



MOODY'S

Physical Climate Risk & Asset Resilience

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AICB Kuala Lumpur Malaysia



Agenda

- Identifying climate-driven physical risks across suppliers and critical assets
- Assessing asset resilience and concentration risk within the value chain
- Leveraging AI-driven analytics to anticipate disruption and strengthen resilience

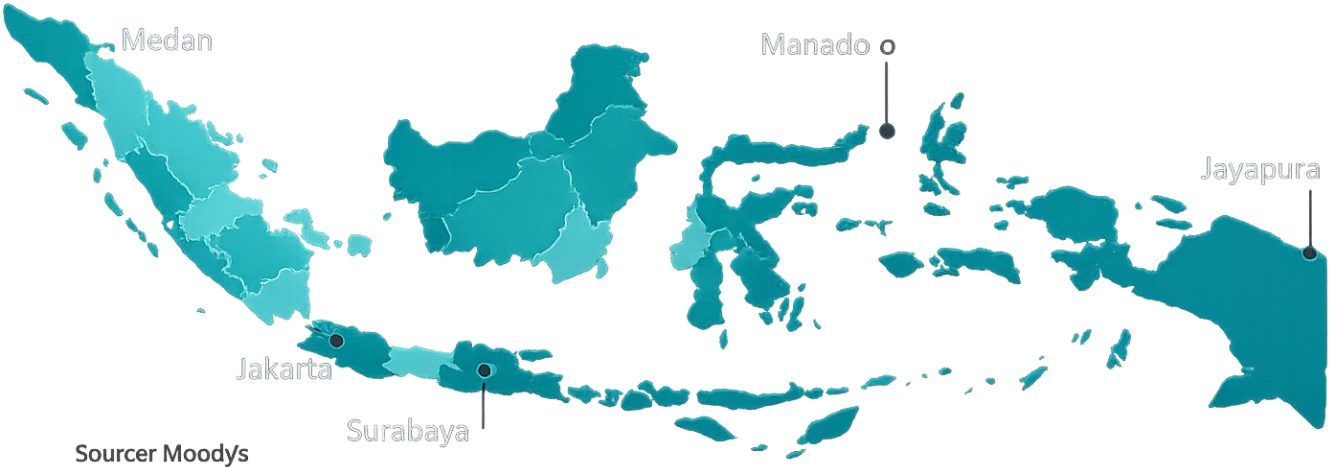


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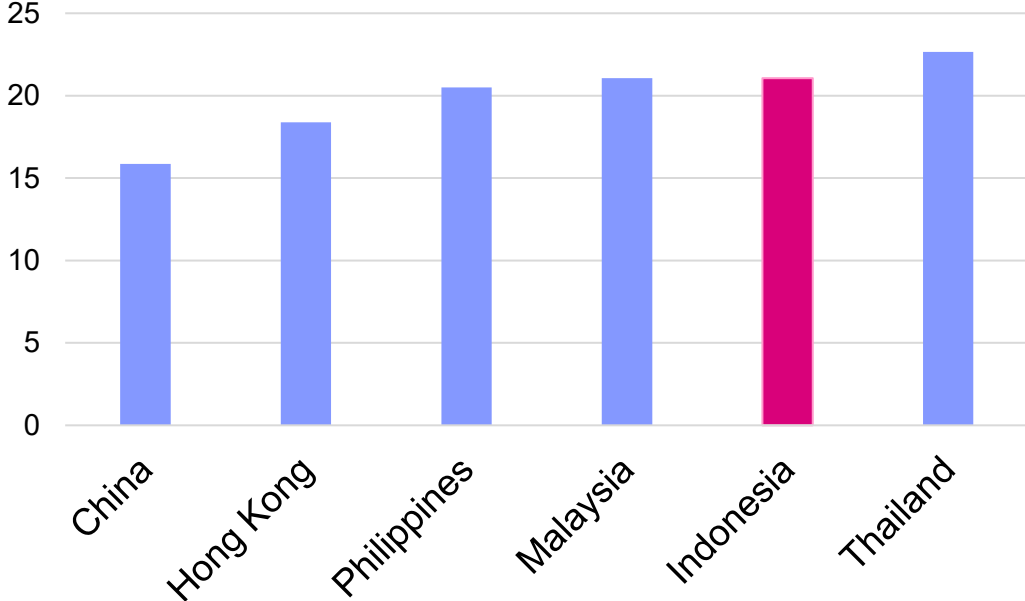
1. Identifying climate-driven physical risks across suppliers and critical assets

Asia Pacific (APAC) is Exposed to Physical Risks

60% of the GDP of certain provinces of Indonesia will face risks from SLR by 2040



Real GDP loss due to physical risk by 2050 under current policies NGFS 5



<https://www.moody's.com/web/en/us/insights/data-stories/global-climate-finance-gap-cop29.html>

Source: NGFS, Moody's

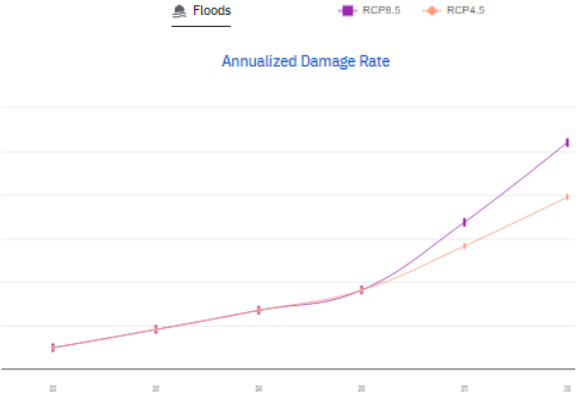
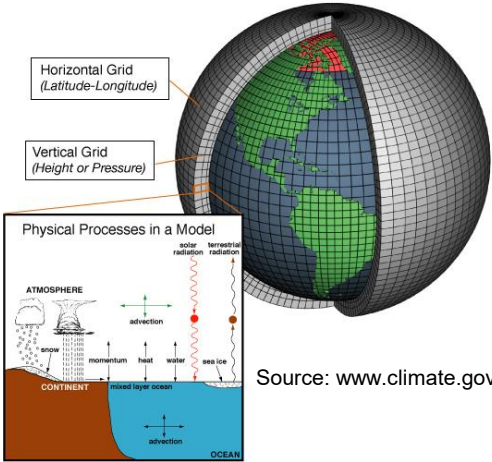
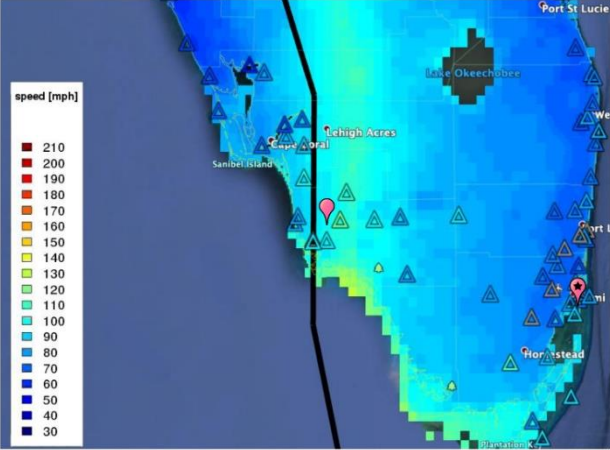
Moody's RMS Physical Risk Expertise

A pioneer of disaster risk modelling

- **30 years of modelling expertise**, founded in Stanford in 1988 and acquired by Moody's in 2021
- More than **350 scientists** and engineers employed, 50% PhD included. More than **400 people** in the field of analytics
- Moody's RMS spends **\$150 millions a year on R&D**
- Moody's RMS models **cover over 90% of global property insurance premiums** - we power a \$1.6 Tn industry with our models and data
- Our offering spans **site-specific analytics to company-wide risk assessments**, including portfolios of assets and suppliers, to accurately reflect correlations between **different sources of risk**
- Our teams also offer flexible **advisory support** enabling user to fine-tune their analysis thanks to tailored services



Climate-Conditioned Catastrophy Models Approach



Catastrophe Risk Models

- Granular acute events (e.g. Hurricanes)
- Built to directly model asset impact and damage



Climate Models

- Dynamic hazard exposure
- Captures anticipated climate change



Climate-Conditioned Cat Models

- Bring the best of both worlds :
1. Stochastic modelling
 2. Translation of the hazard into local metrics
 3. Integration of climate change
 4. Addition of vulnerabilities
 5. Financial damage assessment

Physical Risk Assessment

Physical risk provides two complementary views and supports :

- i) Identification of perils exposure at asset level
- ii) Quantification of potential impact from damage & disruption

Features

- **Global coverage**
- **Acute & chronic** hazards screening
- Scenarios: RCP2.6,4.5,6.0,8.5 and all NGFS scenarios
- Time horizons: Present, 2030, 2040, 2050, 2075, 2100
- Single-asset & **portfolio assessments**
- **Highly precise resolution** by peril



Hazards Coverage



Hurricanes & Typhoons



Floods



Sea Level Rise



Wildfires



Water Stress



Heat Stress



Earthquakes

Output Type

- Hazard output (identification)
 - Hazard scores from 0 to 100 (highest risk)
 - 5-level materiality scale
 - Climate sub-indicators
- Impact output (quantification)
 - Impact scores from 0 to 100 (highest risk)
 - 5-level materiality scale
 - Annualized Damage Rate, Average Annual Damage, Standard Deviation

Each hazard corresponds to diverse sub-indicators effectively capturing broader perils considerations (e.g. heavy precipitations captured in floods modelling)

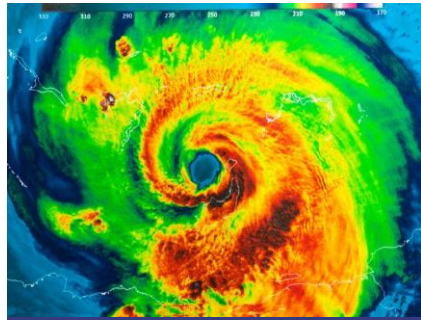
Catastrophe Modelling 5 Key Steps

Catastrophe models quantify the monetary impacts of infrequent, severe, and unpredictable events



Stochastic Event Module

Create an event set probabilistically simulated from historical data and considering climate change where applicable.



Hazard Module

Quantify the parameters that could cause damage.

E.g., flood severity, high winds, storm surge



Exposure Module

Determine assets that are exposed to the hazard.



Vulnerability Module

Calculate damage based on building vulnerability.

E.g., steel frame building with concrete roof deck built in 2015



Financial Analysis Module

Calculate the financial impact and generate loss metrics.

E.g., 1-in-200-year loss of \$12.9M (≈14% of asset value).

Flood HD Models: Main Data Sources

High quality data are instrumental for realistic results

Precipitation, Meteorological, and Hydrological Data



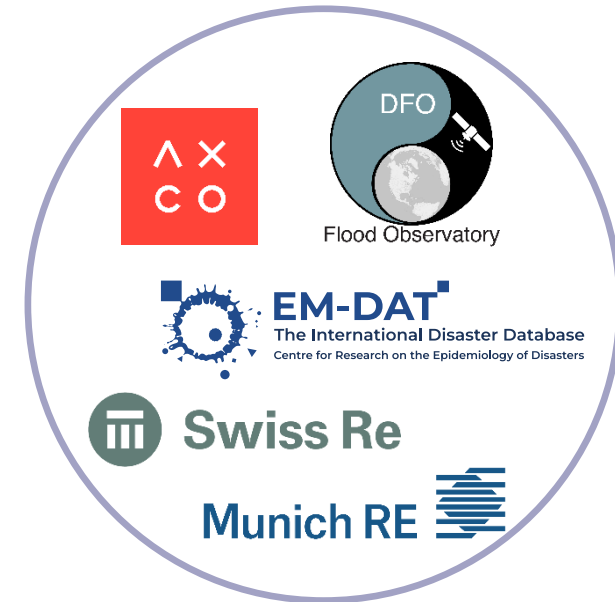
Digital Terrain Model Data Sources



Relying on Local Data Sources as Much as Possible










Data Sources for Loss Benchmarking



Financial Impact – Sample Report Pertamina Assets

Financial Impact

■ Red Flag
 ■ High
 ■ Medium
 ■ Low
 ■ No Risk
 i

Category	Impact Score (1 to 100)	Annualized Damage Rate	Standard Deviation
 Floods	92	0.0002005	0.0030251
 Heat Stress	78	0.0001339	0.0001862
 Hurricanes & Typhoons	4	0.0000036	0.0000534
 Sea Level Rise	17	0.0000062	0.0000541
 Water Stress	99	0.0001482	0.0005387
 Wildfires	12	0.0000016	0.0000479
 Earthquakes	96	0.0005878	0.0063917
All Categories	88	0.0010817	0.0070950

Physical Risk Tail Risk: RCP 8.5 – 2050 and 1-in-200-years event severity

RCP scenarios: future projection of greenhouse gas emissions

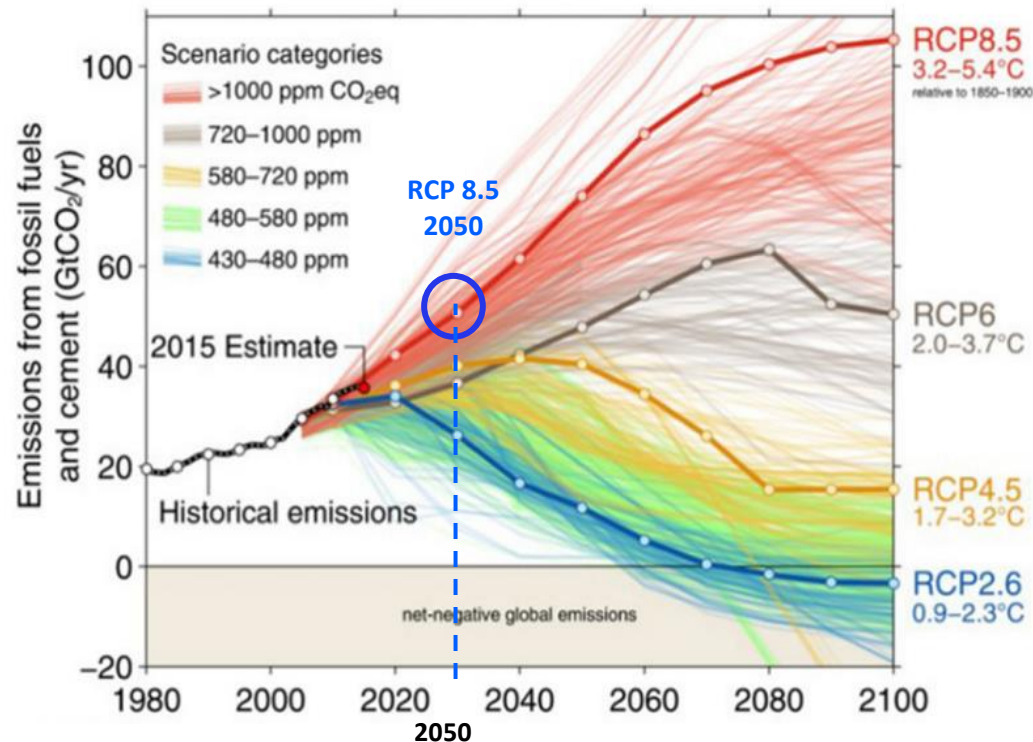
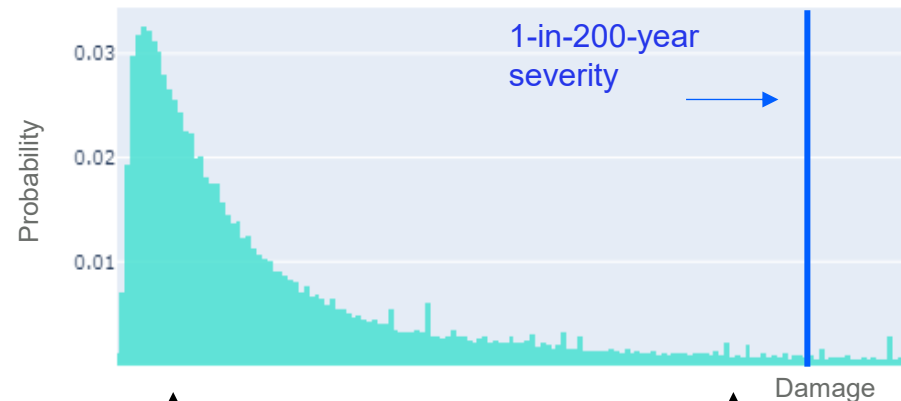


Image Credit: Neil Craik, University of Waterloo. [Article link](#).

- Within the RCP 8.5 scenario pathway of emissions, One APAC Regulator has selected the 2050 time point.
- At that time point, multiple flood events with different severities, probabilities and levels of damage can take place.
- One APAC Regulator has selected the 1-in-200 years severity point (extreme flood that happens on average once every 200 years) for the One APAC Regulator short-term scenario exercise. This is at the tail of the distribution of flood damages:

Illustrative distribution of possible flood damages for RCP 8.5, 2050 (*)



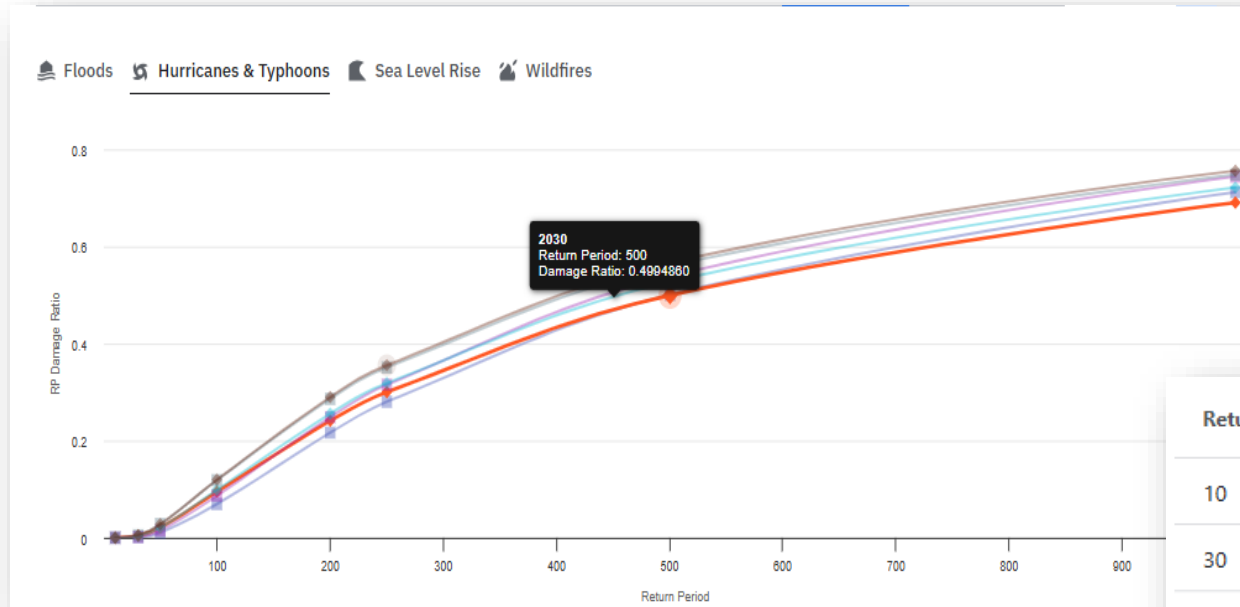
(*) not the actual distribution but a schematic qualitative one for illustration purposes only.

↑
Low severity events: high probability

↑
High severity events: low probability

Tail Risk Financial Impact Sample

Damage rates vary from 0.38% to 69% across different return periods



Return Period	2020	2030	2040	2050
10	0.0000000	0.0000030	0.0000000	0.0000020
30	0.0010980	0.0038700	0.0018490	0.0035480
50	0.0103120	0.0210890	0.0147800	0.0209670
100	0.0696740	0.0947570	0.0869620	0.0990600
200	0.2165930	0.2411360	0.2485050	0.2556830
250	0.2803590	0.3003520	0.3154180	0.3186070
500	0.5007640	0.4994860	0.5385070	0.5270830
1000	0.7120870	0.6906780	0.7441970	0.7217830
Annualized Dam...	0.0034939	0.0038954	0.0038954	0.0041131



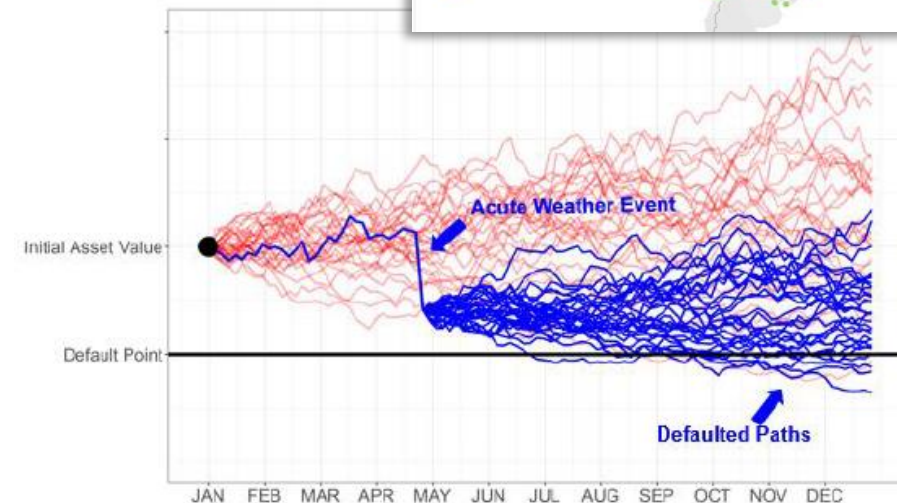
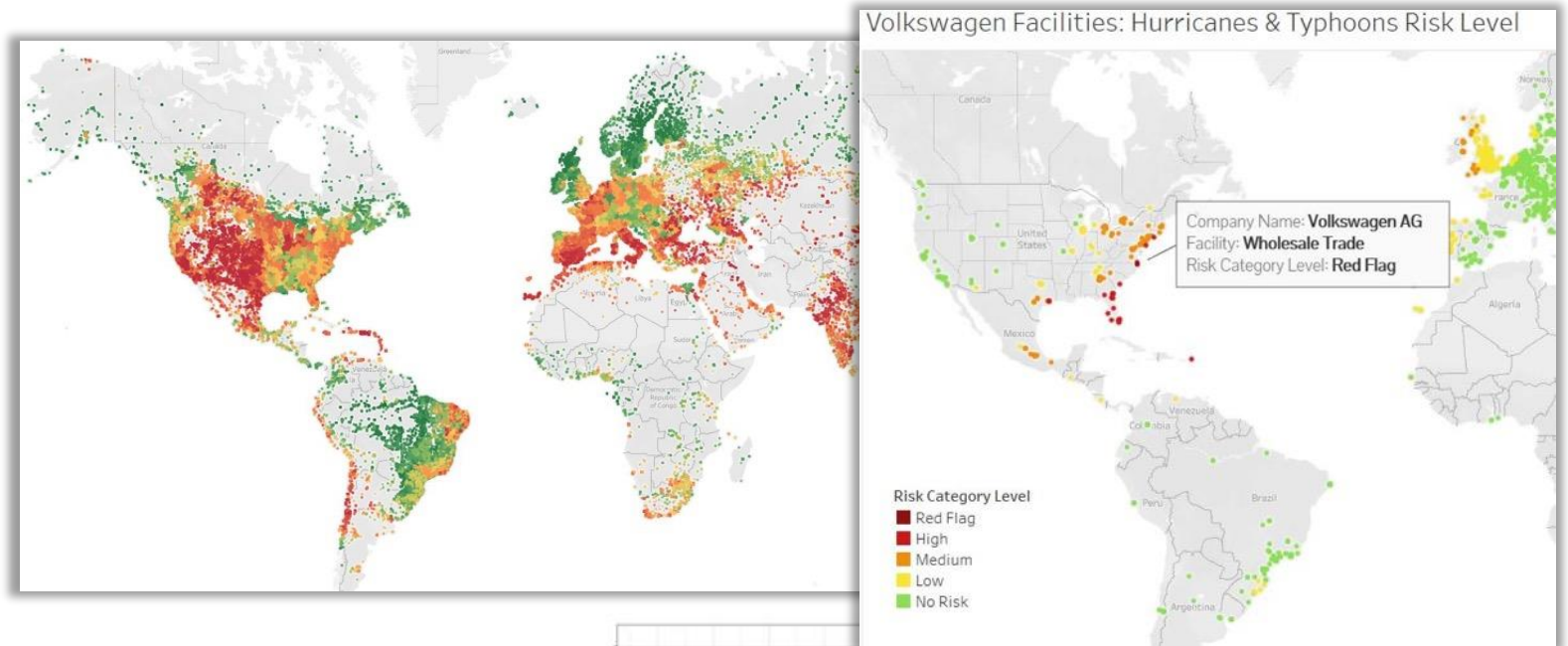
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2. Assessing asset resilience and concentration risk within the value chain

Corporate Physical Risk

Leverage Moody's Corporate Physical Risk Dataset to estimate physical risk exposure of firms

- » Climate risk metrics for over **3.5 million corporate facilities** mapped to the **23,000+ largest listed companies**
- » Corporate physical risk derived from precise **facility locations** and asset types
- » **Quantification** of physical risk damage and business interruption in \$ terms
- » **Hazard coverage** include floods, heat stress, hurricanes & typhoons, sea level rise, water stress, wildfires, and earthquake
- » Captures **future climate risk** aligned to multiple time horizons and RCP scenarios:
 - RCP 4.5 and 8.5
 - Present day, 2030, 2040, 2050, 2075 and 2100
- » **Facility materiality** weights assessed from economic value-add by asset type



Physical Risk Poses Additional Risk to Homes and Businesses



Long term climate scenarios



Analyze damages by hazard

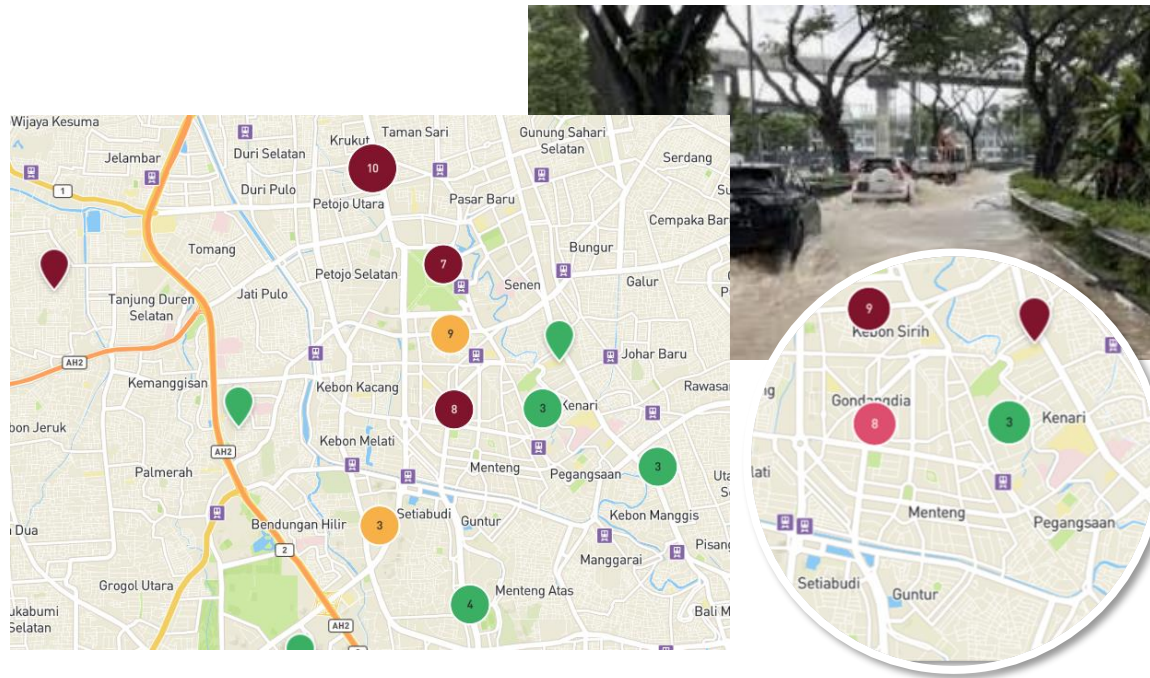


Quantify Resulting Impact



Consider transmission channels

Climate impact to homes and collaterals

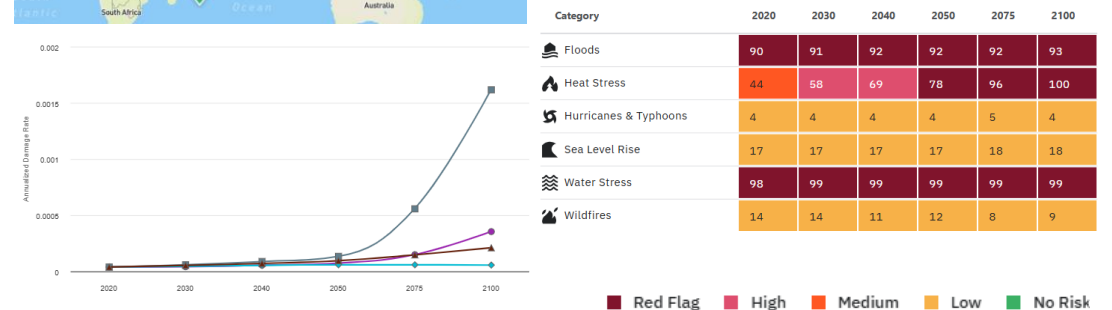


Climate impact to companies' operation downtime and supply chains

Pertamina



- 139 Facilities in total
- 25 facilities abroad



* Powered by Moody's Physical Risk data

Company Report

Company Level and facility level

88 Impact Score	139 Facilities	ID Country	050994211 Orbis ID	Petroleum and Coal Products Man... NAICS ID
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Portfolio Impact

Financial Impact

Category	Impact Score	Annualized Damage Rate	Standard Deviation
Floods	92	0.0002005	0.0030251
Heat Stress	78	0.0001339	0.0001862
Hurricanes & Typhoons	4	0.0000036	0.0000534
Sea Level Rise	17	0.0000062	0.0000541
Water Stress	99	0.0001482	0.0005387
Wildfires	12	0.0000016	0.0000479
Earthquakes	96	0.0005878	0.0063917
All Categories	88	0.0010817	0.0070950

Facility Impact

Orbis ID	Name	Floods	Heat Stress	Hurricanes ...	Sea Level R...	Water Stress	Wildfires	Earthquakes	All Categor...
730905448	Pertamina-B Sh...	0	85	0	0	80	100	33	98
159415619	Cyprus Mnazi B...	0	69	0	0	0	0	100	97
263074291	Pertamina Hulu...	0	62	99	34	0	0	6	97
622512454	PT Rolas Nusan...	96	48	61	0	0	0	75	97
050994211	PT Pertamina (...)	95	74	0	0	93	0	89	96
057132100	PT Pertamina G...	95	74	0	0	93	0	89	96
342778767	PT Pertamina P...	95	74	0	0	93	0	89	96
387459183	PT Kilang Perta...	95	74	0	0	93	0	89	96
604277187	PT Kilang Perta...	95	74	0	0	93	0	89	96
050994356	PT Transportasi...	93	78	0	0	93	0	89	95
074900112	PT Perta-Samta...	94	55	0	0	67	92	65	95

Facility Attributes

Orbis ID	Name	Street	City	Country	NAICS	SIC	NACE	Exposure Value	Company Exposure Weight
196916089	Wentworth ...	oysterbay, to...	Kinondoni	TZ	Grantmaking...	Social service...	Activities of ...	\$506,709,511	2.4429%
051091666	PT Patra Drill...	graha pdsi, 1...	Pal Meriam	ID	Foundation, ...	Miscellaneous...	Other special...	\$445,681,818	2.1487%
157086735	PT PGAS Sol...	c bulding, 4t...	Krukut	ID	Other Heavy ...	Heavy constr...	Construction...	\$445,681,818	2.1487%
370815507	PT Peteka Ka...	building of p...	Sunter Agung	ID	Other Heavy ...	Heavy constr...	Construction...	\$445,681,818	2.1487%
050994356	PT Transport...	jb tower bul...	Kebon Sirih	ID	General Frei...	Trucking and...	Freight trans...	\$342,304,526	1.6503%
051090293	PT Mitra Tou...	patra jasa off...	Kuningan Tl...	ID	Other Suppo...	Miscellaneous...	Other transp...	\$342,304,526	1.6503%
051091746	PT Pelita Air ...	jl. pondok ca...	Pamulang	ID	Scheduled Ai...	Air transport...	Passenger air...	\$342,304,526	1.6503%
051091998	PT Pertamina...	jl. kratam ray...	Kwitang	ID	Deep Sea, C...	Deep sea do...	Sea and coas...	\$342,304,526	1.6503%
060785579	PT Patra Log...	jl. epicentru...	Karet Kuning...	ID	Warehousing...	Public wareh...	Warehousing...	\$342,304,526	1.6503%
342778768	PT Pertamina...	rt 006 nw 003	Kuningan Tl...	ID	Inland Water...	Water transp...	Sea and coas...	\$342,304,526	1.6503%
060210575	Caroil S A Su...	113 52 of 605	Bogota	CO	Support Acti...	Oil and gas fi...	Support acti...	\$336,893,634	1.6242%

Map View





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3. Leveraging AI-driven analytics to anticipate disruption and strengthen resilience

Corporate Physical Risk Intelligence

AI for Hazard Modelling and AI Agent for Methodology Assistance

Hazard Modeling: AI simulates climate hazards like floods and wildfires at 30m resolution globally, using physics-based models and IPCC scenarios.

Portfolio Analytics: AI maps hazard correlations to assess risk across entire portfolios more accurately.

A global manufacturing company Flood Risk Exposure



Source: Moody's COD Pro

RCP8.5 2050

IRP Navigator

YH do you have climate on demand input fields data dictionary

Citations

1. KB: Uploading Portfolios in Climate on Demand

The Climate on Demand input fields data dictionary is available in the documentation for uploading portfolios. Here are the key fields you can include in your CSV template for submitting data:

1. **Name** (Required): Used to identify the asset.
2. **Activity** (Required): Specifies the commercial use or activity of the asset, which influences sensitivity factors for Heat Stress and Water Stress.
3. **Location** (Required): Full street address or precise latitude and longitude.
4. **Country** (Required): Three-digit ISO code for the country.
5. **ID** (Optional): Unique identifier for the asset.
6. **Latitude/Longitude** (Optional): Coordinates for the asset, used if provided alongside street address.
7. **Value** (Optional): Monetary value of the asset for aggregation purposes.
8. **Value Category** (Optional): Non-monetary indication of asset importance (Low, Medium, High).
9. **Custom Fields (Custom1 to Custom5)** (Optional): Additional information for grouping and presentation, such as portfolio name, tags, or site characteristics.

Suggest Prompt

Settings 1

Ask me anything...

AI Generated Report Based on Moody's RMS Climate Data

ID	Facility	Activity	Impact Score (NDCs 50)	ADR % (NDCs 50)	Overall Risk	Primary Hazard Driver
T006	Crystal River	Power Plant	100	2.05%	Sea Level Rise + Hurricanes	High
T008	Dan River CC	Power Plant	98	0.60%	Floods	High
T018	Brunswick Nuclear	Nuclear	84	0.08%	Hurricanes + Wildfire	High
T005	Hines Energy	Power Plant	70	0.06%	Hurricanes + Floods	High
T003	Gibson Gen.	Power Plant	56	0.03%	Earthquakes + Floods	Medium
T002	Markland Hydro	Power Plant	47	0.02%	Floods + Earthquakes	Medium

Crystal River's ADR of 2.05% under NDCs is exceptional and warrants immediate attention. At this rate, for every USD 1 billion of asset value, an investor expects USD 20.5 million in annual losses from physical climate hazards on a probability-weighted basis. The corresponding figures for Dan River (0.60%) and Brunswick Nuclear (0.08%) are materially elevated compared to the portfolio median of approximately 0.01%.

FINANCIAL TRANSLATION: Where asset replacement values are known, multiply the ADR (%) by the replacement value to obtain Average Annual Damage in USD terms. For a USD 500M asset at Crystal River, expected annual damage = 500M x 2.05% = USD 10.25M per year under NDCs by 2050.



Priority 1 — Crystal River Energy Complex (T006)

This facility presents the portfolio's most acute physical risk. The compound effect of sea level rise and hurricane intensification, combined with an ADR of 2.05%, places it in a class of its own within this portfolio.

Recommended actions:

- Request issuer's formal Climate Resilience and Adaptation Plan with asset-level detail.
- Assess feasibility and cost of coastal flood defences (seawalls, levees, drainage).
- Evaluate whether the insurance market can adequately price this risk at 2030+ time horizons.
- Model asset impairment risk under 1-in-100 and 1-in-250 return period events

The background is a solid dark blue color. It features several large, overlapping, wavy white lines that create a sense of depth and movement. These lines are composed of many thin, parallel white lines that are slightly offset from each other, creating a mesh-like or interference pattern effect. The lines flow from the top left towards the bottom right, with some lines curving and looping back. In the top left corner, the text 'M'' is written in a bold, white, serif font. In the bottom left corner, the text 'FAQ' is written in a bold, white, serif font.

M'

FAQ

Thank you

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