorderly	Hot House
Temperature alignment (2100)	**~1.5°C**	**>2°C**	**>4°C**
External Data Alignment	RCP 2.6 (IPCC) Optimistic (WRI/WWF) Net Zero 2050 (NGFS)	RCP 6.0 (IPCC) Current/Business as Usual (WRI/WWF) Delayed Transition (NGFS)	RCP 8.5 (IPCC) Pessimistic (WRI/WWF)
Summary	Strong, sustained and internationally-coordinated action on climate results in net zero emissions being achieved globally by 2050. Nature rapidly emerges as a key issue for companies and governments alike through the 2020s.  **Inter-governmental harmonisation**  **Green growth & nature regeneration**	Climate and nature action is divergent across countries and sectors. Differing, and sometimes competing regulations, incentives and climate/nature 'solutions' are embraced in different regions.  **Mixed/delayed signals from Governments**  **Disputed 'solutions'**	Governments fail to build on current policies and action is insufficient to keep warming below 2°C by 2050. Progressive investors and companies attempt to drive continued action and activism becomes increasingly unpredictable and extreme.  **Radical activism**  **Extreme weather**
Associated 'what if' questions	• *What if all current and proposed climate- and nature- regulation is adopted and scaled globally?* • *What if customers demand best-practice on both climate and nature?*	• *What if a complex/conflicting regulatory landscape emerges, with differing regional priorities and/or differing emphases on nature/climate?* • *What if key customers impose differing demands on growers re: climate and nature?*	• *What if no new regulation is introduced to drive climate action and progress on nature stalls?* • *How might customers – and other stakeholders – respond if governments backtrack?*

Time horizons

In line with the TCFD's recommendations, short-, medium- and long-term time horizons were used to analyse physical and transition impacts. The medium- and long-term time horizons extend AEP's typical planning cycle.

The time horizons selected for analysis were aligned to key 3rd party climate and nature target years (NGO and/or government). These encourage AEP to consider strategic risk across a range of time horizons.

Short-term

2024–2025
(2 years from present)

Medium-term

2025–2030
(7 years from present)

Long-term

2030–2050
(27 years from present)

Rationale for time horizon selection:

- The short-term horizon aligns with AEP's risk management planning cycle
- The medium-term horizon aligns with Near-Term Science-Based Target dates for many companies/countries
- The long-term horizon aligns with Net Zero Target dates for much of the world (and also broadly aligns with the average economic life of an oil palm plant)

Impact scoring

To give an indication of the relative potential impacts of risks, the following rating system was used. It is recommended that AEP take a view on the materiality of the findings to the operation of the business.

Rating	Impact	Quantitative Description of impact on AEP
1. Low	Minor consequences with limited impact	Would result in small decline in revenue (<1%), limited impact on operations, or small reputational impact in local or niche media
2. Moderate	Moderate consequences that can be managed	Would result in moderate decline in revenue (1-5%), moderate impact on operations, or moderate reputational impact in mainstream media
3. High	Severe consequences for the organization and stakeholders	Would result in serious decline in revenue (>5%), severe impact on operations, or severe reputational impact in mainstream media

4

Systemic Risk

Systemic risk

The TNFD has built upon the TCFD's categorization of risk types to identify, and to ask companies to consider, *systemic* risk alongside *physical* and *transition* risk. It outlines two categories of nature-related systemic risk:

- Ecosystem stability risk: Risk of the destabilisation of a critical natural system, so it can no longer provide ecosystem services in the same manner as before; and
- Financial stability risk: Risk that a materialisation and compounding of physical and/or transition risk leads to the destabilisation of an entire financial system.

Such possibilities are very hard to model (and/or to prepare for/mitigate against) but they cannot be ruled out. We have therefore considered – at a very high-level, and through a research process that used 'what if?' questions to gather evidence – three distinct, but related, possibilities that have the potential to rapidly change AEP's operating context:

- *What if reaching 1.5°C 'early' results in a step-change in climate action?*
- *What if a climate-instigated economic shock occurs?*
- *What if there is a breakdown of ecological processes in key geographies?*

A key conclusion from this assessment is that, even if such risks represent low-probability events – especially in scenarios in which societal action to tackle climate change and protect biodiversity accelerate – they raise the possibility that climate and nature risk might emerge more rapidly, and/or have more fundamental impacts, than suggested by our scenario analysis.

What if reaching 1.5°C in the 2020s/2030s results in a step-change in climate action?

- 1.5°C has been widely accepted as the maximum level of warming that humanity should risk experiencing; and a number of governments and companies have embraced targets of 'net zero by 2050' on the assumption that those targets are aligned with staying under the 1.5°C threshold.
- Yet *all* of the scenarios produced by the IPCC see society cross 1.5°C in the 2020s or 2030s. Even its best-case 'Very Low Emissions Scenario' crosses 1.5°C around 2035 (before returning below that threshold later in the century).
- There is also a reasonable chance that an individual year might cross 1.5°C before then – with the Berkeley Earth dataset suggesting that this threshold was indeed crossed in 2023 (NB. Other datasets suggest that 2023 did not quite cross this threshold).
- Reaching 1.5°C, even temporarily, will likely instil a period of reflection amongst the governments, companies and investors that have collectively embraced 'net zero by 2040/2050' targets on the assumption those were 1.5°C-aligned and/or 'Paris Agreement-compliant.'
- The potential outcomes from such a period of reflection are highly uncertain, but a variety of organisations will have to face up to having failed with the stated objective of their ambition – to avoid 1.5°C – and an urgent rethink of corporate climate targets and an acceleration of action cannot be discounted.

Potential Implications

- A more frantic, 'panic stations' world might emerge in response to an 'early' crossing of the 1.5°C threshold, with considerable uncertainty as to how various stakeholders (governments, companies, investors, activists) will respond.
- NB. There could also be a 'shrug of the shoulders' and a re-focus on 2°C as a 'realistic' target for global action.
- The framing of climate communications/action around 1.5°C will inevitably change however, and expectations of companies could tighten rapidly. 'Net zero by 2040+' targets will be de facto "too little; too late" for any companies seeking to align their progress against either 1.5°C or the Paris Agreement.

What if a climate-instigated economic shock occurs?

- Although the rate and scale of warming remains in line with that projected by climate models, individual scientists are increasingly expressing alarm about how this warming is manifesting 'on the ground'. The earth system is now not only experiencing impacts projected to arise simply because the world is warmer (i.e., because of 'basic' thermodynamics); but also impacts arising as a result of that warming having 'dynamic effects' on atmospheric/ocean circulation patterns and stability.
- These dynamic effects are not yet captured in climate projections – including those used in our analysis of flood and drought risk – and nor are the potential impacts that would arise if geophysical 'tipping points' were breached. Research published in Science in Sept 2022 suggests that up to 5 tipping points could be triggered if the 1.5°C threshold is crossed – with as many as 13 'at risk' at 2°C.
- This raises the possibility that the physical impacts of climate change might hit more quickly and severely than projected, with the potential to create systemic economic risk.
- Both the global food system and the property sector have been flagged as being vulnerable to escalating *physical* impacts:
  - A 2020 McKinsey analysis into the vulnerability of the global food system found that; "a 'true' multiple-breadbasket failure – simultaneous shocks to grain production through acute climate events in a sufficient number of breadbaskets to affect global production – becomes increasingly likely in the decades ahead, driven by an increase in both the likelihood and the severity of climate events."
  - Research published in *Nature Climate Change* in 2023 into "unpriced flood risk in the [US] housing market," estimated that residential properties in the US are overvalued by US$121–US$237 billion (based on *flood* risk alone). Other research suggests that this figure could be an underestimate. Given the role a US housing bubble played in precipitating the 2008 global financial crisis, such 'unpriced' property risk could have significant wider economic impacts.
- Other research – more focused on *transition*, rather than *physical*, risk – has flagged the potential of 'stranded assets' to result in financial contagion.
  - According to a 2022 study in the journal *Nature*, an estimated 60% of oil and gas reserves and 90% of known coal reserves should remain unused in order to limit global warming to 1.5°C, raising the possibility that these assets become 'stranded.'
  - Another 2022 study in *Nature Climate Change* estimated that; "global stranded assets as present value of future lost profits in the upstream oil and gas sector exceed US$1 trillion." The study concluded that "most of the market risk falls on private investors, overwhelmingly in OECD countries, including substantial exposure through pension funds and financial markets." Under a scenario that sees society reach net-zero emissions by 2050/2060, these losses are fully realised by 2036.

Potential Implications

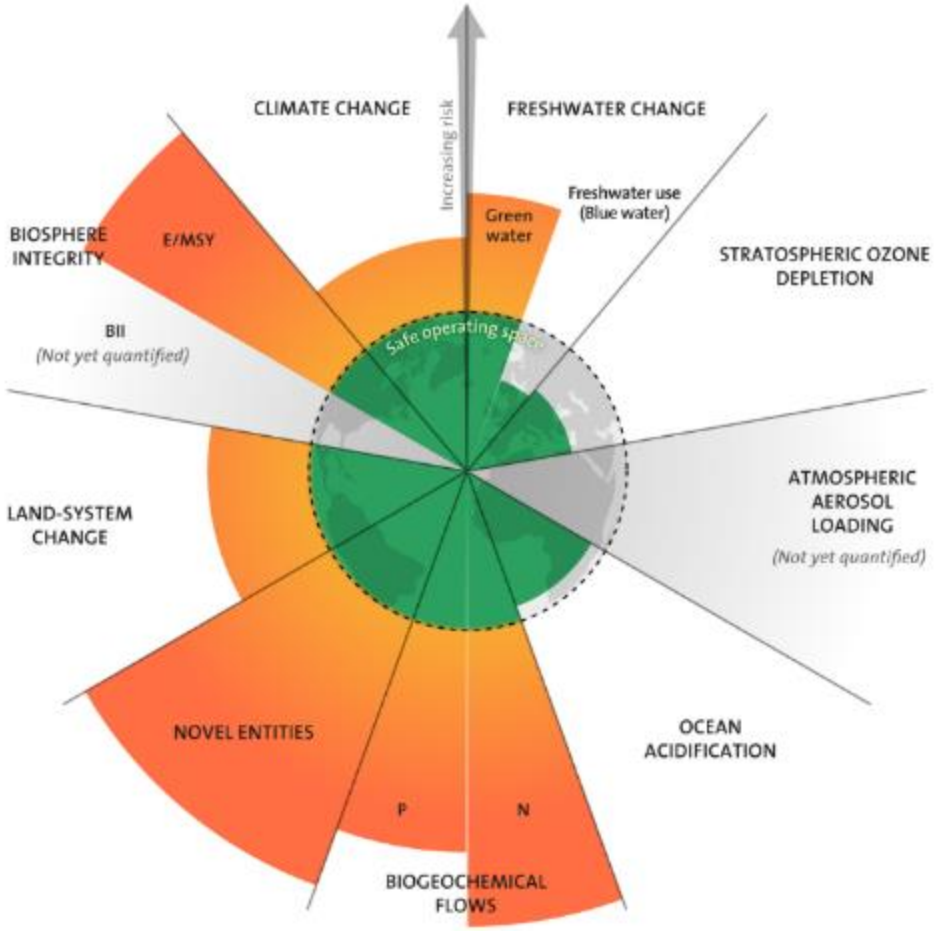
- Climate change could potentially bring about (or contribute significantly to) major economic disruption in time frames faster than anyone is prepared for.
- This potentially increases the pace and severity in which *all* climate risks might manifest – whilst also adding additional uncertainty into the mix
- Projections re: how climate change might impact GDP could be considerable underestimates, and the possibility of a prolonged, depression-like slump (with associated low consumer confidence) and associated socio-political instability and unrest cannot be discounted.

What if there is a breakdown of ecological processes in key geographies?

- Climate change is only one of multiple ecological 'boundaries' that have been crossed – and which either individually, or cumulatively, could flow through as systemic economic risk.
- In 2022, the Stockholm Resilience Centre announced that the planetary boundaries relating to 1) environmental pollutants and other "novel entities" including plastics; and 2) freshwater had been crossed – joining climate change; biogeochemical flows; land-system change; and biosphere integrity.
- The 2023 World Economic Forum (WEF) Global Risks Report not only ranks 'climate action failure' as the most severe risk facing the world over the next ten years, but stresses that 'biodiversity loss and ecosystem collapse' is one of the fastest deteriorating global risks over the same time frame.
- The same report goes on to stress that; "Concurrent shocks, deeply interconnected risks and eroding resilience are giving rise to the risk of poly-crises – where disparate crises interact such that the overall impact far exceeds the sum of each part."

Potential Implications

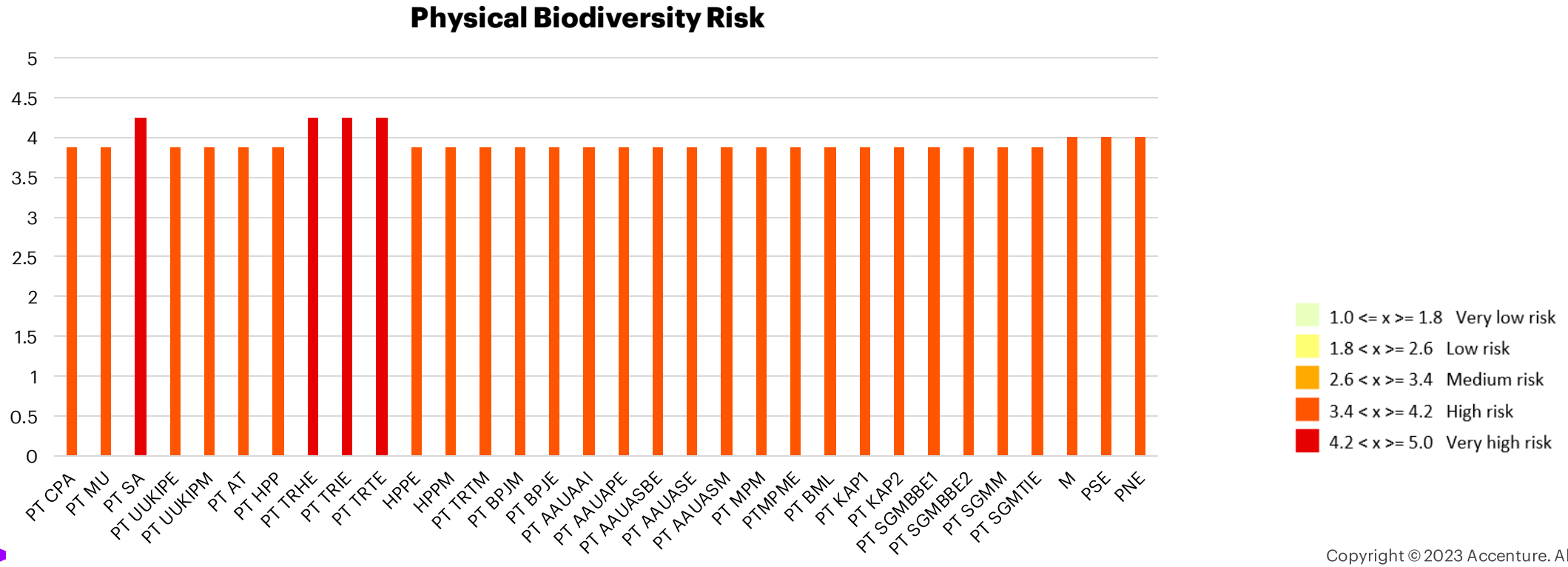
- Emerging analyses of climate and nature risk often look at individual risks in isolation, rather than as a set of potentially dovetailing risks.
- If these analyses were expanded to consider *compounding* impacts across a fuller range of geophysical risks (and, indeed, society's potential responses to those risks) – it is highly likely that the potential for systemic economic risk would increase.



Planetary Boundaries Framework, Stockholm Resilience Centre, 2022

What if there is a breakdown of ecological processes in key geographies?

- The WWF Biodiversity Risk Filter flags that AEP's plantations and mills operate within areas identified as facing high 'physical risk'.
- Physical risk is driven by the ways in which a business depends on nature and can be affected by both natural and human-induced landscape conditions.
- A locality's physical risk score is an aggregate score covering the 'provisioning services' provided by nature (such as water availability); 'enabling services' (such as soil health and water quality); 'regulating services' that can help to mitigate the impacts of natural hazards; and pressures on those services.
- A high score by no means suggests that ecological breakdown is likely, but it does suggest that ecosystem service provision is under greater stress there than in localities with low risk scores, and thus that disruption is more likely.



5

Transition Risk

Introduction

Both **changing regulation**, and **changing customer expectations**, vis-à-vis climate and nature performance have been identified as key risks – and potentially opportunities – facing AEP. This reflects not only recent developments and trends in both these areas, but also the palm sector's prominence in debates about the drivers of tropical deforestation.

A wide range of climate and nature, and wider ESG reporting, regulation has been adopted or proposed around the globe in recent years. And, with increasing pressure on companies to demonstrate strong performance on climate and nature – and growing awareness from within the corporate world as to the benefits of strong performance in these areas – companies themselves are increasingly placing expectations on their suppliers to disclose and improve strategy and performance across a suite of sustainability issues and metrics, including:

- their impacts on climate and nature;
- their dependencies on a stable climate and functioning ecosystems;
- their resilience to potential climatic and ecological change;
- their ambitions and targets to improve performance;
- how these targets align with national objectives and underlying science; and
- their strategies to meet those targets.

The following pages outline recent developments in both these areas, laying out the current 'state of play' and emerging trends. Our scenario builds and the analysis therein then consider whether these trends accelerate (and whether they do so in a globally-coordinated manner) or stall; and the potential implications for the palm sector and AEP.

5a

Emerging Climate and Nature Regulation

Notable emerging climate and nature regulation

National Action Plans to address climate and nature

- Mirroring the 2015 Paris Agreement, which obliged countries to produce **Nationally Determined Contributions (NDCs)** outlining their individual plans to reduce emissions and adapt to the impacts of climate change, the 2022 Kunming-Montreal Global Biodiversity Framework requires countries to prepare and communicate their **National Biodiversity Strategies and Action Plans (NBSAPs**). Both NDCs and NBSAPs are expected to be updated every five years.
- **The Global Biodiversity Framework** contains 23 targets for 2030, including:
  - Ensuring that at least 30% of the planet – with an emphasis on areas of particular importance for biodiversity and ecosystem functioning and services – is under effective conservation.
  - Restoration completed or underway on at least 30% of degraded terrestrial, inland waters, and coastal and marine ecosystems.
  - Reducing to near zero the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity.

Emerging regulation to restrict markets for products associated with deforestation

- The **EU Deforestation Regulation (EUDR)** requires that key goods (including palm oil) exported or placed on the EU market are deforestation-free. It entered into force in June 2023, with operators and traders expected to implement the new rules by 2025. To comply, palm growers and traders will need to disclose information on their efforts to prevent deforestation, and establish and maintain traceability systems to ensure that the origin of palm oil can be reliably identified. Non-compliance with the regulation will restrict market access to the EU.
- On December 1, 2023, members of the US House of Representatives and Senate introduced a bill – the **Fostering Overseas Rule of Law and Environmentally Sound Trade (FOREST) Act 2023 –** that seeks to prohibit the import of products made from commodities (including palm oil) produced on illegally deforested land.

Expanding disclosures requirements (in terms of both scope and geographic coverage)

- The **EU Corporate Sustainability Reporting Directive (CSRD)** revises and strengthens EU rules around non-financial disclosures. Nearly 50,000 companies fall within its scope, and all will be required to report according to the **EU Sustainability Reporting Standards (ESRS)** by 2029 (with all large companies expected to report by 2026).
- In March 2022, the US Securities and Exchange Commission **(SEC) released proposed rules on climate-related disclosures** that were broadly consistent with the recommendations of the TCFD. Its final climate-related disclosure rule is expected to be issued in 2024.
- From financial year 2022-2023, the top 1,000 listed companies in **India** (by market capitalization) will be required to include a **Business Responsibility and Sustainability Report (BRSR)**, containing detailed ESG disclosures, within their annual reports.

Notable emerging climate and nature regulation continued

Expanding disclosure requirements (in terms of both scope and geographic coverage) continued

- Formed by the International Financial Reporting Standards' (IFRS) Foundation at COP26 in Glasgow, the **International Sustainability Standards Board (ISSB)** was set up to develop standards to provide a comprehensive global baseline for sustainability disclosures. It issued its inaugural standards – IFRS S1 and IFRS S2 – in June 2023. The requirements in IFRS S2 are consistent with the Taskforce on Climate-related Financial Disclosures (TCFD) recommended disclosures, and ISSB will take over responsibility for monitoring of the progress on companies' climate-related disclosures from the TCFD in 2024. Reporting under IFRS is required in more than 140 countries, and ISSB standards will be part of the broader body of IFRS. In September 2023, the ISSB welcomed the release of the recommendations of the **Taskforce on Nature-related Financial Disclosures (TNFD)** and stated its intent – subject to the outcome of an ongoing consultation on future priorities – to consider the TNFD's work as it continues to develop its standards.
- In October 2023 the **Transition Plan Taskforce (TPT),** a group commissioned by the UK government, released a Disclosure Framework to help organisations set out a credible and robust climate transition plan. Transition plans are expected to explain how an organisation will meet climate targets, manage climate-related risks, and contribute to the economy-wide climate transition. Transition plan disclosures are expected to become mandatory in the UK for at least some companies for accounting periods from January 2025. The TPT's Framework was designed to complement the International Sustainability Standards Board (ISSB) and draws on the Glasgow Financial Alliance for Net Zero (GFANZ) framework for transition planning. GFANZ is working with policymakers globally to advance approaches to transition planning.
- The **TPT Food & Beverage Working Group released Sectoral Guidance** in November 2023, recognising the need to reduce the emissions related to agriculture and land use change (largely deforestation for food production), and the challenges associated with a fragmented and diverse set of upstream producers.

Expanding carbon pricing systems

- More than 70 different carbon pricing regimes are currently in force around the world, with Indonesia introducing a carbon trading mechanism in September 2023.
- The **EU Carbon Border Adjustment Mechanism (CBAM)** will impose carbon costs on certain imports into the European Union, aiming to ensure that products manufactured outside the EU face a carbon price comparable to those produced within the EU. From 2026, it will apply to importers of 'high carbon' goods (initially cement, fertilisers, iron and steel, aluminium, and electricity) but the scope is expected to widen over time. Other economies – including the US, Canada and Australia – have either begun consultations on carbon border adjustments or are considering the implications of adoption.

Notable emerging climate and nature regulation continued

An increasing emphasis on 'science-based' targets – including science-based targets for nature

- Since the **Science Based Targets Initiative (SBTi)** launched in 2015, its guidance has become the de facto standard for companies seeking to demonstrate that their targets are in line with climate science. Over 4000 companies now have targets approved by the SBTi, with a further 3000 engaging with its process.
- The **SBTi's Forest, Land and Agriculture Guidance (FLAG**), released in September 2022, enables companies in land-intensive sectors such as food, agriculture and forestry, to set science-based targets that include land-based emission reductions and removals.
- In May 2023, the **Science Based Targets Network (SBTN)** published the first formal framework to help companies set **science-based targets for preserving nature and biodiversity**. Its guidance includes three land ecosystem targets that are designed to halt conversion of natural ecosystems, free up agricultural land for natural ecosystem restoration, and improve the ecological integrity of landscapes

Emerging regulation to tackle 'greenwashing'

- Recognising increasing consumers demand for more sustainable products and services, and growing concern that the 'green' claims made by companies seeking to meet that demand may be exaggerated and misleading, the UK Financial Conduct Authority (FCA) is currently consulting on new guidance for FCA-authorised firms making **claims about the sustainability of a product or service**. The Advertising Standards Authority (ASA) in the UK is increasingly clamping down on 'misleading' claims used in advertising, with adverts for Air France, Lufthansa and Etihad banned in December 2024 for misleading consumers about the airlines' environmental impact.
- The EU has also proposed a law to protect consumers from greenwashing, with a **Proposal for a Directive on Green Claims** published in March 2023.

5b

Changing Customer Requirements

Emerging customer commitments

AEP's top 10 key customers are listed in the table below (which also provides their ranking and score in a November 2023 Assessment of the palm sector by SPOTT, an initiative developed by the Zoological Society of London (ZSL)). With the exception of BEST Group, which scores poorly in the SPOTT assessment and makes no mention of sustainability or responsible sourcing on its website, all of these customers have enacted policies and made commitments to address concerns about nature and climate:

- Wilmar International, Musim Mas, Apical, Golden Agri-Resources, KLK, and Pacific Palmindo all have detailed and comprehensive sustainability policies; are supporters of the Roundtable on Sustainable Palm Oil (RSPO); and stress the centrality of their No Deforestation, No Peat, No Exploitation (NDPE) policies to their business operations.
- BKP has a No Deforestation, No Peat, No Exploitation (NDPE) policy, which "applies to all palm and palm kernel oil we use and covers our entire supply chain."
- STA Resources has a Sustainability Policy that lacks detail, but which states concern for areas with high conservation value, high carbon stocks, and peatlands.

ZSL's SPOTT initiative assesses palm oil producers, processors and traders on their public disclosure regarding their organisation, policies and practices related to environmental, social and governance issues. The SPOTT Assessment offers a sense check into the preparedness of AEP's top customers to comply with the EU Deforestation Regulation (EUDR) – and their commitment to climate and nature leadership more broadly. This, in turn, provides a signal as to which of AEP's customers are more likely to demand climate and nature excellence from AEP in scenarios in which regulation and supply chain pressure increases.

AEP is confident that it is compliant with the traceability expectations of the EUDR, but its mid-level SPOTT score suggests that more could be done to communicate its efforts externally. AEP also has an NDPE policy, first created in 2019.

No.	AEP Customer	Parent company	SPOTT Ranking (of Parent Company)	SPOTT Score
1.	PT. WILMAR NABATI INDONESIA	Wilmar International	6	92.8%
2.	PT. MUSIM MAS	Musim Mas Holdings	7	91.8%
3.	PT. PACIFIC PALMINDO INDUSTRI	HSA Group	Not ranked	
4.	PT. SARI DUMAI SEJATI	The Apical Group	2	95.3%
5.	PT. ENERGI UNGGUL PERSADA	Wilmar International	6	92.8%
6.	PT. SMART TBK	Golden Agri Resources	20	81.6%
7.	PT. ADEI PLANTATION & INDUSTRY	Kuala Lumpur Kepong Berhad (KLK)	30	74.8%
8.	PT. KARYA SERASI JAYA ABADI	PT Sumber Tani Agung Resources Tbk (STAR)	Not ranked	
9.	PT. BERLIAN EKA SAKTI TANGGUH	BEST Group	92	0.8%
10.	PT. BINA KARYA PRIMA	BKP	Not ranked	
	Anglo-Eastern Plantations plc		48	51.9%

Key: Green = top 10 ranking; yellow = top 50; red = bottom 50

AEP's customers' customers

A number of AEP's customers are themselves selling palm oil and palm oil products to consumer-facing brands. Such brands have been at the forefront of consumer and NGO concerns and campaigning around deforestation and climate, and any commitments they make are likely to have implications along the palm supply chain.

Whereas some companies (such as Iceland and Lush in the UK) have actively reduced and, in some cases, removed palm oil from their products, most consumer-facing brands have sought instead to address consumer concern by ensuring the provenance and sustainability of their palm sourcing. As with AEP's direct customers, such brands stress their commitment to NDPE Principles; and RSPO is the certification scheme of choice. Palm-oil purchasing brands such as Unilever, Pepsico, General Mills, Danone, Wal-mart and Kroger all stress that 100% (or close to 100%) of their supply is RSPO-certified.

Beyond specific commitments to palm sourcing, ambitious consumer-facing brands are starting to state their commitment to supporting the goals outlined in the Kunming-Montreal global biodiversity framework, embracing the concept of not just protecting, but restoring, ecosystems. Commitments to 'regenerative agriculture', and to 'landscape level' engagement and action are also gaining traction:

- AstraZeneca's Biodiversity Position Statement outlines a commitment to go "beyond minimising impacts" and to "invest in nature restoration beyond our operations." AstraZeneca have also committed to set science-based targets to halt and reverse biodiversity loss within its supply chain by 2025.
- Unilever has called for systemic change to transform agricultural systems and the way we use land. "At a farm level, this means applying regenerative agriculture practices... It also means being more ambitious than ever before by looking outside of the farm boundary and aiming to protect and regenerate natural spaces, both in our supply chain and beyond it."
- Nestle has stated an ambition to advance regenerative food systems at scale, recognising that an unsustainable food system is currently making the climate crisis worse. It is also increasing its focus on 'landscape initiatives' – "integrated, multi-stakeholder efforts that work across industries at a jurisdictional level to address the root causes of the issues we work to address".

Industry bodies – and investor networks – are also pushing for greater ambition and action:

- The Consumer Goods Forum (CGF) has created the Forest Positive Coalition of Action, led by 22 companies with a collective market value of around US$2 trillion, to leverage collective action to create 'forest positive' rather than deforestation-free businesses.
- Nature Action 100 is a global investor engagement initiative focused on driving greater corporate ambition and action to reverse nature and biodiversity loss. Investors participating in the initiative are engaging with 100 companies in key sectors deemed to be systemically important in reversing nature and biodiversity loss by 2030.
- The Rockefeller Foundation has partnered with the Asian Institute of Technology to drive Climate-Resilient Agriculture Solutions in Southeast Asia. The partnership emphasizes nature-positive solutions, characterized by regenerative, non-depleting, and non-destructive production systems.

Commitments to regenerative agriculture could, over time, pass through as requirements for palm growers to embrace new 'on-site' methods and techniques (from soil protection through to multi-cropping) and 'landscape level' engagement could result in pressure for land to be taken out of production.

End-consumers

These brands, as well as seeking to build supply chains that are resilient, are also responding to growing interest and concern regarding climate, nature and sustainability more broadly from their end-consumers:

- Numerous studies have confirmed that consumers are increasingly interested in the environmental and social credentials of the products and services they purchase – although how and when this translates into action, and which specific claims resonate most, has been less clear. This is all the more so at a time of economic, social, environmental and political upheaval, with Accenture's July 2022 Human Paradox report revealing that 60% of consumers say their priorities keep changing as a result of everything going on in the world.
- Nevertheless, a February 2023 joint study by McKinsey and NielsenIQ looking into the US market found a clear and material link between ESG-related claims and consumer spending across incomes, life stages, ages, races, and geographies.
- Dentsu and Kantar's *Marketing a Better Future* Report (Jan 2023) suggests that similar trends are emerging in Asia, with 89% of consumers reporting a willingness to boycott products or services that damage the environment, whilst also being positive about business' role in helping them "green" their consumption behaviour (91%).
- A Nov 2023 Survey of 23,000 global consumers by Bain & Company found that concern about sustainability was not only increasing, but had intensified over the past two years, with 64% of consumers worldwide reporting high levels of concern about sustainability. Interestingly, their research found that consumers in fast-growing markets like China, India, and Indonesia are more concerned about sustainability than those in developed markets, with 79% of consumers in fast-growing markets (compared with 55% in developed markets like the US and Europe) stating they were very or extremely concerned about environmental sustainability.
- A significant societal uptick in concern about climate change and/or the ecological crisis could accelerate – and possibly complicate – these trends. What exactly will future consumers prioritise, what 'evidence' will they demand, and how will consumer-facing FMCGs respond?

5c

Implications for AEP under the scenarios considered

Summary of scenarios used to assess risk

Archetype	Orderly	Disorderly	Hot House
Temperature alignment (2100)	**~1.5°C**	**>2°C**	**>4°C**
External Data Alignment	RCP 2.6 (IPCC) Optimistic (WRI/WWF) Net Zero 2050 (NGFS)	RCP 6.0 (IPCC) Current/Business as Usual (WRI/WWF) Delayed Transition (NGFS)	RCP 8.5 (IPCC) Pessimistic (WRI/WWF)
Summary	Strong, sustained and internationally-coordinated action on climate results in net zero emissions being achieved globally by 2050. Nature rapidly emerges as a key issue for companies and governments alike through the 2020s.  **Inter-governmental harmonisation**  **Green growth & nature regeneration**	Climate and nature action is divergent across countries and sectors. Differing, and sometimes competing regulations, incentives and climate/nature 'solutions' are embraced in different regions.  **Mixed/delayed signals from Governments**  **Disputed 'solutions'**	Governments fail to build on current policies and action is insufficient to keep warming below 2°C by 2050. Progressive investors and companies attempt to drive continued action and activism becomes increasingly unpredictable and extreme.  **Radical activism**  **Extreme weather**
Associated 'what if' questions	• *What if all current and proposed climate- and nature- regulation is adopted and scaled globally?* • *What if customers demand best-practice on both climate and nature?*	• *What if a complex/conflicting regulatory landscape emerges, with differing regional priorities and/or differing emphases on nature/climate?* • *What if key customers impose differing demands on growers re: climate and nature?*	• *What if no new regulation is introduced to drive climate action and progress on nature stalls?* • *How might customers – and other stakeholders – respond if governments backtrack?*

Scenario detail

Orderly	Disorderly	Hot House
• Ambitious climate and nature policies are introduced in an internationally-coordinated and consistent manner. In a 'race-to-the-top' significant cleantech and 'nature positive' subsidy programmes are the norm and governments support a suite of zero-carbon and nature-positive technologies and interventions. • Mandatory International Sustainability Standards Board (ISSB) reporting – covering both climate and nature – enacted *globally* by 2030. • National agricultural policies – and customer sourcing requirements – start to demand the uptake of regenerative/carbon-smart farming practices • Explicit efforts are made to ensure climate policy supports biodiversity and vice versa – and Loss and Damage and 'just transition' funding and subsidy programs assist companies and communities to enact required changes. • Public awareness of, and support for action on, climate change and nature regeneration is strong – and this translates through into strong sustainability and traceability requirements from consumer-facing companies. • Strong and coordinated governmental and institutional action mean that most consumers 'trust the system' (and 3rd party certification systems in particular) to deliver progress. • Increased demand for food, bio-based materials, carbon sequestration, BECCS, biodiversity and ecosystem services creates competition for land and increasingly influences policy through the 2030s. • Palm successfully positions itself as the most-efficient use of land for oil production, but public scrutiny is intense and the sector is held to very high standards, and – by the 2030s – lab-based alternatives to meat, dairy and plant-based oils attract considerable investment. • SBTs (including SBTs for Nature), TCFD and TNFD are expected for all companies; and full life-cycle carbon accounting is the norm. Agricultural supply chains are expected to be fully-traceable and certified deforestation-free.	• Disputes and disagreements about the roll-out, implementation and impacts of current and proposed regulation sees governments enact little new climate and/or nature regulation through the 2020s. • TNFD recommendations are enacted enthusiastically in Europe and the US – but gain little traction elsewhere; and efforts to translate TCFD recommendations into regulation globally stall. • Worsening climatic/ecological conditions see increasingly-stringent policies introduced in the early 2030s, but the pace of change exacerbates the lack of coordination between countries – and conflicting, and sometimes contradictory, policies are introduced in different jurisdictions. • Tensions between the EU and Malaysia/Indonesia re: forest- and nature-based expectations and disclosure requirements continue through the 2020s and into the 2030s. • Public awareness of, and support for climate action, varies considerably through the 2020s. It strengthens in the 2030s, but the pass-through costs of draconian regulation creates vocal opposition in places. • Policies to drive climate action are often developed without consideration for nature and vice versa – creating conflict in places. • Demands for 'action' are often campaign-driven and uncoordinated; and create a complicated and capricious landscape for companies to navigate. • Some consumers, for example, prioritise fossil-fuel free products; while others demand deforestation-free products. • SBTs and RSPO remain the voluntary target-setting/certification schemes of choice, but there is considerable disagreement as to the 'optimal' decarbonization/deforestation strategies and pathways available to companies.	• Governments do not significantly backtrack from current efforts, but no new regulation is introduced to drive climate action and progress on nature stalls. • Geopolitical tensions escalate; protectionism impacts global supply chains; and security concerns dominate national energy, nature and agricultural policies. • Progressive investors, environmental NGOs, and a handful of FMCG companies (recognizing the risks that climate change poses to their supply chains) continue to promote action on climate and nature. • Investors, in particular, promote both TCFD and TNFD disclosures on a voluntary basis – but these frameworks gain little further traction beyond Europe during the 2020s and early 2030s. • US state-level efforts to limit/prohibit ESG investing – and to penalize companies that limit/avoid fossil fuel use expand. • Public awareness of and support for climate and/or nature action varies considerably, but as the physical impacts of climate change escalate, anger at governmental and corporate inaction creates a febrile environment. • Significant 'direct action' by concerned/impacted stakeholders emerges in the 2030s and becomes increasingly unpredictable and extreme. • By the mid-2030s, climate *resilience* emerges as a key differentiator, featuring prominently not only in disclosures to investors, but increasingly in supply-chain contracts. • Companies also face increasing pressure to demonstrate to employees how they will be protected if and when extreme weather hits. • SBTs remain the voluntary target setting tool of choice; but uptake stalls – and the lack of supportive regulation and/or wider societal decarbonisation makes meeting SBTs increasingly hard.

Implications and risks in an Orderly scenario

AEP's operating context	• Strong expectations for all palm growers to be able to demonstrate climate/nature excellence. • RSPO harmonizes with other certification schemes, including ISPO, becomes the universally-accepted global certification system for palm, becomes more stringent over time (in response to emerging regulation) and becomes a *requirement* for all major customers by the 2030s. • Carbon pricing systems become more pervasive, expanding rapidly in Asia from the late 2020s. • Strong, internationally-aligned 'support mechanisms' in place – making it relatively easy to 'comply' with suite of climate and nature regulations and expectations. But there are still significant ongoing expenses to ensure compliance. • By the late 2020s, regenerative farming practices are heavily promoted by national regulation – and become requirements globally through the 2030s. • Compliance is determined by satellite/remote monitoring/measurement across an ever-expanding array of sustainability indicators (e.g., regional forest cover; soil carbon content; ecological services; etc). • Widespread recognition that palm represents the most efficient use of land for oil production – which, alongside improved governance mechanisms, results in the 'rehabilitation' of palm amongst western consumers. • Nevertheless, a growing 'land crunch' means this has to be balanced against increasing expectations from global agricultural land to provide multiple benefits – and 'justifying our land take' becomes a critical element of sustainability leadership for agricultural and food companies. • In the 2030s, there is pressure for certain plantations/agricultural areas to be 'restored/returned to nature' – building out from biodiversity hotspots – as national governments start to implement their National Biodiversity Action plans (as mandated by the Kunming-Montreal Global Biodiversity Framework). • Land scarcity also encourages investment in lab-based alternatives to vegetable oils – and these start to compete for market share through the late 2030s. • The palm market grows through the 2020s and 2030s. Although demand for biodiesel drops significantly in the 2030s (as electrification of ground transportation wins out); a combination of widespread palm industry action on climate and nature – combined with growing awareness that of the land efficiency of palm relative to other oil crops – sees it largely 'rehabilitated' in the eyes of Western consumers. • Severe consequences (loss of markets/consumers) for palm producers from non-compliance. The EU is the most 'at-risk' market in this scenario in the 2020s; but the roll-out of regulation/expectation becomes universal through the 2030s. • With strong climate and biodiversity performance commonplace across the palm sector, there is little space for growers to differentiate their product through climate and/or nature excellence. With the emergence of 'full landscape' carbon accounting in the 2030s, however, certain FMCGs are willing to pay a premium for 'carbon-positive palm'.

	Short-term	Medium-term	Long-term	
Regulatory risk	Low	Moderate	High	Risk is low in short-term as the EU resolves concerns about the implementation of the EUDR, granting a grace period for smallholder performance and implementing support mechanisms to help growers meet requirements. Risk grows over time however, with significant reporting and implementation costs emerging over time as climate and nature regulation escalates. Global reporting and performance requirements align over time, helping to limit the costs of compliance, but ever-increasing obligations across a range of sustainability criteria require continual investment by growers. Effective international and national financial support helps growers manage these costs.
Changing customer requirements	Low	Moderate	High	Low in short-term; but escalates rapidly as leading FMCGs push ever-more stringent demands down their supply chains – raising compliance costs and the prospect of lost sales if compliance/excellence cannot be demonstrated (the risk of lost sales as a result of non-compliance are very high in this scenario). In the medium- to long-term, strong performance across the palm sector makes it hard for any company to charge a premium for certified palm products; although certain FMCG brands are willing to pay more for 'carbon-positive' palm.

Implications and risks in a Disorderly scenario

In practice this means	• Expectations for palm growers to demonstrate climate/nature excellence grow, but confusion and disagreement about the implementation of the EUDR creates a backlash – and a lack of agreement about what determines 'excellence'. • This exacerbates tensions between the EU and Malaysia/Indonesia – and tension lingers through the 2020s and into the 2030s. • To ensure continued access to the EU market, a number of palm companies 'play it safe' and exclude third-party/smallholder and non-RSPO certified palm from products sold to the EU. EU 'sustainable palm' prices rise considerably as a result. This price rise encourages palm companies to invest to ensure compliance, but continues the trend towards 'certified plantation palm' – further disenfranchising smallholders (which in turn splits the environmental and development communities and further exacerbates tensions between Indonesia and the EU). • Where possible, palm suppliers attempt to serve all markets – diverting certified, plantation palm to the EU market; and smallholder/uncertified palm to India, China and other markets – but uncertainty as to whether the EU will restrict access to companies that are EU-compliant *across all their production* maintains market confusion through the 2030s. • Such confusion – not only regarding how EU regulation might evolve, but also the potential costs associated with ensuring compliance – sees some palm companies choose to withdraw from the EU market, focusing instead on regional/international markets and embracing a more incremental approach to climate/nature improvement. • Biofuels (for ground transportation) fall from favour in Europe and North America as electric vehicles gain traction; but are supported heavily through the 2020s and 2030s by Indonesia and Brazil. Both countries develop and maintain their own palm certification schemes (linked to national biodiversity and carbon action plans); helping to maintain a growing market for palm growers that choose not to align with the EU market. Aviation and shipping interest in biofuel remains strong – but high-profile, international shipping and aviation companies shun palm as a feedstock. • European – and other national – policies on climate, nature, agriculture and land-use continue to strengthen through the 2020s and 2030s, but a lack of global coordination sees this create tension and, in places, unexpected consequences. Carbon policies – and action – are often implemented without consideration of other sustainability concerns, and the rise of eucalyptus plantations in Africa and South America (justified in terms of rapid carbon storage) have been widely condemned as a 'missed opportunity' for nature. The inclusion of a number of palm and rubber plantations in central American 'forest recovery' initiatives have also raised concerns from environmental NGOs and European governments. • Confusion about what represents 'best practice' in terms of sustainability extends to consumers. The 'efficiency case' for palm resonates strongly in some markets, but is rejected by consumers in others. Some consumers prioritise 'fossil-free' products (and welcome palm oil as an ingredient in household goods, cosmetics and plastics/packaging) whereas others demand deforestation-free products (and avoid palm as a result). This adds to volatility in the palm market, with FMCG companies often responding rapidly to aggressive consumer/NGO campaigns. • 3rd party certification schemes have widely differing clout and credibility in differing geographies and with different stakeholders – and multiple, competing certification schemes, reporting requirements and regulations increase compliance and reporting costs for companies that seek access to multiple markets. The RSPO tries to bridge markets and act as a unifying standard – and remains the global palm certification scheme of choice – but is seen as overly burdensome by some and overly lax by others.

	Short-term	Medium-term	Long-term	
Regulatory risk	Moderate	Moderate	High	Moderate, even in the short-term, as the EUDR is rigorously enforced in 2025. Risks grow over the medium- and long-term as regulation is developed and enforced in other markets in an uncoordinated manner. Different expectations and frameworks apply in different geographies; and there is a lack of alignment between climate and nature policy. Reporting and compliance costs are very high for companies seeking to access all markets.
Changing customer requirements	Low	Moderate	Moderate	Low in the short-term; moderate in medium- term as leading European and North American FMCGs push demands down their supply chains (with global buyers following in the long-term). The percentage of sales at risk from 'non-compliance' is medium-high. Entry requirements to the EU market are very high; and individual brands demand pristine supply chains, but alternative markets/buyers are still available (and the Indonesian government is highly supportive of 'home grown' palm oil). Conversely, strong and demonstrable climate and nature performance can help ensure access to all markets – and to access premiums paid for exemplary performance. Additional uncertainty arises through a relatively capricious market – with individual FMCG companies changing their sourcing policies in response to responding/reacting to campaigns.

Implications and risks in a Hot House scenario

In practice this means	• Momentum around nature and climate action stalls. • The EU waters down/delays the implementation of EUDR in response to international pressure and concerns about impacts on smallholders. • In the US, the SEC backtracks from requiring TCFD-style disclosures – and emboldened state legislatures rein in a range of ESG regulations, claiming they are 'anti-American'. • No further TCFD-style regulation is enacted around the world, the TNFD remains voluntary, and no further policy action is taken to support the COP15 biodiversity commitments. • Progressive investors and FMCG companies continue to push for continued action – and disclosure – on climate and nature, but are largely fighting against governments rather than being supported by them. • Environmental NGOs step up their activities in response to governmental inaction, and while most *climate* campaigning is directed towards oil and gas companies; the palm sector remains a target for NGOs concerned about biodiversity and deforestation. • Through the 2030s, environmental activism becomes increasingly unpredictable and extreme – and 'direct action' increases as activists embrace more radical tactics. Dutch activists regularly target the port of Rotterdam, blocking and delaying the import of palm oil and associated products. • Most consumers remain largely indifferent towards the use of palm products, but 'successful' activist campaigns in Europe sees a handful of companies rapidly phase out the use of palm oil, citing a loss of faith in third party certification and a lack of governmental action as important in their decision-making. These companies pivot to using 'home grown' oils instead. • With forest burning to expand palm production continuing in SE Asia through the 2030s, Singaporean-based companies face increasing pressure during 'haze season' – with activists calling on them to not only tackle their own supply chains, but to advocate for more effective fire control across the region. • As geopolitical tensions escalate, protectionist policies and interventions are increasingly embraced by governments – and concerns about domestic food prices make interventions such as Indonesia's month-long palm oil export ban in 2022 become much more common, although no more predictable. • National Food Security Plans become commonplace – and prioritise domestic food production. • By the 2030s, investors and customers increasingly prioritise climate/nature *resilience* – and expect palm (and other agricultural) growers to demonstrate how a rapidly changing climate (and increasingly volatile geopolitics) will not disrupt supply. • Through the 2030s, climate change starts to significantly impact the reliability of global yields, workforces, and the public infrastructure (roads, ports and energy systems) upon which agricultural growers depend. The relative resilience of palm in SE Asia (compared to other palm growing regions) through the 2030s sees it able to market itself as 'resilient palm'. • SBTs remain the voluntary target setting tool of choice; but uptake stalls – and the lack of supportive regulation and/or wider societal decarbonisation makes meeting associated targets increasingly hard. • RSPO still exists but uptake and influence wanes.

	Short-term	Medium-term	Long-term	
Regulatory risk	Low	Low	Moderate	Low in the short- and medium-term as no new climate/nature regulation is introduced or enforced. Risk increases in the longer-term as a result of protectionism and associated export bans. Reporting and compliance costs are low, although expectations grow over time to demonstrate climate/nature resilience and an ability to provide secure supply.
Changing customer requirements	Low	Low	Moderate	Low in the short- and medium-term, although customers that are *already* pushing carbon and nature disclosure and performance improvement continue to do so. The percentage of sales at risk from 'non-compliance' is low, but sales *are* at risk from protectionism (both from Indonesia/Malaysia restricting exports and overseas markets promoting domestic alternatives to palm). Additional uncertainty arises from volatile activism, and how customers will respond if targeted.

6

Physical Risk

An evolving research approach/methodology

Accenture methodology for assessing physical risk associated with drought evolved throughout the analysis. The focus for the financial modelling shifted to focus on temperature increase, as a more comprehensive and modellable indicator of yield risk.

Accenture's analysis of physical climate risk started with a plan to consider drought and flood risk ***in isolation*** using the risk ratings determined by the WWF water risk tool.

As described in the sections that follow, this tool suggested that baseline drought risk at all sites was low, and that drought risk will not increase at any of AEP's sites through 2050 under any of our scenarios. The implication of this is that the financial impact of drought risk increase over time is also likely to be minimal.

This is an important, and reassuring finding for AEP.

However, this finding jars with wider research that suggests that climate change could indeed have significant impacts on palm yield in Indonesia and Malaysia, especially towards the latter end of the timeframes considered in this research (2050 and beyond). Further, as noted in the Systemic Risk section, there is emerging concern within the wider climate science community that current projections of climate change might not capture the full range of possible impacts.

Given that an explicit purpose of climate scenario analysis is to explore uncertainty and complexity, we have therefore also assessed the potential implications on yield arising from the *aggregated* impacts of climate change under different scenarios i.e. temperature increase.

Physical risk analysis summary

The physical risks examined were flood risk and drought risk, supplemented by a consideration of the potential aggregated impacts of climate change at different temperature thresholds

	Flood Risk	Drought Risk	Aggregated Impacts at Temperature Thresholds
Potential Impact	Heavy rainfall/flooding can have material impacts on palm companies by causing disruption to operations – both on-plantation and beyond.	Drought is known to have a significant impact on palm yield, particularly of saplings and young plants.	Projections regarding the potential impact of climate change on palm yield are not consistent across all studies, but a selection suggest that the crossing of different temperature thresholds will have a negative impact.
Baseline	AEP's baseline flood risk was examined using both the WRI and WWF water risk tools. Both of these tools indicated that AEP was currently tolerating high flood risk across its sites.	Baseline drought risk, according to both the WRI water depletion and WWF water scarcity tools, was shown to be low across AEP's sites.	Using the IPCC's representative concentration pathway baseline for 2020, temperature change vs preindustrial level was established for Indonesia and Malaysia. This was shown to be 1.2C.
Scenario Differences	Flood risk increases across the 2030 and 2050 time horizons in the hot house world and disorderly scenarios. In the orderly scenario flood risk increases by 2030, but returns to base levels by 2050.	According to the WWF water risk tool there is no change in drought risk across 2030 or 2050 time horizons at AEP's sites in any scenario. NB. These projections do *not* account for a potential increase in drought arising from an increase in the frequency and intensity of El Nino events.	Under the Hothouse scenario, global temperatures cross the 2C threshold before 2050. Both the Orderly and Disorderly scenarios cross 1.5C in the 2040s (although, in Orderly, temperatures stabilise, and then return below 1.5C later in the century).
Financial Impact	The financial impact of flood risk is low (<1% revenue impact) across all time horizons and scenarios given that AEP has demonstrated that it can tolerate high baseline flood risk.	Although drought can have a significant impact on revenue via its moderation of yield, risk exposure is low for AEP and remains so through 2050. The projected financial impact is therefore negligible.	The aggregated impacts of climate change are projected to significantly impact palm yield, particularly in the Disorderly and Hothouse scenarios. The potential financial impact on AEP is high by 2050 in both these scenarios, and moderate in the Orderly scenario.

Linking literature to financial metrics

Key impacts factors were selected based on the material risk indicators found during the literature review.

The table below illustrates the range of ways that flooding; drought; and the aggregated Impacts of climate change could impact AEP's financial performance. The literature review revealed that heavy rainfall/flooding primarily impacts operations, whereas drought/water scarcity and the aggregated impacts of climate change primarily impact yield. This informed the approach taken to analyse these risks and consider their potential financial impact on AEP. Given data availability we have only considered the impact factors highlighted below in our financial modelling.

Our analysis of drought risk using the WWF Water Risk Tool revealed no additional risk to any of AEP's sites within the timeframes considered, even under the Hothouse scenario. This risk was therefore not explored any further through a quantitative model.

The impact factors listed in the table that have *not* been used in our financial modelling are still relevant to AEP despite being unquantified in this analysis. They can all be expected to worsen as a result of climate change, with impacts greatest in a Hothouse scenario.

Flood - Operational disruption	Drought – Yield disruption	Aggregated Impacts – Yield disruption
Flooded transport links	Reduced fresh fruit bunches yield due to water stress	Reduced fresh fruit bunch yield due at different temperature thresholds
Flooded/damaged milling/harvesting equipment	Workforce efficiency reduction due to heat stress	Reduced palm oil yield due to climate change and decreased climate stability
Excessive runoff causing erosion and landslides	El Nino events increase drought risk in Indonesia and Malaysia, and have historically had a significant negative impact on yield. El Nino events are projected to increase in frequency and intensity as a result of climate change	Basal stem rot increase due to climate change impacting palm yield beyond 2050
Worker disruption due to flooded homes and transport links		
Root rot due to waterlogged soil		
Pollination disruption due to heavy rain		

Impact factor used in financial model

Potential longer-term climate change impacts on palm oil

Additional climate risks which are not well-represented in climate projections, or which occur outside the timeframes considered through this analysis, were also identified during the literature review.

The potential impact of climate change on SE Asia, and on palm oil in particular, is an active area of research. This analysis has focused on potential impacts out to 2050, but academic research suggests that the most significant impacts of climate change on palm in Indonesia and Malaysia are likely to emerge *after* 2050 (especially in a Hothouse scenario):

- Paterson (2015) concluded that any decrease in the overall 'climatic suitability' of Malaysia and Indonesia for oil palm production would be gradual through 2030, but would become more pronounced by 2100.
- More recent research by the same author (Paterson, 2023) suggested that, not only would the yield of Malaysian palm oil not be negatively impacted through to 2030, but that yield would *increase slightly* by 2050.
- Nevertheless, Paterson (2020) has also concluded that basal stem rot (BSR) could become much more prevalent in Malaysia as a result of climate change, finding that "climate change will not affect the incidence of BSR greatly until 2050" but that, thereafter, the situation could deteriorate rapidly. The author concludes that "Palm oil production may be unsustainable after 2050, and urgent action must be taken."

The potential impacts of climate change on the El Nino-La Nina cycle adds additional uncertainty into climate projections for South East Asia. El Nino events are associated with drought in both Indonesia and Malaysia – and are associated with palm yield reductions of approximately (El Nino events occurred in 1998 and 2015/16, and another event is underway at the time of writing (2023). The potential impacts of an intensifying La Nina-El Nino cycle are discussed in more detail on Page 69.

Key data used for physical risk analysis

A variety of 3rd party tools were used when considering the quantitative scenarios to use in this analysis.

Flood Risk

- To consider the potential impacts of flooding, we separated AEP's sites into basin 'areas' for analysis. These areas were site clusters that sit in the same river basin areas. Average risk for each area was analysed across the selected time horizons and scenarios. The area groupings are listed on page 50.
- Baseline flood risk was assessed using the World Wildlife Fund (WWF)'s water risk tool and sense-checked using the World Resources Institute (WRI)'s water risk tool.
- Flood risk trajectory was assessed using the optimistic, current trends and pessimistic pathways in the WWF water risk tool (which were taken to represent scenario archetypes orderly, disorderly and hothouse respectively).
- Financial impact of flooding was assessed based on the potential impact the operational disruption of a large flood event could have on revenue.

Drought Risk

- To consider the potential impacts of drought, we separated sites into basin 'areas' for analysis.
- Baseline risk was assessed using the WWF water risk tool water scarcity metric and sense-checked using the WRI water risk tool water depletion metric. Both these tools signalled that AEP's exposure to drought is low (although we note that potential impact of climate change on the frequency and intensity of El Nino events is poorly factored into this risk rating).
- Drought risk trajectory was assessed using the optimistic, current trends and pessimistic pathways in the WWF water risk tool (which again were taken to represent scenario archetypes orderly, disorderly and hothouse respectively).
- We intended to assess the financial impact of drought on yield. However, projections for drought suggested no additional risk to any of AEP's sites within the timeframes considered. The financial impact of drought risk was therefore categorised as low and not modelled.

Key data used for physical risk analysis continued

The aggregated impacts of climate change on palm oil fresh fruit bunch yield was assessed by examining yield depreciation at different temperature thresholds

Aggregated Impacts of Climate Change at Different Temperature Thresholds

- Our literature review identified research (Sankar et al, 2020) that suggested that the aggregated impacts of climate change at different temperature thresholds would have a material impact on palm yield in Malaysia.
- NB. It should be noted that this finding is not universal amongst academic literature. Paterson, 2023, for example, suggested that yield of Malaysian palm oil would not be negatively impacted by climate change through to 2030, and that yield would *increase slightly* by 2050. However, given that an explicit purpose of climate scenario analysis is to explore uncertainty and complexity, we have modelled the potential impacts associated with the findings of Sankar et al (2020).
- To consider the potential impacts on yield, country-level temperature profiles produced by the Intergovernmental Panel on Climate Change's (IPCC) were used. Temperature trajectory was assessed using the IPCC's Representative concentration pathways (RCPs). RCPs 2.6, 4.5 and 8.5 were used and were taken to represent scenario archetypes; orderly, disorderly and hothouse world respectively.
- Financial impact of temperature increase was assessed based on the impact that each 0.1˚C of warming has on palm oil fresh fruit bunch yield. Yield was assumed to impact revenue at a 1:1 ratio.

Risk analysis area groupings

AEP's sites were segregated by river basin area in order to analyse drought and flood risk trajectory

In order to analyse physical risk across multiple climate change scenarios, AEP's sites were clustered into area groupings.

- These groupings were based on the river basin the sites sit within according to the WWF and WRI water risk tools.
- Risk in each of these locations was analysed as an average of relevant sites.
- When assessing the potential revenue implication that flood risk has on AEP, revenue area was used. Where several 'analysis areas' sit within the same AEP 'revenue area', an average score was taken.
- The financial impact of drought risk was premised on country level data and therefore area specific risk was not relevant
- Smallholders were out of scope for this analysis but should be considered in future years as AEP's approach to scenario analysis continues to mature.

Analysis Area	River Basin	Site Name	Site Initials	Revenue Area
Area 2	West Coast 1	PT Cahaya Pelita Andhika	PT CPA	Sumatera Utara South
Area 3	East Coast 1	PT Musam Utjing	PT MU	Sumatera Utara North
		PT Simpang Ampat	PT SA	
		PT Ukindo United Kingdom Indonesia Plantations - Estate	PT UUKIPE	
		PT Ukindo United Kingdom Indonesia Plantations - Mill	PT UUKIPM	
Area 4	East Coast 2	PT Anak Tasik	PT AT	Sumatera Utara South
		PT Hijau Pryan Perdana	PT HPP	
		PT Tasik Raja Harapan Estate	PT TRHE	
		PT Tasik Raja Idaman Estate	PT TRIE	
		PT Tasik Raja Tasik Estate	PT TRTE	
		HPP Estate	HPPE	
		HPP Mill	HPPM	
Area 5	Rokan	PT Tasik Raja Tasik Mill	PT TRTM	Sumatera Utara South
Area 6	Siak / Tapung	PT Bina Pitri Jaya - Mill	PT BPJM	Riau
		PT Bina Pitri Jaya – Estate	PT BPJE	
Area 1	West Coast6	PT Alno Agro Utama Alno Air Ikan	PT AAUAAI	Bengkulu
		PT Alno Agro Utama Alno Pangeran Estate	PT AAUAPE	
		PT Alno Agro Utama Alno Sabta Buana Estate	PT AAUASBE	
		PT Alno Agro Utama Alno Sumindo Estate	PT AAUASE	
		PT Alno Agro Utama Alno Sumindo Mill	PT AAUASM	
		PT Mitra Puding Mas - Mill	PT MPM	
		PT Mitra Puding Mas - Estate	PTMPME	
Area 7	Bangka Island	PT Bangka Malindo Lestari	PT BML	Bangka
Area 8	Rungan/ Kahayan	PT Kahayan Agro Plantation KAP 1	PT KAP1	Kalimantan
		PT Kahayan Agro Plantation KAP 2	PT KAP2	
Area 9	Barito	PT Sawit Graha Manunggal Bumi Borneo Estate 1	PT SGMBBE1	Kalimantan
		PT Sawit Graha Manunggal Bumi Borneo Estate 2	PT SGMBBE2	
		PT Sawit Graha Manunggal Mill	PT SGMM	
		PT Sawit Graha Manunggal Tamiang Indah Estate	PT SGMTIE	
Area 10	Malaysia Coast 2	Manyvest	M	Terengganu
		Putra South Estate	PSE	
		Putra North Estate	PNE	

6a

Flood Risk

Methodology for flood risk

To create a financial risk indicative model for flood risk, the following steps were taken:

Step	Methodology	Key assumptions
1	**Reviewed relevance of flood risk to AEP using external tools** Discussions with AEP personnel did not show a documented precedent of high impact of flood risk. WWF water risk tool identified 23 of 31 examined sites experiencing high flood risk in the base year (i.e. current risk level). WRI water risk tool examined to validate baseline risk level produced by the WWF water risk tool	• Current level of flood risk defined by the WWF water risk tool relays $0 impact on revenue. This assumption is based on AEP feedback that they are operating within the current WWF risk levels with no financial or operational impact.
2	**Reviewed literature to understand the impact channels of flood on operations and palm oil yield** Cited precedents of large floods having impacts within the palm oil sector due to operational disruption	• A large flood can have 6% revenue impact within the following month, and an additional 13% in the following quarter (~4% over a year).
3	**Utilised climate scenario data from WWF water risk tool to identify areas of change in risk over time** Risk score metric based on projections of change in frequency of 1-100 year flood events. The WWF scenario-based risk increases equate to increased probability that one large flood event would occur per year. Each increase in WWF flood risk category represents a 5% increase in likelihood of an impactful flood.	• Additional (>baseline level) floodings would have a financial impact on AEP
4	**Calculated a hypothetical financial impact for any additional 1-100 year events assumed** In the analysed year (2030 or 2050), multiplied the additional increase in likelihood of flood per area from the WWF scenario data by the financial impact size of the event. This was subtracted from assumed revenue for the year to estimate impact.	• Model baseline assumes revenue stays constant out to 2050, before factoring in climate impacts

Understanding flood impacts

The WRI and WWF tools were used to understand AEPs current and future flood risk exposure.

Baseline

Using the WWF water risk tool, Accenture established the baseline level of flood risk that AEP is currently experiencing. This was validated by examining baseline flood risk according to the WRI water risk tool.

Relevance of flood risk to the regions AEP operate in: Both the WWF and WRI water risk tools showed high levels of baseline (current) flood risk in AEP's areas of operation.

- While this means that flood risk is *relevant* to AEP based on the WWF risk findings, AEP reports that this high baseline risk rating has not historically translated into flood events at AEP's sites (and/or AEP has been able to withstand, without any significant disruption, events that have caused regional flooding).
- Flood is the most frequent natural disaster in Indonesia and deadly floods have been increasing in the recent past in both Malaysia and Indonesia (e.g. Malaysia 2021, Indonesia 2023, Indonesia 2020) . Extreme rainfall days are increasing in frequency, particularly in the North Indonesia.
- Loss of tree cover due, in part, to agricultural deforestation contributes to flood frequency and intensity meaning that AEP's management of plantation zones is relevant to flood risk and expansion of plantation zones will impact risk within the surrounding area.
- Riverine flood risk is more relevant to AEP than coastal flood risk as many plantations lie inland and in zones a safe distance above sea level. 28% of AEP's locations show equal flood risk from riverine and coastal sources, the remaining 72% show higher riverine flood risk than coastal flood risk.

Future change

The WWF water risk tool was used to examine how flood risk level changes by 2030 and 2050 within the different climate change scenarios.

Future changes in Flood risk: The WWF water risk tool provides scenario analysis based on future change in flood risk. Flood risk increases in all scenarios until 2030. In the orderly scenario only, flood risk returns to baseline level by 2050, the hot house world and disorderly scenarios both see continued increase in flood risk to 2050. This means that patterns of extreme weather (e.g. intense periods of rainfall and/or storm surges) become more likely as a result of uncontrolled climate change, relaying an increase in flood risk.

Understanding flood impacts

Through literature review, Accenture found that there are multiple ways in which flooding can disrupt palm oil producers, these can lead to operational delays and reduction in revenue.

How flooding may disrupt palm operations by 2050:

- Preventing normal harvesting,
- Disrupting transport of fresh fruit bunches to crushing mills thereby delaying outputs and/or diminishing yield from fresh fruit bunches
- Damage roads, bridges, and oil palm processing equipment
- Rain interference with pollination
- Potentially lower oil extraction rates from waterlogged fruit
- Worker disruption; inability to attend work due to flooded transport links or due to flooding at their homes

How flooding may disrupt palm growth by 2050:

- Prolonged floods of weeks to months can cause plant mortality. Seedlings and young plants are especially vulnerable
- In waterlogged soil conditions, soil pores become water filled, leading to several major problems for the plant such as oxygen and nutrient deficits
- In Malaysian oil palm plantations there are numerous studies evidencing the impact of flood on palm oil yield;
    - A flood of 7 days at 25 cm has been observed to lead to a productivity loss of 20%
    - A fresh fruit bunch production drop of about 30% was reported by because of flood events in 2008
    - Seasonal episodes of poor (-10–20%) fruit have been observed due to a decline in pollinating weevil populations in excessive rain
- Prolonged floods may also cause physical damage to trees (toppling over), causing permanent production losses
- Long term flooding can significantly impact water uptake by palm oil crops.

Flood impacts may manifest in subsequent years and therefore may not be easily or intuitively attributed to a flood event. Many of the disruptions caused by flooding are unquantifiable given the limitations within current modelling methods such as large uncertainty in soil moisture changes elicited through increased flood risk, highly variability due to localised conditions or lack of clear percentage impacts for each flood disruption factor. However, they are still relevant to AEP and should be considered important, qualitative elements of the flood risk picture.

Flood risk financials

To define the financial implication of plausible future flood related disruption, Malaysian flood impact case studies were used. Operational disruption was used as the key financial moderator in this model.

A proxy for future impact:

Localised flooding in Malaysia in 2014 across approximately 842,000 hectares of mature palm plantations resulted in an estimated loss of 230,000 tons of palm oil (**6%**) within one month of the flood, and 500,000 tonnes in the following quarter (**13%**).

Additionally, Floods in November 2021 reduced palm oil exports by **6.6%** compared to the previous month in Malaysia due to flooding induced harvesting disruptions.

Possible types of disruption	Possible Yield Implications
Delays in operations (logistics and harvesting)	**6% within month**
Delays in operations (infrastructure and equipment repairs)	**13% within following quarter**
Worker disruption (inability to attend work)	A possible consequence but impact unquantified in the model
Pollination disruption	
Increased pests	
Reduced root water uptake or tree toppling	
Waterlogging causing reduced disease resilience and diminished nutrient uptake	
Damage to fresh fruit bunches due to increased rainfall and humidity	
Excessive runoff of rainwater causing erosion & landslides	
Soil nutrient leaching due to water excessive rainfall	

These impacts sum to a single flood event having 6% impact within one month and a 13% impact within one quarter. The risk model indicates likelihood of one of these events occurring per year.

Applying future projections and calculating impact

To assess financial impact, change in WWF baseline flood risk was assessed vs 2030 and 2050.

WWF's flood risk tool in future climate scenarios:

Future trends are based on projections that apply global climate models and hydrological models to project changes in frequency of a '100 year' flood events.

Leveraging from the logic of the WWF scoring system*, our model takes an increase in the risk score as a 5% increase in likelihood of a 1 in 100-year flood.

e.g. If a site had a risk score of 3 in the baseline, and a 4 in the future scenario, it was assumed an additional 5% chance that a 1 in 100-year event will occur.

Flood Risk	Risk Indicator	Rating
Very Low	No change	1 - 1.8
Low	Up to 5% increase	1.8 -2.6
Moderate	5-10% increase	2.6 – 3.4
High	10-15% increase	3.4 – 4.2
Very High	>15% increase	4.2 <

How it is used to estimate magnitude of financial impact:

Assumption: a 1 in 100-year event equates to the impact of the proxy event (6% impact in the following month, 13% impact per quarter).

Where the baseline impact to AEP is 0:

- The additional likelihood is added e.g. + 5% likelihood of a 1 in 100-year event occurring
- The impact is roughly 4% calculated by dividing the 6% operational impact per month by 12 months (as the risk represents the likelihood of one event per year) and, dividing the 13% operational impact per quarter by 4.
- This 4% is multiplied by the new additional risk likelihood (5% per impact band) to give annualised percentage impact on revenue per site .

Revenue impact of all the sites is summed to give total revenue exposure to flood risk for each modelled year (2030 and 2050) due to operational disruption.

*Source WWF Water Risk Methodology

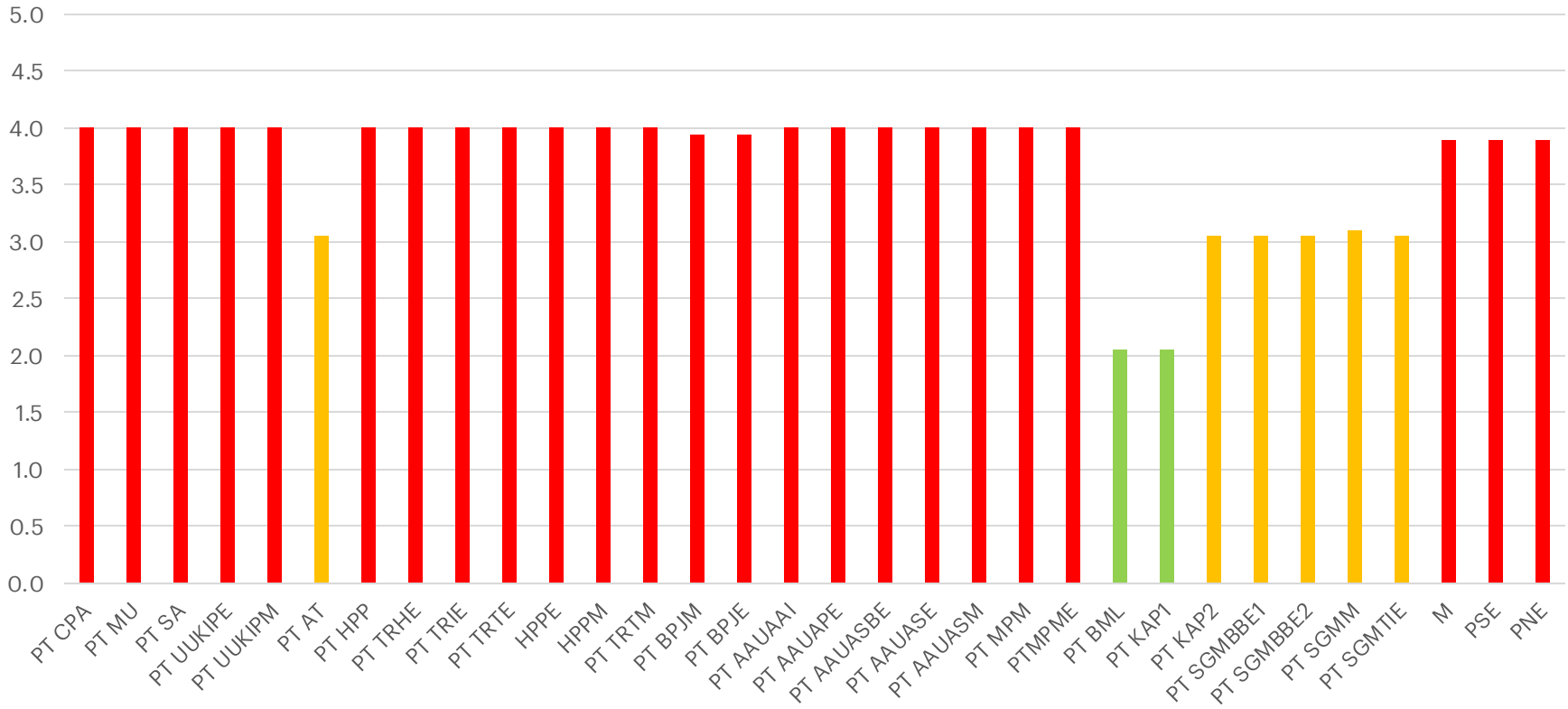
Baseline risk per site according to WWF

Baseline flood risk according to the **WWF water risk tool,** examining historical frequency of 'large' flood events.

WWF: Flood risk in the baseline is based on historical patterns of flood events between 1985 and present. The scores indicate the number of observed large events in the basin.

Flood Risk	Rating	Observed large floods in basin since 1985
Very Low	1 - 1.8	0
Low	1.8 -2.6	1-2
Moderate	2.6 – 3.4	2-10
High	3.4 – 4.2	10-35
Very High	4.2 <	>35

The WWF water risk tool indicates that **current levels** of flood risk are high at 23 of the 31 assessed AEP sites. 6 sites were at moderate risk (5 in the Borneo area and 1 in the Sumatera Utara South area) and 2 sites were at low risk (PT Bangka Malindo Lestari and PT Kahayan Agro Plantation KAP 1).



Baseline risk per site according to WRI

The WRI water risk tool offers an alternative outlook on baseline (current) flood risk.

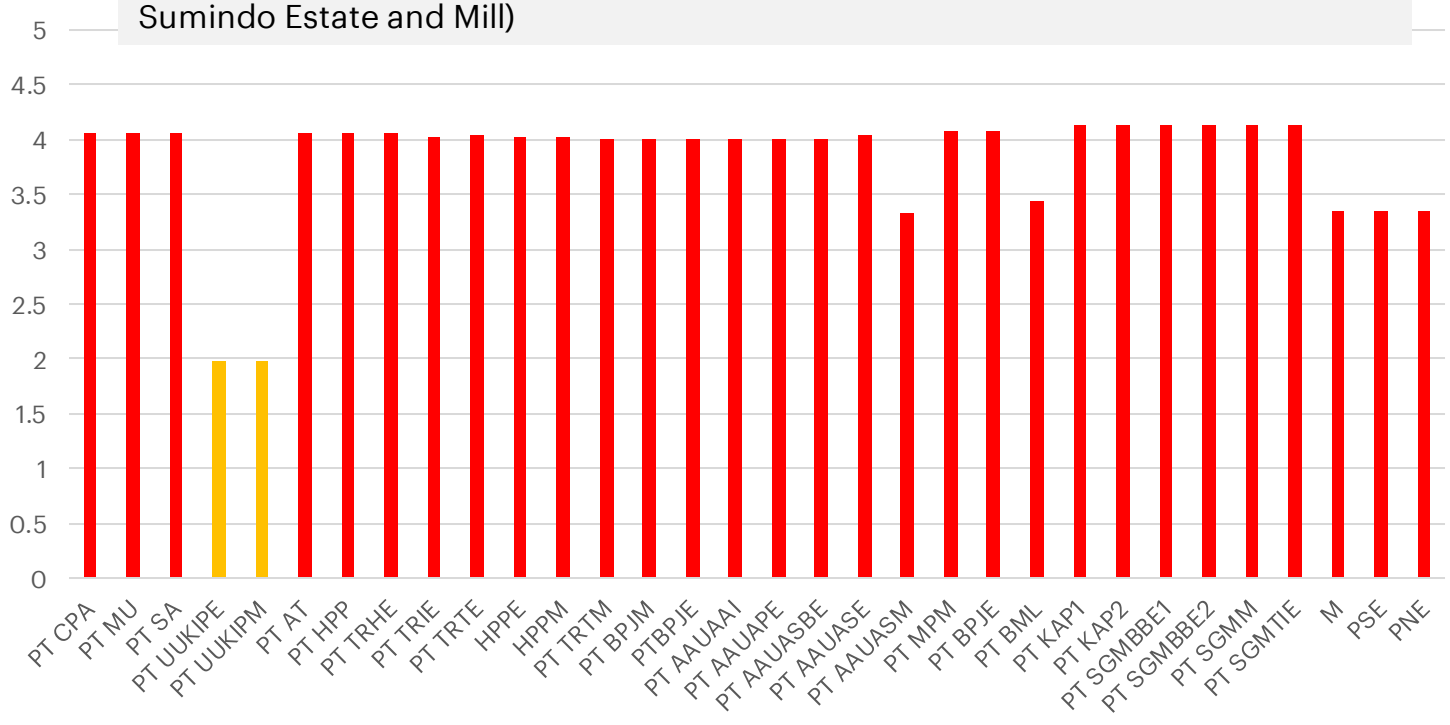
The WRI water risk tool has been used to sense-check the baseline flood risk produced by the WWF water risk tool. This produces a different score per site to the WWF water risk tool but validates that generally, flood risk is high in the baseline. This metric adds depth to the flood risk level produced by the WWF water risk tool by looking at the population likely to be impacted by flood in an average year per area. This risk is relevant to AEP as the population impacted by flood risk is likely to include workers who could be unable to travel to work during flood events.

WRI: Flood risk in the baseline is based on population at risk should a major flood event occur.

Flood Risk	Population at risk (Riverine Flood)	Population at risk (Coastal Flood)	Rating
Very Low	0 to 1 in 1,000	0 to 9 in 1,000, 000	0 - 1
Low	1 in 1,000 to 2 in 1,000	9 in 1,000,000 to 7 100,000	1 - 2
Moderate	2 in 1,000 to 6 in 1,000	7 in 100,000 to 3 in 10,000	2 - 3
High	6 in 1,000 to 1 in 100	3 in 10,000 to 2 in 1,000	3 - 4
Extremely High	> 1 in 100	> 2 in 1,000	4 - 5

The population in the areas that AEP operate are classed as vulnerable to flooding in an average year. This will impact workers as their homes and transport links to and from plantations/mills may be flooded.

The WRI water risk tool indicates that **current levels** of flood risk are high at 29 of the 31 assessed AEP sites. 2 sites were at moderate risk (Alno Agro Utama Alno Sumindo Estate and Mill)



Flood risk trajectory

Due to AEP's tolerance of flood high levels of flood risk, the financial implications of flood risk trajectory within each of the climate change scenarios modelled is low. In the hothouse scenario (i.e. aligned to global warming of >3C by 2050) flood risk increase is most pronounced and therefore the financial implication is highest.

- In the hothouse scenario, all of the areas within which AEP sites are located saw increased flood risk across the 2050 time horizon. The percentage increase in flood risk is most pronounced in this scenario averaging 13% by 2030 and 22% by 2050 across all sites.
- The below table indicates the changes in flood risk experienced per area. Areas 3 and 1 account for the majority of AEPs revenue (32% and 31% respectively) and therefore change in flood risk in these areas has the greatest impact on financials. In the hothouse scenario area 3 saw a 20% increase in flood risk by 2050 and area 1 saw a 23% increase.

	Bengkulu	Sumatera Utara South	Sumatera Utara North	Sumatera Utara South	Sumatera Utara South	Riau	Bangka	Kalimantan	Kalimantan	Terengganu
	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10
baseline										
2030 hot house world	↑	↑	↑	↑	↑	↑	↑	↑	–	↑
2050 hot house world	↑	–	↑	↑	↑	↑	–	↑	↑	↑

Movement	Key
Risk increase	↑
Risk decrease	↓
No change	–

Despite the modelling indicating that absolute flood risk is high and increases over time in this scenario, the impact that this relays to AEP is limited as the company demonstrates high tolerance to drought risk.

* See Appendix 3 for further information on risk changes per area

Flood risk trajectory

Flood risk in the disorderly and orderly scenarios conveys lower impact to AEP than the hothouse scenario.

In the disorderly scenario, all the analysed sites saw increased flood risk by 2050, whereas in the orderly scenario, 66% of the sites examined saw flood risk decrease or remain the same by 2050. Flood risk in the disorderly and orderly scenario pathways conveys low impact to AEP. To see the detailed analysis of flood risk and financial risk trajectory in these scenarios, refer to appendix 3. The risk movements and financial implications are summarised below;

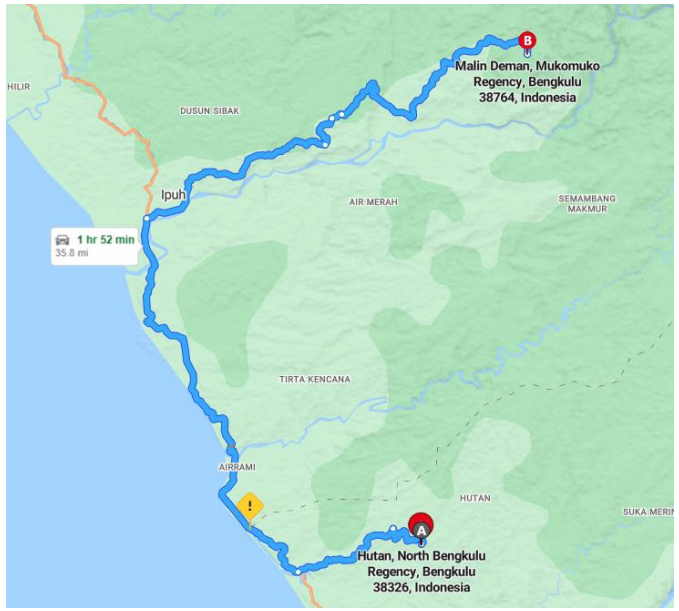
	Orderly Scenario		Disorderly Scenario		Hot House Scenario	
Year	2030	2050	2030	2050	2030	2050
Flood risk change vs baseline	+6%	0%	+12%	+16%	+13%	+22%
% impact on Revenue	0.08%	0.05%	0.1%	0.14%	0.11%	0.2%
Financial Impact Band	Low	Low	Low	Low	Low	Low

In total, potential revenue at risk from operations delays and disruption in the hot house world scenario is roughly **$340,000** in 2030. In 2050 potential revenue at risk is **$600,000**. In the disorderly and orderly scenarios revenue at risk is below this threshold.

* See Appendix 3 for further information on risk changes per area

Flood risk - operational vulnerability

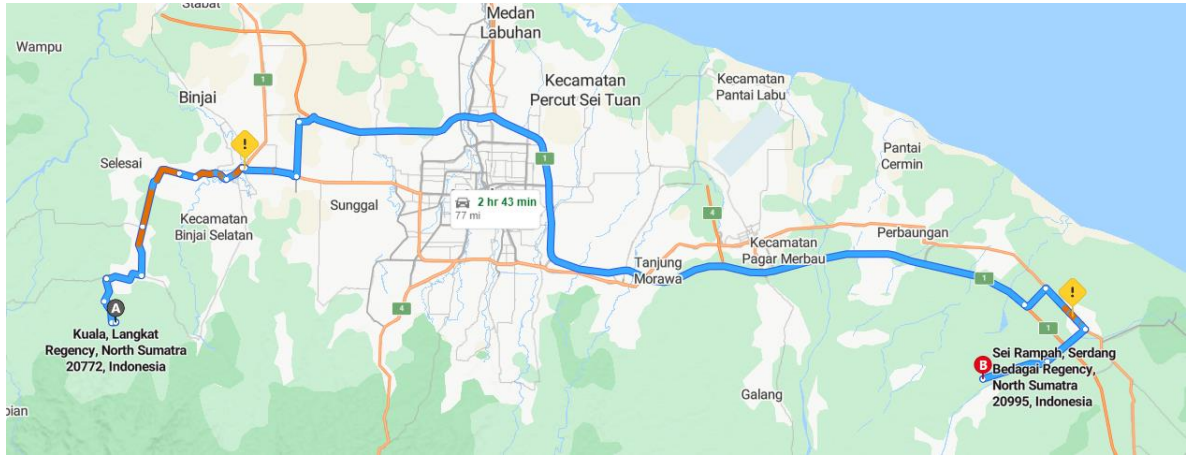
Flood risk might not just manifest ‘on-site’ but could also impact the wider transportation infrastructure upon which AEP depends



As the sites that generate the greatest revenue for AEP (averaging 32% and 31% respectively over 2020-2023), any flood-related disruption to operations at Areas 1 (Bengkulu) and 3 (Sumatera Utara North) would have a disproportionate impact on the company. Both of these areas are projected to experience an increase in flood risk between the base year and 2030 in all scenarios. This risk is maintained or increased through 2050 (except in the orderly scenario, in which Area 3 sees a reduction in risk between 2030 and 2050).

Flood risk might not just impact AEP's operations 'on site' (by, for example, damaging equipment or disrupting harvesting) - it could also impact the wider transportation infrastructure upon which AEP depends.

For example, harvested materials must travel nearly 2 hours along coastal- and river-adjacent roads in order to travel between Alno Air Ikan Estate and Mitra Puding Mas Oil Mill (left). Although this road sits on relatively high ground the potential for flood related disruption - through wider slope erosion/landslides, for example - remains.



Transportation routes that cross/run alongside rivers are particularly vulnerable to flood risk, but flood risk can also manifest in less obvious places.

The route between PT. Simpang Ampat and PT United Kingdom Indonesia Plantations and Blankahan Mill passes through the city of Medan, for example, which experienced flooding in both 2022 and 2023.

6b

Drought Risk

Methodology for drought risk

Step	Methodology	Key assumptions
1	**Reviewed relevance of drought risk to AEP using external tools** Despite literature review and discussions with AEP personnel revealing that drought can impact palm yield, and is a growing concern, both the WWF and WRI water risk tools showed most of AEP's site to be at low risk (low water scarcity risk in the case of the WWF tool; and low water depletion risk in the WRI water risk tool).	
2	**Utilised climate scenario data from WWF water risk tool to determine how water scarcity was projected to change over time.** According to the WWF water risk tool there is no change in drought risk across 2030 or 2050 time horizons at AEP's sites in any scenario. ***The projected financial impact is therefore negligible and was not modelled.*** NB. These projections do *not* account for a potential increase in drought arising from an increase in the frequency and intensity of El Nino events. The potential impact of climate change on the frequency and intensity of the La Nina-El Nino cycle – and the potential impacts of those changes on palm yield in Indonesia and Malaysia were considered qualitatively	• WWF and WRI water scarcity and water depletion risk levels cannot be linked to a defined water deficit, e.g. X mm deficit for Y weeks, as their creation factors in too many variables. Therefore, the potential impact on yield under our different scenarios could not be directly modelled using these indicators.

Understanding current and possible future impacts

Literature review showed that water stress/drought can have a significant impact on palm oil yield

Multiple studies and observational papers link drought stress or water deficit to reduced palm oil yield:

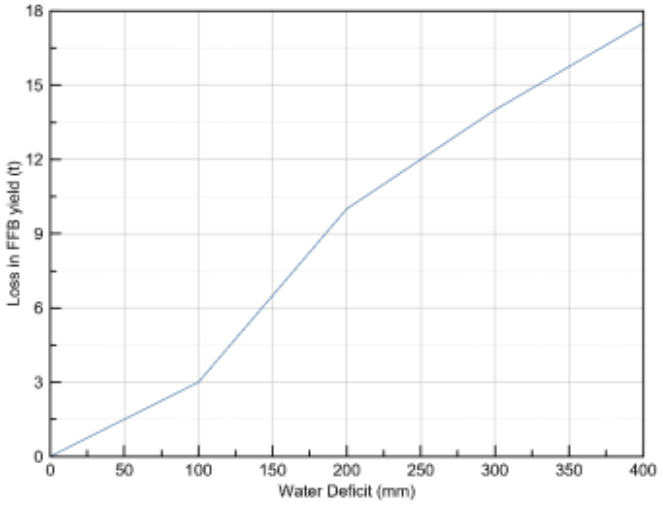
- Monzon et al (2022) found that, whereas the relationship between precipitation and yield in Indonesia was "loose and not significant," yield was "closely associated with water stress".
- Fleiss et al (2022) found that future periods of low-rainfall, particularly drought events, will drive periods of low oil palm yield.

Long-term projections suggest that drought risk will increase in Indonesia:

- Changes in the annual probability of Indonesia experiencing a year with a severe drought by the 2090s roughly doubles from 4% to 9% under RCP2.6 and RCP8.5 emissions pathways respectively (The World Bank Group and Asian Development Bank, 2021), particularly in the south of the country.

Possible types of disruption	Possible Yield Implications
Water-limited yields are less than half of potential yields in drier growing regions of Thailand, Africa and the Americas.	**50%**
In environments with water deficits of >400 mm year^{-1} yield can be less than one-third of the potential yield	**33%**
Yield loss per 100 mm deficit in soil moisture	**10%**
100 mm of water deficit recorded in year has a negative impact on the yields during the following three years	year 1; 8-10% year 2; 3-4% year 3; slight
Drought stress lasting more than 8 weeks can reduced yield during the subsequent 4-12 month period	**Up to 30%**
Exponential decline down in fruit bunches per hectare per year observed at water deficits of >500 mm	

Impact of water deficit on fresh fruit bunch yield (Carr, 2011)

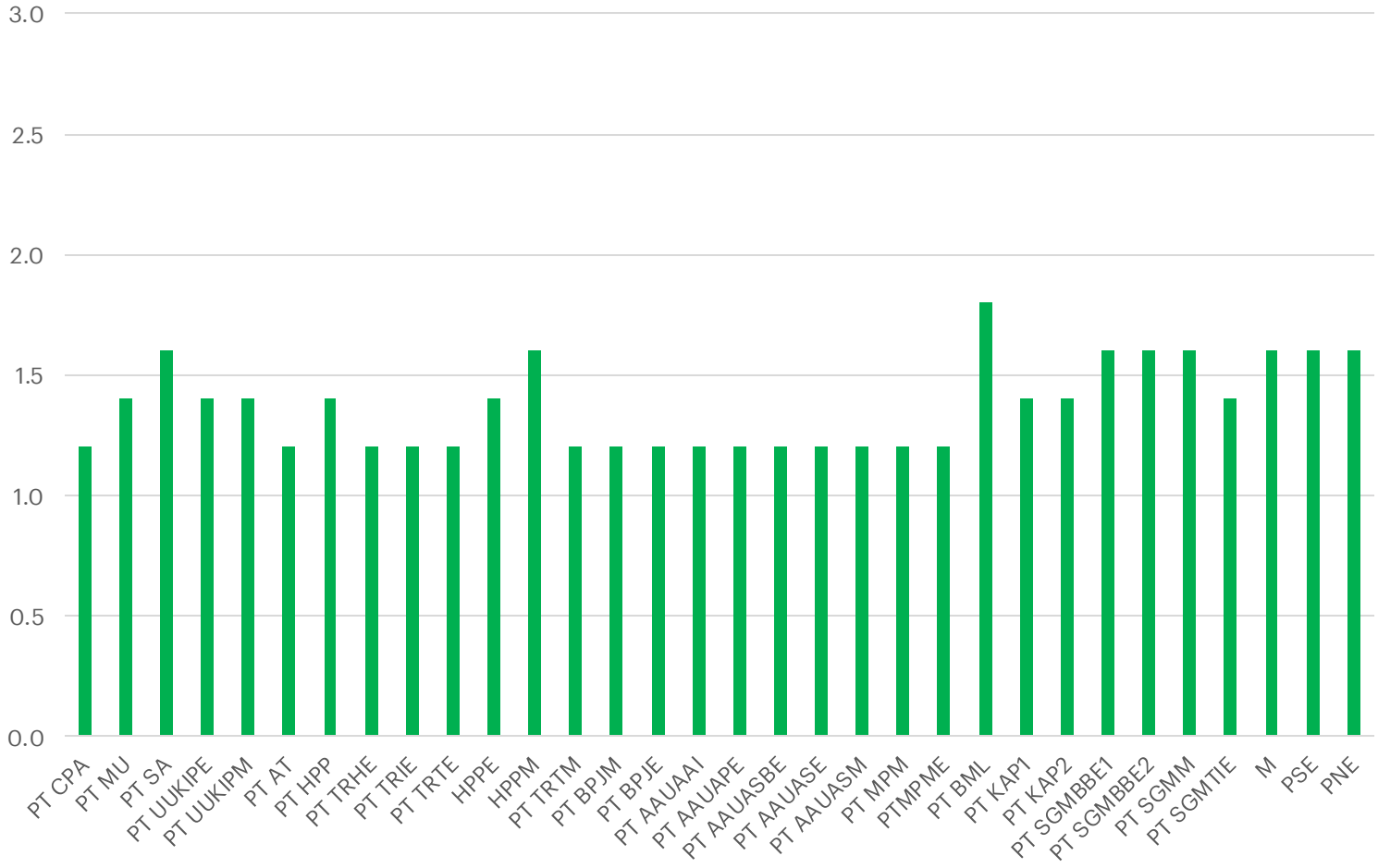


Baseline risk per site according to WWF

The WWF tool offers a localised indicator of baseline drought (water scarcity) risk for AEP

- The **WWF** water risk tool indicates that **current levels** of **water scarcity** are very low for all of AEP's sites.
- The water scarcity metric draws upon 7 indicators: aridity index, water depletion, baseline water stress, blue water scarcity, available water remaining, drought frequency probability, and projected change in drought occurrence.

Water Scarcity Risk	Rating
Very Low	1 - 1.8
Low	1.8 -2.6
Moderate	2.6 – 3.4
High	3.4 – 4.2
Very High	4.2 <

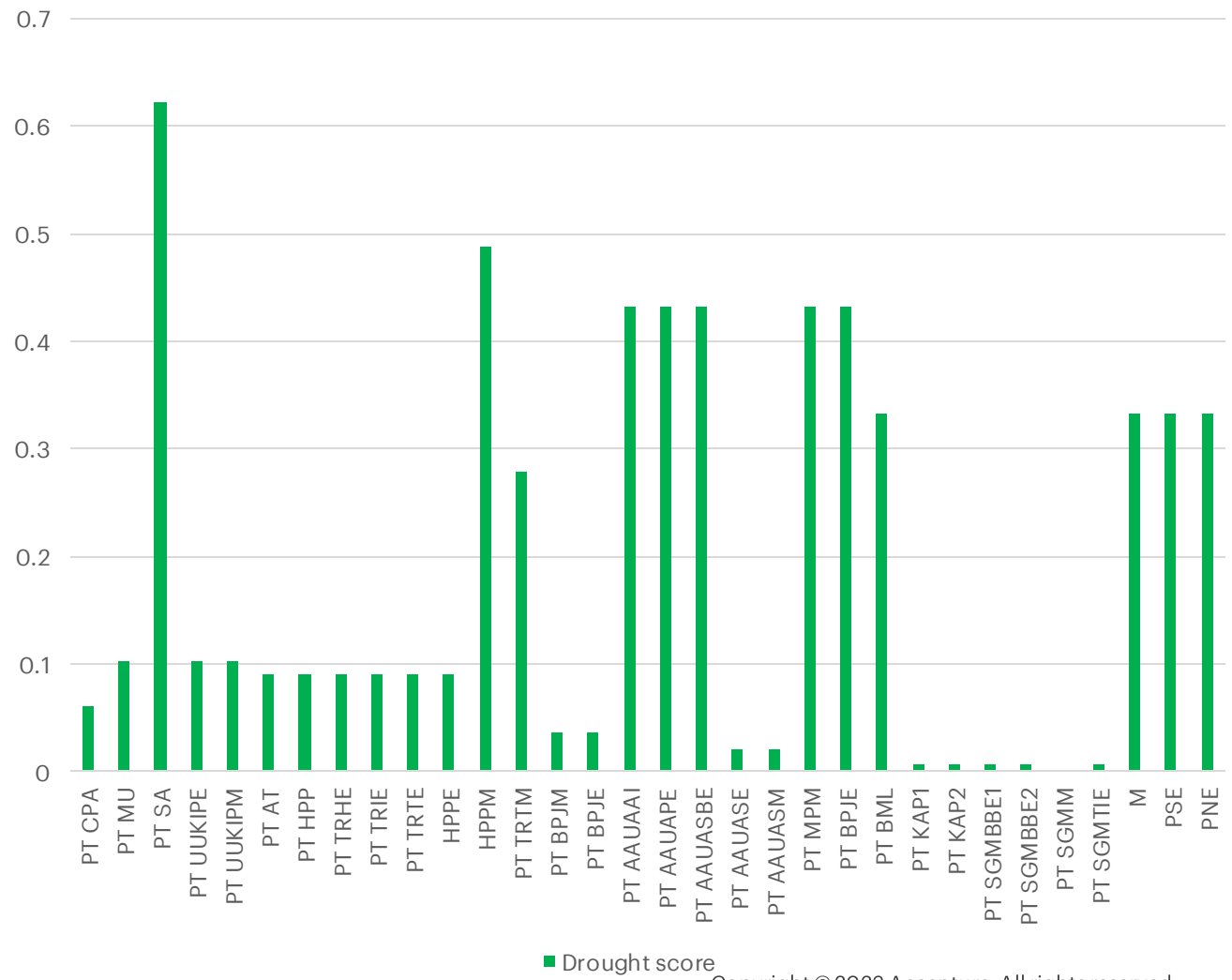


Baseline risk per site according to WRI

The WRI water risk tool was used to sense-check baseline drought risk

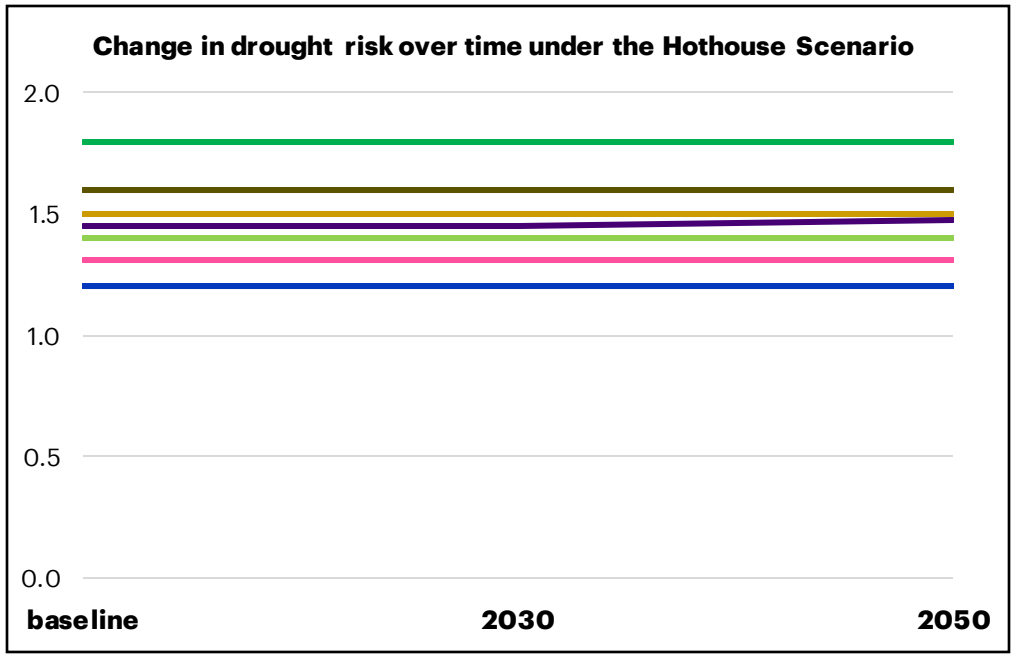
- The **WRI water risk tool** also provides a localised (basin) view of water depletion (availability vs consumption) relevant to industrial and agricultural use.
- As with the WWF tool, all of AEP's sites are categorised as currently having very low drought risk.

Drought Risk	Depletion Water availability to consumption ratio	Rating
Very Low	<5%	0 - 1
Low	5-25%	1 -2
Moderate	25-50%	2 – 3
High	50-75%	3 – 4
Very High	>75%	4 <



WWF water scarcity risk trajectory

The WWF water risk tool places all of AEP's sites within the 'Low Risk' category for water scarcity through 2050 *under all scenarios.*



Accenture Area Map	Number of Sites
Area 1 Bengkulu	7
Area 2 Sumatera Utara South	1
Area 3 Sumatera Utara North	4
Area 4 Sumatera Utara South	7
Area 5 Sumatera Utara South	1
Area 6 Riau	2
Area 7 Bangka	1
Area 8 Kalimantan	2
Area 9 Kalimantan	4
Area 10 Terengganu	3

All of AEP's sites remain within the 'Low Risk' category for water scarcity (i.e. a WWF score of <2.6) through 2050 *under all scenarios*. There is no change to risk rating at any site in the orderly scenario, but in the disorderly and hothouse scenarios, there is a minor uplift in risk (2%) for Plantation Simpang Ampat. All other sites see no change to their risks level.

Accordingly, the potential financial impact in 2030 and 2050 is very low and has not been modelled.

However, because El Nino is likely to increase drought exposure, but is poorly factored in to modelling metrics (see next page), we have ranked drought risk by 2050 as moderate within the disorderly and hothouse scenarios. *This has been informed by qualitative analysis, rather than financial modelling.*

Risk Rating (Drought)	2025	2030	2050
Orderly Scenario	Low	Low	Low
Disorderly Scenario	Low	Low	Moderate
Hothouse Scenario	Low	Low	Moderate

The Potential Impacts of Climate Change on El Nino – A Missing Factor in Projections

Through our literature review, the relationship between El Nino events (which typically result in drought conditions in Indonesia and Malaysia) and palm yield became evident.

Malaysia and Indonesia are vulnerable to the El Nino/La Nina cycle, with El Nino being associated with drought conditions that significantly impact palm oil yield, and La Nina being associated with wetter conditions that can disrupt operations.

Prior El Nino's have been associated with annual yield reductions of roughly 15%-20% in Malaysia and the Malaysian government has warned that the 2023/2024 El Nino event could impact at similar level of magnitude.

These impacts are often experienced 4-12 months after the drought stress has occurred, but negative impacts can also manifest immediately through plantation fires.

The potential impacts of climate change on the La Nino-El Nino cycle are uncertain but research published in 2023 suggests that strong El Nino events are increasing in frequency, and that such events will continue to happen more frequently as global temperatures rise. The potential impacts of a changing La Nina-El Nino cycle are not yet factored into projections of drought and flood risk, and thus the projected impacts of both within the WWF Water Risk Filter (and similar tools) may well underplay the associated risks.

6c

Aggregated Impacts at Temperature Thresholds

Methodology for aggregated impacts

Step	Methodology	Key assumptions
1	**Reviewed potential impacts of climate change on palm yield via a literature review** • The aggregated impacts of climate change at different temperature thresholds were demonstrated to impact palm oil yield in the literature review. • The exact nature of these impacts are subject to ongoing research, and not all analysis suggests that palm yield in Indonesia and Malaysia will be negatively impacted prior to 2050. • Sankar (2020), however, suggest that yield *will* be negatively impacted – and propose a model that enables yield impacts at different temperature thresholds to be projected.	1˚C increase in temperature can lead to a 10% reduction in yield
2	**Utilised climate scenario data from Climate Impact Explorer to identify change in risk over time by scenario** • Temperature change impacts on fresh fruit bunch yield were modelled against the temperature trajectories associated with each of our scenarios (hot house world, disorderly and orderly). • The climate impact explorer platform provides temperature change at a country level projected to 2050 in accordance with the IPCC's RCPs aligned with our scenarios.	• Data is available at a country level, therefore yield and financial implications were calculated at a country level
3	**Calculated a hypothetical financial impact for any additional warming projected** • The additional (versus a 2020 baseline) surface temperature per scenario was multiplied by the change in yield factor linked to warming, to calculate a potential revenue impact in the given scenario and year.	• Model baseline assumes revenue stays constant out to 2050, before factoring in climate impacts

Understanding possible future impacts

A study by Sankar (2020) reviewed the historical relationship between temperature and yield in Malaysia to create a model for the future relationship between yield and temperature under different climate scenarios.

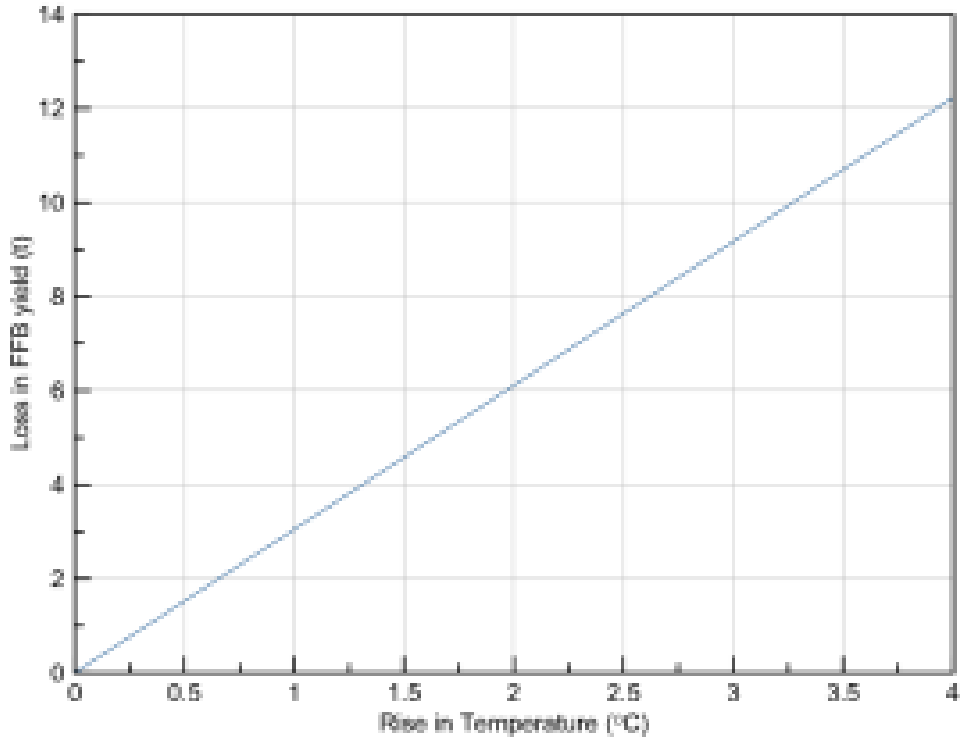
It proposes that if temperature increases by 1 °C, 2 °C, 3 °C, and 4 °C; then oil palm production will decrease in Malaysia by 10.17%, 20.38%, 30.55%, and 40.75%, respectively.

Impact of temperature on palm fresh fruit bunch yield (Sankar, 2020)

Table 5 Impacts of temperature rise on oil palm productions

Temperature rise	Loss of oil palm production (%)
1 °C* (3.57%)	10.17
2 °C (7.15%)	20.38
3 °C (10.72%)	30.55
4 °C (14.29%)	40.75

*For 1 °C temperature rise, $LOPP_{TR} = Coeff_{TEM} \times \%TR = -2.85 \times 3.57 = 10.17$

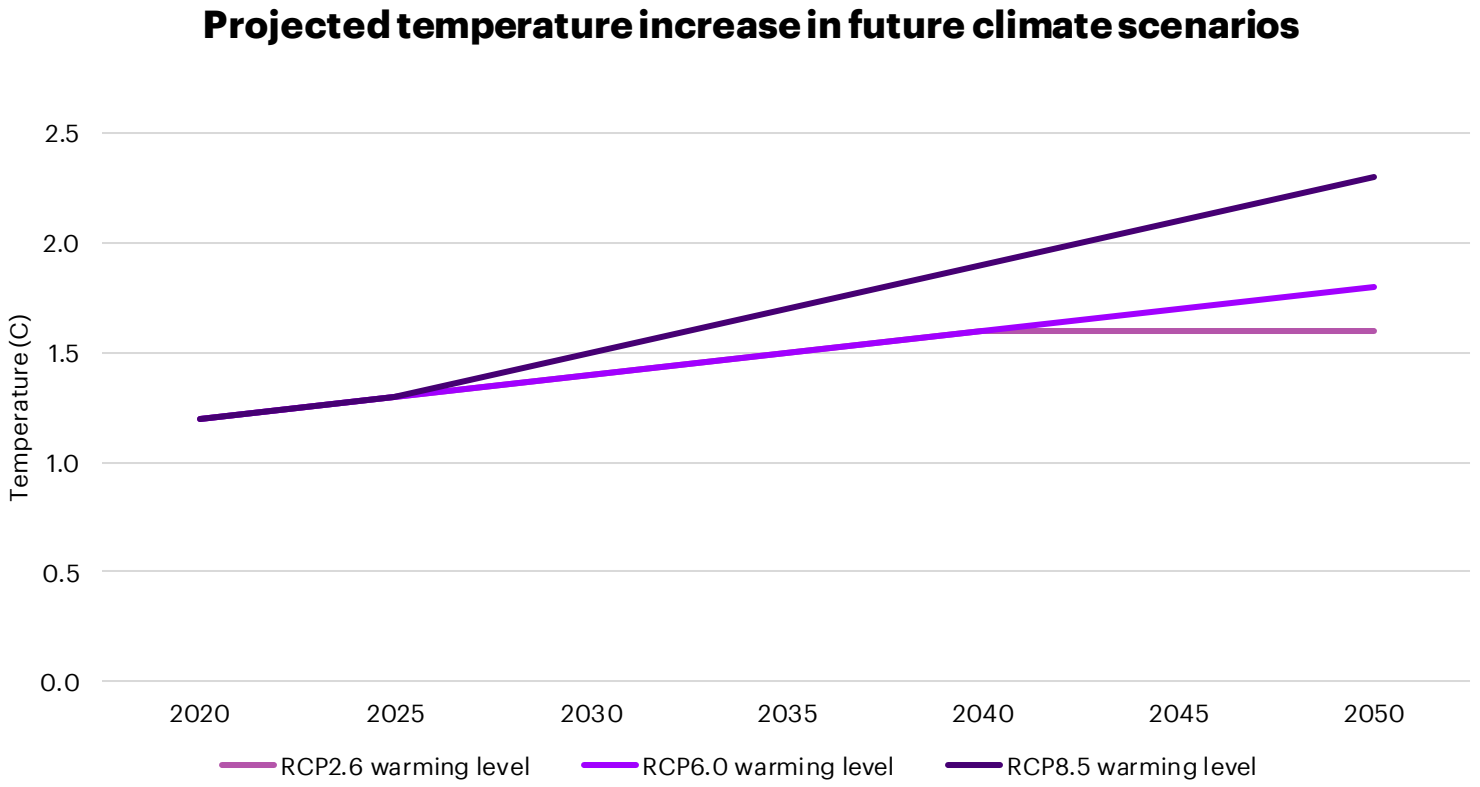


Approach to modelling

Impact of reaching temperature thresholds on palm oil yield

The modelling methodology:

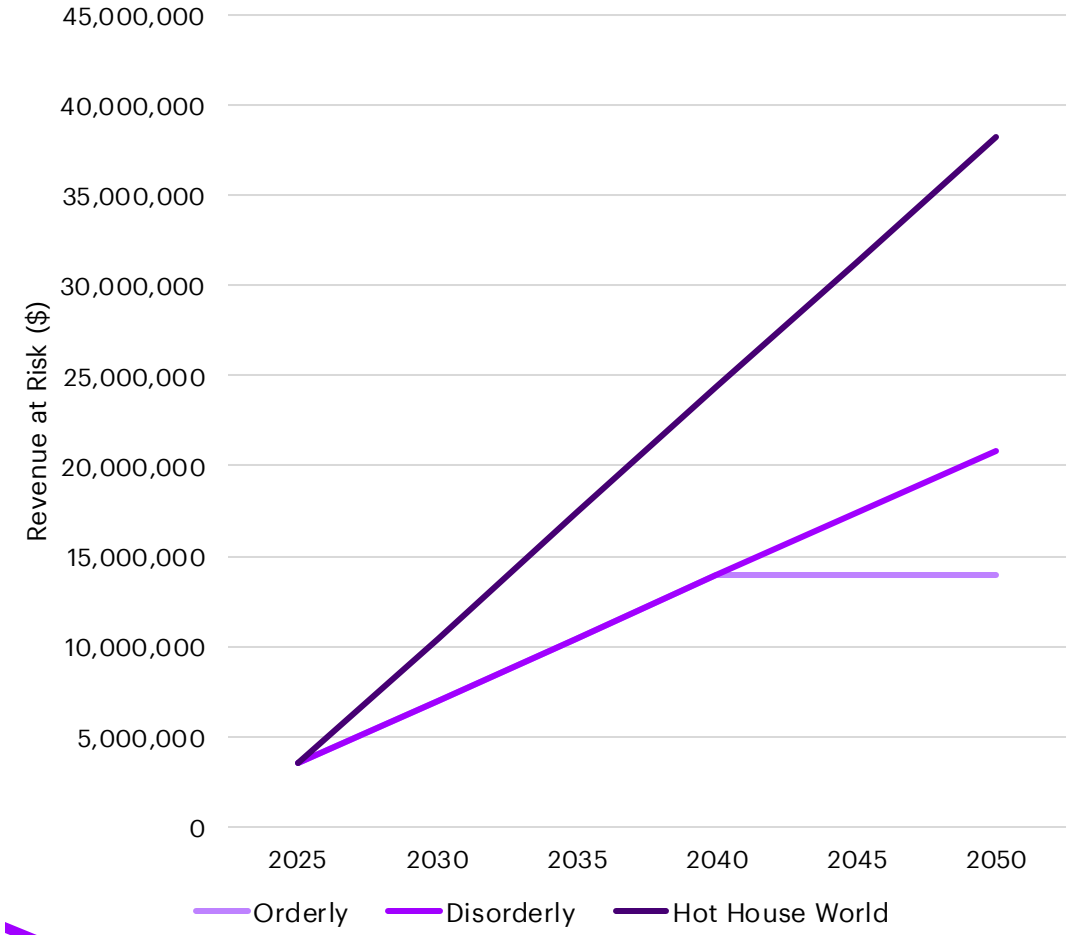
1. The model considered the relative change in median modelled temperature from the baseline year of 2020.
2. It applied a yield impact in the given year of -10.17% per 1 °C of temperature in Malaysia, which was the focus of the study. The same logic was also extended to AEP's Indonesian grown palm.
3. The projected change in yield was applied to the average palm revenue between 2020 and 2022 to estimate future impact to AEP.
4. The model does not capture any additional changes to variable costs such as harvesting related to a change in yield.
5. NB. It should be recognised scenarios – and higher emissions scenarios in particular – have increasingly large uncertainty bars through time.



Scenario Alignment	RPC
Orderly	2.6
Disorderly	6.0
Hot House World	8.5

Risk trajectory associated with increasing temperature

In the hothouse scenario projected temperature increase is most pronounced and the financial risk associated with yield decrease is greatest in this scenario. In the other scenarios, temperature increase is less pronounced but still results in a high risk to revenue by 2050 (>5%) in the disorderly scenario and a moderate risk to revenue (1-5%) in the orderly scenario.



% Revenue at Risk (Malaysia & Indonesia)*	2025	2030	2035	2040	2045	2050
Hot House World	1.0%	3.1%	5.1%	7.1%	9.2%	11.2%
Risk level	Low	Moderate	High	High	High	High
Disorderly	1.0%	2.0%	3.1%	4.1%	5.1%	6.1%
Risk level	Low	Moderate	Moderate	Moderate	High	High
Orderly	1.0%	2.0%	3.1%	4.1%	4.1%	4.1%
Risk level	Low	Moderate	Moderate	Moderate	Moderate	Moderate

Revenue and yield show the same percentage change because the impact of yield is assumed to be at a 1:1 ratio with revenue.

Percentage revenue at risk is the same for Indonesia and Malaysia because temperature change is predicted to be the same in both countries. Absolute revenue at risk is higher in Indonesia because it is AEP's primary revenue generating area.

*See Appendix 4 for more detail

Appendix 1

Caveats and limitations of approach

Disclaimer:

Whilst all reasonable steps have been taken to ensure that the information contained within this report is correct, the information contained within it may be incomplete, inaccurate or may have become out of date. Accordingly, Accenture makes no warranties or representations of any kind as to the content of this report or its accuracy and, to the maximum extent permitted by law, accept no liability whatsoever for the same including, without limit, for direct, indirect or consequential loss, business interruption, loss of profits, productions, contracts, goodwill or anticipated savings. Any person making use of this report does so at their own risk.

Important notice on scenario analysis:

Scenario analysis does not constitute a forecast. Scenario analysis does not provide precise or exact calculations due to the nature of the modelling and the number of assumptions and parameters used. However, it does provide a range of future possibilities that encourage companies to think about climate change impacts differently. All companies using scenario analysis should consider how to integrate scenario analysis techniques into the overall Enterprise Risk Management framework.

Physical risk approach:

- Accenture has utilised the latest publicly available modelled datasets to extract climate projections for AEP's sites. These represent the best data available at the time of analysis. These are referenced throughout the report in the methodology sections.
- Whilst climate models/projections have been remarkably prescient at a global level; and in projecting climatic means/averages, they are much less capable of projecting specific events or extremes (e.g. storms, floods, heatwaves) at specific locations. The potential impacts of climatic 'tipping points' are also not accounted for within current climate projections.
- All projections become more uncertain the further into the future we look, and/or the warmer the planet gets. The projections presented in this work – even those aligned to a Hothouse/RCP8.5 scenario – do not therefore represent the 'worst case' climate impacts that AEP might face.

Appendix 2

Climate- and nature-related risk 'Long-List'

Physical

Acute: Heavy rainfall/flooding (NB. Water collection opportunities)

Chronic: Drought (especially in Kalimantan and South Sumatera)

*(**Chronic**: Water cycle disruption and competition)*

Acute/Chronic: Fire

Chronic: Pests and Disease (stem rot, leaf beetles; reduced pollination services)

Chronic: Increasing temperatures

Chronic: Sea-level rise

Chronic: Ecosystem disruption through forest conversion

Chronic: Ecosystem disruption through waste and/or nitrogen (e.g., fertiliser) release

Chronic: Loss of key pollinator species

Transition

Policy and Legal: Compliance with changing regulations & access to markets (re: sustainability performance and reporting)

- Carbon pricing/taxation
- Deforestation/ NDPE policies
- Supply chain transparency/provenance tracing
- Regenerative agriculture/forest restoration/biodiversity policies post COP15

Market/Reputation: Changes in buyer preferences

- Societal acceptance
- Consumer preferences
- Investor/supply chain pressure

Market/Reputation: Development of new products (e.g., biofuels; methane; fibre)

Market: Increased competition for land

Market/Reputation: Development/uptake of lab-based and/or other alternatives to palm

Technology: Biogas and Bio-CNG production

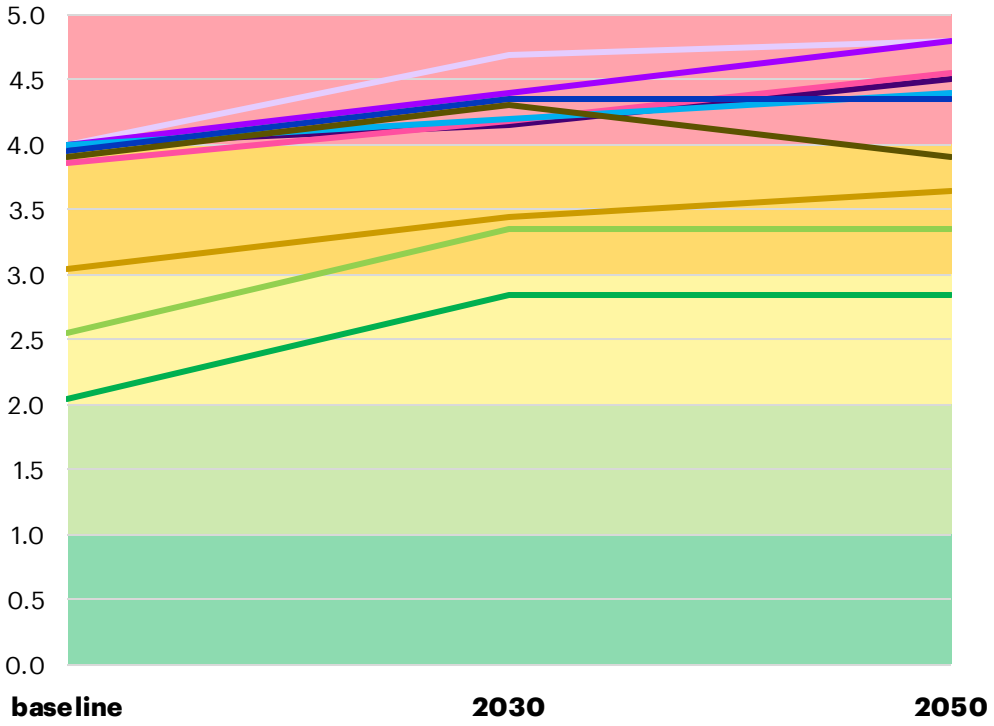
Appendix 3
Flood Risk

Flood risk financial impact in $

	Sumatera North	Riau	Bangka	Sumatera South	Bengkulu	Borneo Kalimantan	Malaysia	Total
	Area 3	area 6	area 7	area 4, 2, 5	area 1	area 8, 9	area 10	
2030 orderly	79,085	-	1,816	2,155	111,865	48,749	-	
total								243,670
2050 orderly	-	-	1,816	-	111,865	41,785	1,932	
total								157,397
2030 hot house world	79,085	45,847	3,633	7,424	174,012	27,856	966	
total								338,822
2050 hot house world	180,765	91,694	3,633	11,734	198,870	111,425	3,863	
total								601,986
2030 disorderly	33,894	45,847	3,633	3,832	149,153	83,569	1,932	
total								321,859
2050 disorderly	112,978	45,847	3,633	7,903	174,012	97,497	-	
total								441,870

Flood risk trajectory – WWF disorderly pathway

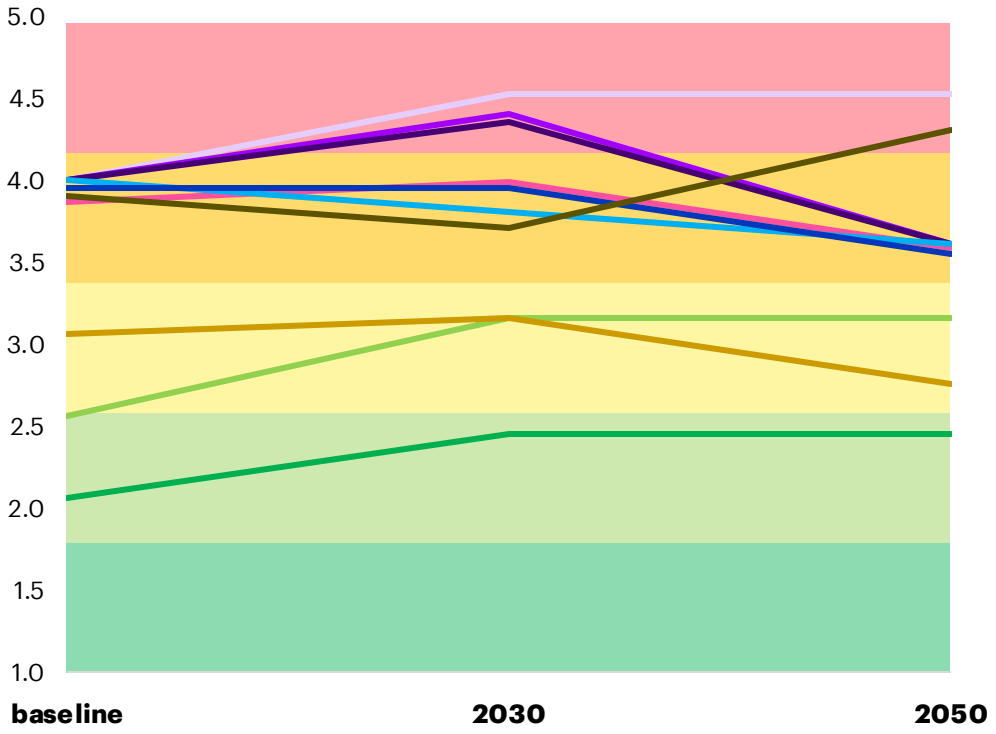
In the disorderly climate change scenario (i.e. aligned to limiting global warming to 2C by 2050) flood risk trajectory increases across all of the Area areas that AEP operate. Risk level above the base year is considered to have a financial impact on AEP.



Accenture Area Map	Number of Sites
Area 1 Bengkulu	7
Area 2 Sumatera Utara South	1
Area 3 Sumatera Utara North	4
Area 4 Sumatera Utara South	7
Area 5 Sumatera Utara South	1
Area 6 Riau	2
Area 7 Bangka	1
Area 8 Kalimantan	2
Area 9 Kalimantan	4
Area 10 Terengganu	3

Flood risk trajectory – WWF orderly pathway

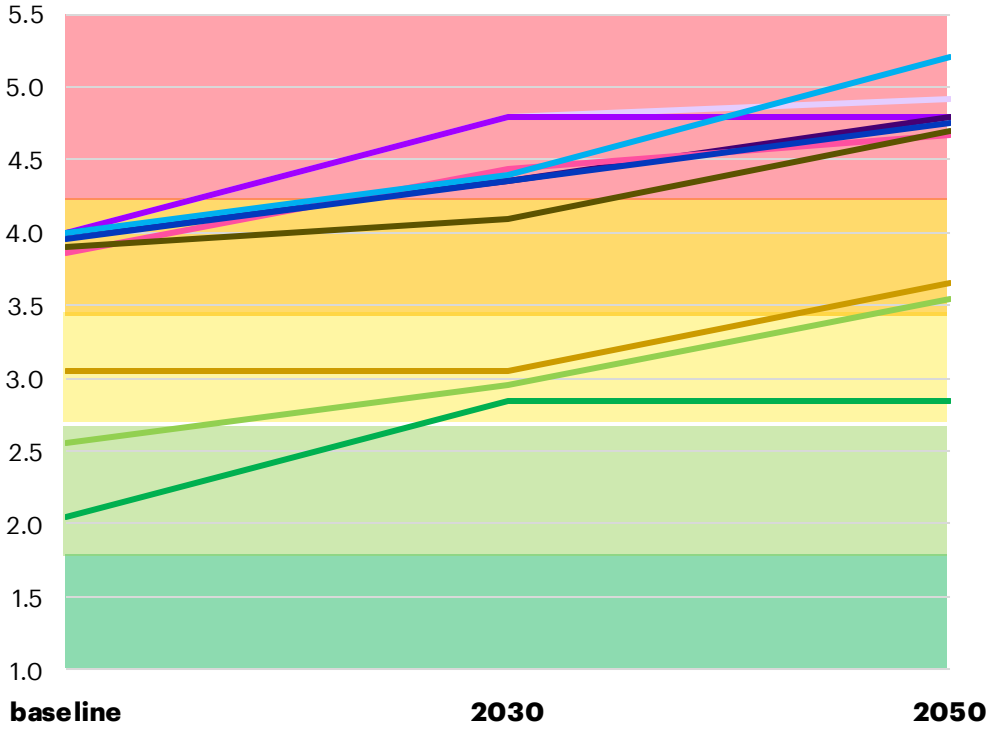
In the orderly climate change scenario (i.e. aligned to limiting global warming to 1.5C by 2050) many sites see their flood risk diminish by 2050. However, some still see their level of risk increase. Risk level above the base year is considered to have a financial impact on AEP.



Accenture Area Map	Number of Sites
Area 1 Bengkulu	7
Area 2 Sumatera Utara South	1
Area 3 Sumatera Utara North	4
Area 4 Sumatera Utara South	7
Area 5 Sumatera Utara South	1
Area 6 Riau	2
Area 7 Bangka	1
Area 8 Kalimantan	2
Area 9 Kalimantan	4
Area 10 Terengganu	3

Flood risk trajectory – WWF hot house pathway

Flood risk trajectory across sites in the Hot house world climate change scenario. Risk level above the base year is considered to have a financial impact on AEP.

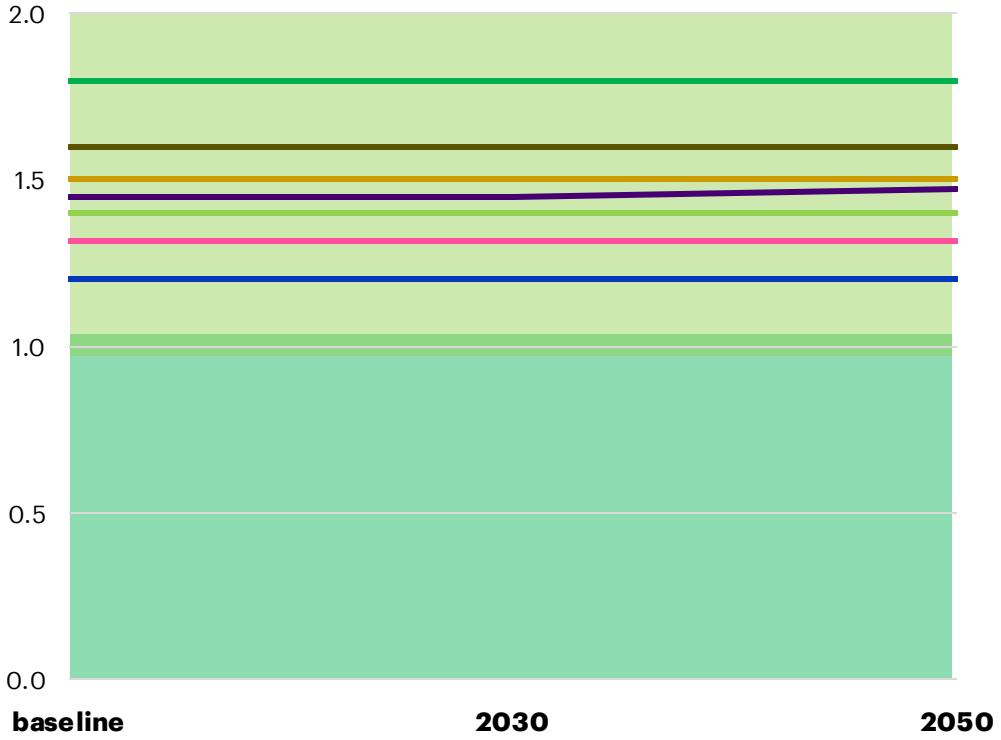


Accenture Area Map	Number of Sites
Area 1 Bengkulu	7
Area 2 Sumatera Utara South	1
Area 3 Sumatera Utara North	4
Area 4 Sumatera Utara South	7
Area 5 Sumatera Utara South	1
Area 6 Riau	2
Area 7 Bangka	1
Area 8 Kalimantan	2
Area 9 Kalimantan	4
Area 10 Terengganu	3

Appendix 4 Drought/Temp Risk

Water scarcity risk trajectory – WWF hot house & disorderly pathway

In the orderly pathway, there is no change versus baseline risk in any of the areas examined



Accenture Area Map	Number of Sites
Area 1	7
Area 2	1
Area 3	4
Area 4	7
Area 5	1
Area 6	2
Area 7	1
Area 8	2
Area 9	4
Area 10	3

Risk financial impact in $ based on temperature increase
Hot house Scenario

Air temp		2020	2025	2030	2035	2040	2045	2050
Malaysia	RCP8.5 warming level	1.2	1.3	1.5	1.7	1.9	2.1	2.3
	Yield	5,419	5,419	5,419	5,419	5,419	5,419	5,419
Indonesia	RCP8.5 warming level	1.2	1.3	1.5	1.7	1.9	2.1	2.3
	Yield	547,720.00	664,011.43	664,011.43	664,011.43	664,011.43	664,011.43	664,011.43
Risk	Malaysia	12.2%	1.0%	3.1%	5.1%	7.1%	9.2%	11.2%
	Indonesia	12.2%	1.0%	3.1%	5.1%	7.1%	9.2%	11.2%
Yield at risk (MT)	Malaysia		55	165	276	386	496	606
	Indonesia		6,753	20,259	33,765	47,271	60,777	74,283
Revenue $ per MT	Malaysia		380	380	380	380	380	380
	Indonesia		512	512	512	512	512	512
Revenue $ at risks	Malaysia		20,954	62,861	104,769	146,676	188,584	230,492
	Indonesia		3,456,525	10,369,576	17,282,626	24,195,676	31,108,727	38,021,777
	Total		3,477,479	10,432,437	17,387,395	24,342,353	31,297,311	38,252,269
	Total % Revenue at Risk		1.02%	3.05%	5.09%	7.12%	9.15%	11.19%

Risk financial impact in $ based on temperature increase
Disorderly Scenario

Air temp		2020	2025	2030	2035	2040	2045	2050
Malaysia	RCP6.0 warming level	1.2	1.3	1.4	1.5	1.6	1.7	1.8
	Yield	5,419	5,419	5,419	5,419	5,419	5,419	5,419
Indonesia	RCP6.0 warming level	1.2	1.3	1.4	1.5	1.6	1.7	1.8
	Yield	547,720.00	664,011.43	664,011.43	664,011.43	664,011.43	664,011.43	664,011.43
Risk	Malaysia	12.2%	1.0%	2.0%	3.1%	4.1%	5.1%	6.1%
	Indonesia	12.2%	1.0%	2.0%	3.1%	4.1%	5.1%	6.1%
Yield at risk (MT)	Malaysia		55	110	165	220	276	331
	Indonesia		6,753	13,506	20,259	27,012	33,765	40,518
Revenue $ per MT	Malaysia		380	380	380	380	380	380
	Indonesia		512	512	512	512	512	512
Revenue $ at risks	Malaysia		20,954	41,908	62,861	83,815	104,769	125,723
	Indonesia		3,456,525	6,913,050	10,369,576	13,826,101	17,282,626	20,739,151
	Total		3,477,479	6,954,958	10,432,437	13,909,916	17,387,395	20,864,874
	Total % Revenue at Risk		1.02%	2.03%	3.05%	4.07%	5.09%	6.10%

Risk financial impact in $ based on temperature increase
Orderly Scenario

Air temp		2020	2025	2030	2035	2040	2045	2050
Malaysia	RCP2.6 warming level	1.2	1.3	1.4	1.5	1.6	1.6	1.6
	Yield (MT)	5,419	5,419	5,419	5,419	5,419	5,419	5,419
Indonesia	RCP2.6 warming level	1.2	1.3	1.4	1.5	1.6	1.6	1.6
	Yield (MT)	547,720.00	664,011.43	664,011.43	664,011.43	664,011.43	664,011.43	664,011.43
Risk	Malaysia	12.2%	1.0%	2.0%	3.1%	4.1%	4.1%	4.1%
	Indonesia	12.2%	1.0%	2.0%	3.1%	4.1%	4.1%	4.1%
Yield at risk (MT)	Malaysia		55	110	165	220	220	220
	Indonesia		6,753	13,506	20,259	27,012	27,012	27,012
Revenue $ per MT	Malaysia		380	380	380	380	380	380
	Indonesia		512	512	512	512	512	512
Revenue $ at risks	Malaysia		20,954	41,908	62,861	83,815	83,815	83,815
	Indonesia		3,456,525	6,913,050	10,369,576	13,826,101	13,826,101	13,826,101
	Total		3,477,479	6,954,958	10,432,437	13,909,916	13,909,916	13,909,916
	Total % Revenue at Risk		1.02%	2.03%	3.05%	4.07%	4.07%	4.07%