INTENSEL
CLIMATE RISK SOLUTIONS

CASE STUDY

Unprepared and Costly:

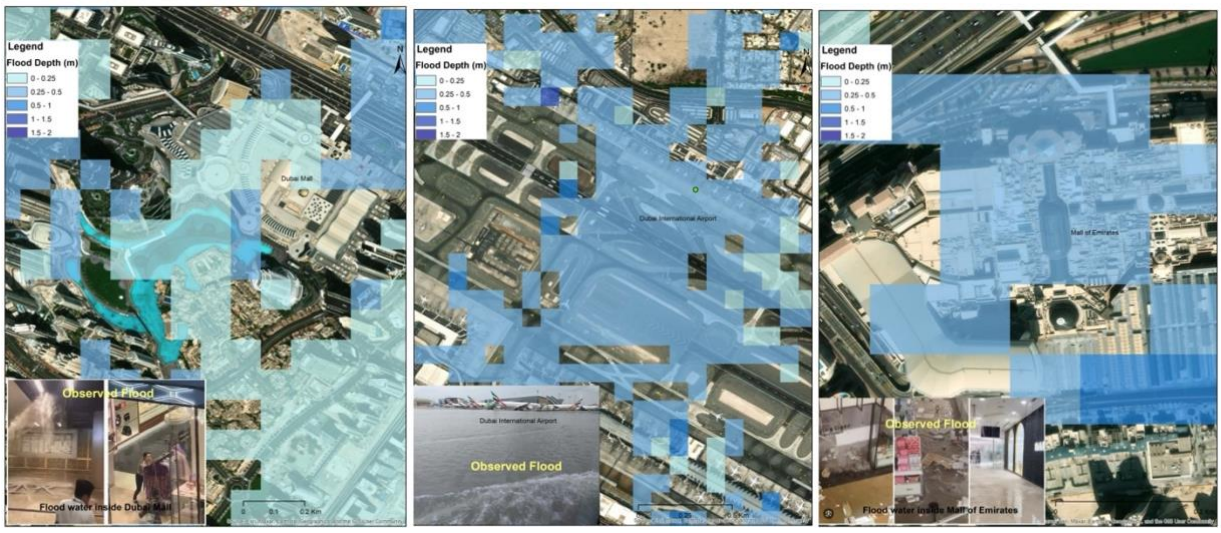
Insights on the impacts of physical risks in the Middle East



In April 2024, the UAE and Oman were hit by record-breaking rainfalls that resulted in widespread flooding across the region. Reports suggested that around 6 inches of rain (1.5 to 2 years' worth of rainfall) had inundated Dubai within 24 hours. Within the city, floodwaters had inundated roads, buildings and airports which led to major operational disruptions and property damages.

Globally, the increasing intensities, frequencies and durations of extreme weather events are expected to result in physical damages and operational losses on individual real assets and portfolios. The flood events in the Middle East raise critical questions around the lack of adequate risk assessments and the preparedness of our existing assets and infrastructure to withstand extreme events of similar intensities.

Intensel's forward-looking modelling capabilities can accurately simulate extreme climate events in regions such as the Middle East where historical precedents are rare or do not exist. Our rainfall flood simulations across three affected areas of the April 2024 Dubai floods show high degrees of accuracy (>80%) when compared with the severity and extent of observed flood inundation.



In-depth present-day rainfall flood simulation and mapping conducted by Intensel across three locations in Dubai, indicating the presence and maximum severity of inundation predominantly reaching depths of 0.5m at specific sites (from left to right: Dubai Mall, Dubai International Airport, and Mall of Emirates).

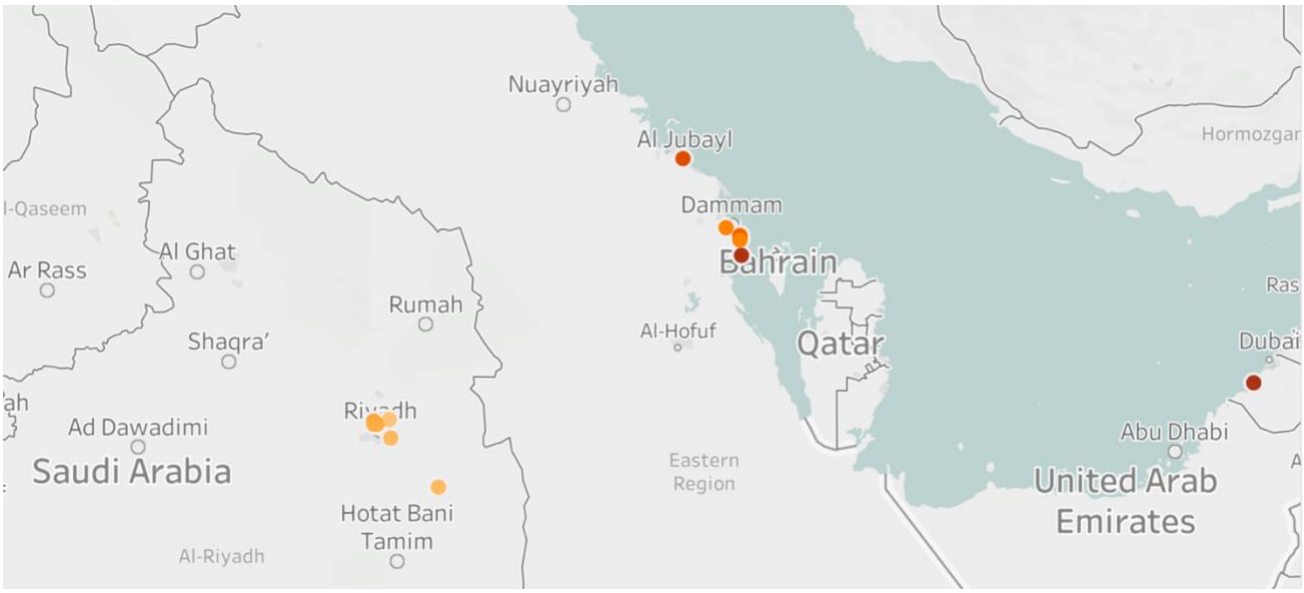
Case Study:
Physical Climate Risk Analysis on a Saudi Arabia and UAE-based Real Estate Investment Trust (REIT)

Against this backdrop, Intensel conducted a Climate Value-at-Risk (CVaR) screen on a Middle East-based REIT that holds a portfolio of 13 real estate assets in the commercial, residential and mixed-use sectors located across Saudi Arabia and the UAE. This analysis assessed the hazard exposure and CVaR of the portfolio across 10 climate hazards, multiple climate scenarios (Shared Socioeconomic Pathways - SSP), and time horizons ranging from 2020 to 2100, drawing upon asset information available via annual financial reports.

Intensel's **Climate Hazard Score** provides an indication of the severity or intensity of various climate hazards impacting each asset within an identified portfolio given their geographical location, and is unbiased with respect to the area, building type or valuation of assets. As such, the score enables users to cross-compare the hazard exposure of assets and portfolios across regions.

Intensel's **CVaR** metric (in % terms) calculated on each asset reflects the maximum amount of loss (i.e. the sum of physical damages and/or operational losses resulting from the impact of hazards on an asset expressed as a fraction of total asset exposure) incurred over a one-year period given the co-occurrence of extreme events. This depends on asset-specific factors that include hazard severity, building valuation and revenue, building area, replacement cost, and characteristics and vulnerability to a specific hazard determined through damage functions.

Our key findings of the portfolio's hazard exposure and CVaR under a high emissions SSP 5-8.5 scenario (aligning with a 4.6-5.2°C temperature pathway by 2100) are as follows:



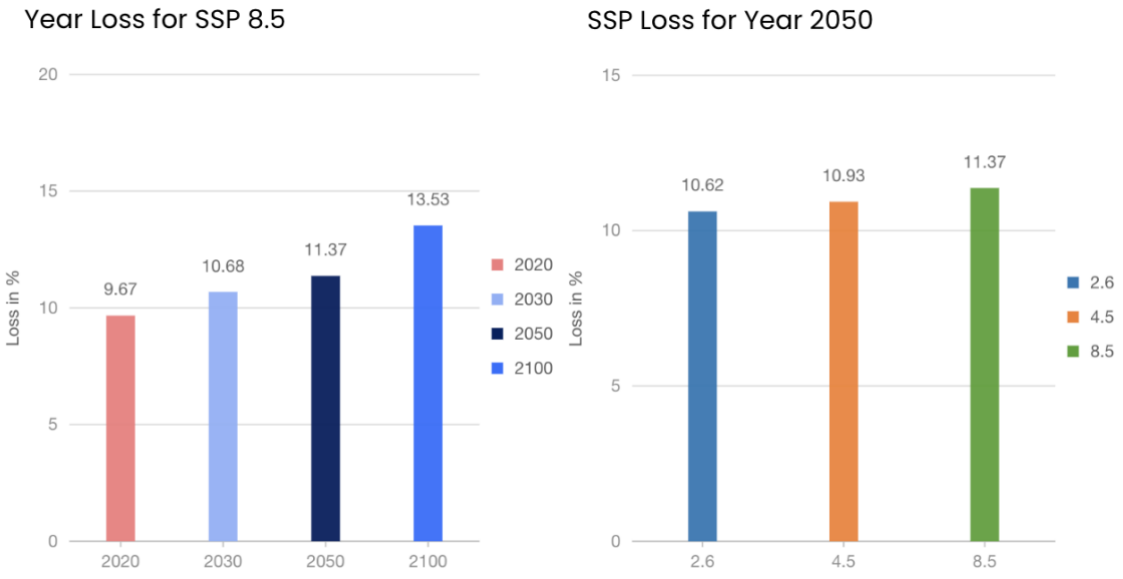
Locations of the 13 real assets in the portfolio across Saudi Arabia and the UAE, under a very-high emissions scenario (SSP 5-8.5) by 2050. Locations are coloured according to their overall climate hazard exposure severity, from the darkest red to lightest shades (white/pale yellow) for the highest to lowest overall climate hazard scores respectively. (Source: Intensel)

Overall exposure to moderate-high projected severity of storm surges and extreme heat, and to a lesser but not inconsequential extent, rainfall flooding

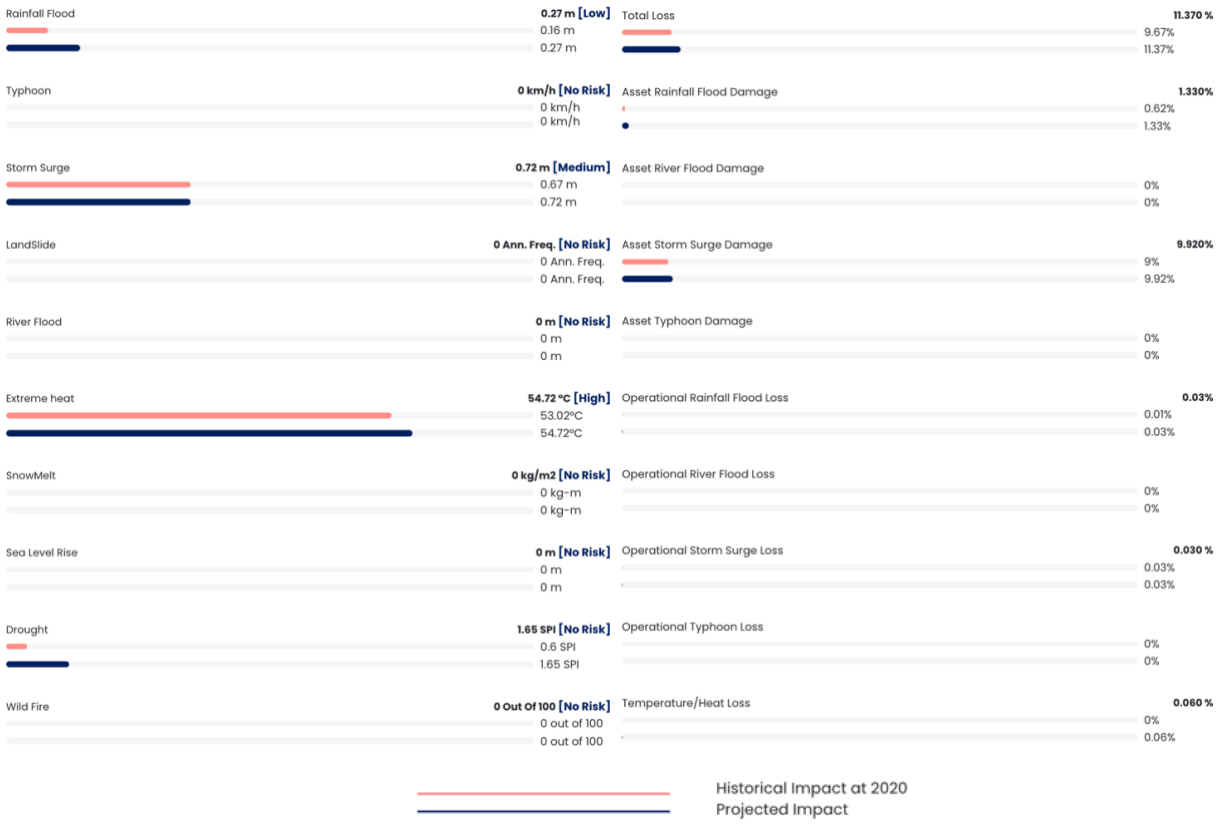
- Overall, the **13 assets across 2 markets** are exposed to the hazards of storm surges (moderate severity), extreme heat (high severity) and rainfall floods (low severity).
- Assets are subjected to the impacts of **Storm Surges** (accounting for 89.4% of total CVaR) and **Rainfall Floods** (accounting for 10% of total CVaR). **3 out of 13 assets** are exposed to Storm Surges - the most material climate event affecting assets within the portfolio.
- The total **portfolio CVaR is projected at 10.7%** and **11.4%** of the portfolio's total exposure by 2030 and 2050 respectively under the SSP 5-8.5 scenario.
- Annual expected losses are projected to **increase** by **8.4% by 2030** and **15.2% by 2050** from baseline.
- The **Technical Insurance Premium** (the annual expected cost of damage assuming all hazards are insured as a fraction of the replacement cost of each asset) **of 9 assets out of 13 exceed a 1% threshold**.
- The **maximum number of days of business interruption** at sites exposed to storm surges and rainfall floods is estimated to range from **23 to 40 days** (due to a storm surge event) and **2.2 to 10 days** (due to a rainfall flood event) by 2050.

	River Flood	Typhoon	Storm Surge	Wild Fire	Landslide	Rainfall Flood	Drought	Sea Level Rise	Snow Melt	Extreme Heat
Asset 1	0	0	89	0	0	10	14	0	0	95
Asset 2	0	0	55	0	0	8	13	0	0	88
Asset 3	0	0	96	0	0	12	7	0	0	81
Asset 4	0	0	0	0	0	25	14	0	0	100
Asset 5	0	0	0	0	0	14	11	0	0	55
Asset 6	0	0	0	0	0	10	12	0	0	52
Asset 7	0	0	0	0	0	15	14	0	0	88
Asset 8	0	0	0	0	0	13	14	0	0	100
Asset 9	0	0	0	0	0	9	11	0	0	55
Asset 10	0	0	0	0	0	24	11	0	0	55

Climate hazard scores by 2050 indicating projected hazard severity (0-no risk to 100-high severity) for each of the ten hazards analysed for the top ten assets with the highest overall value-at-risk, under a very high emissions scenario. Across all 13 assets analysed, exposure to moderate-very high extreme heat hazard is prevalent, followed by 3 assets exposed to moderate-high storm surge severity.



Overall projected portfolio Climate Value-at-Risk (% of total portfolio exposure, including both physical and operational losses) **from 2020 to 2100** (left), and **overall projected portfolio losses (%) over three SSP climate scenarios** 1-2.6 ('best-case' 2 deg C-aligned), 2-4.5 and 5-8.5 ('worst-case') (right). Losses are expected to increase over time and across scenarios.



Overall portfolio hazard severity (left) indicating precise projected hazard metrics for the ten hazards analysed, and **overall portfolio physical and operational loss breakdown (% terms)** (right), each comparing 2050 (blue) and 2020 (red) under a very high emissions scenario (SSP 5-8.5). Financial losses due to extreme heat have not been calculated within this case study.

Among all hazards, storm surge severity in particular is expected to reach an average maximum inundation depth of 0.7m by 2050 across all sites (medium severity), and is the main driver accounting for most of the total losses (9.9% of total exposure) in the portfolio. Extreme heat values (indicator of the combined effects of temperature and humidity) are expected to reach an average maximum of 54.7°C by 2050 across all sites (high severity).

11 of the 13 assets are also exposed to rainfall floods with depths ranging from 0.17 to 0.6m corresponding to an estimated 2.2 to 10 days of business interruption. This presents a low but not inconsequential risk to assets.

3 assets account for 91% of the portfolio's CVaR, driven by storm surge risk

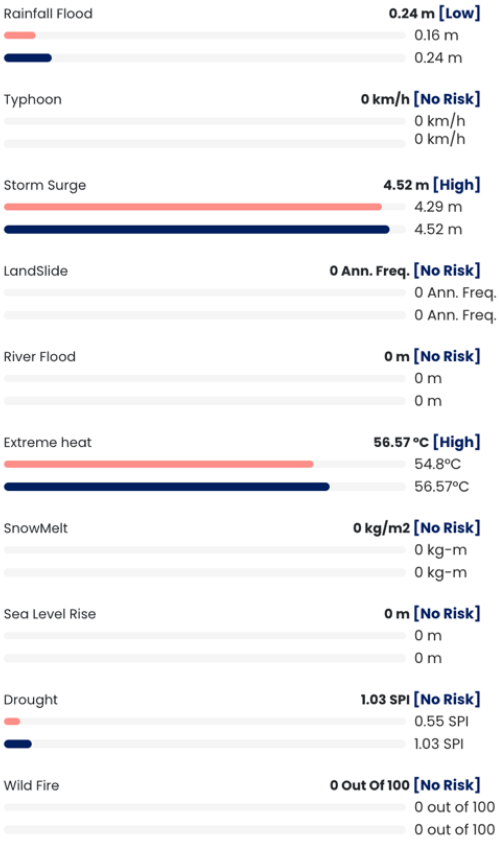
Diving into specific assets within the portfolio, we can then identify specific assets and their hazard drivers accounting for the largest fractions of total losses.

Rank	Asset Name	Geographic Market	Overall Climate Hazard Score by 2050 SSP 5-8.5	Total Loss 2020 (% of asset exposure)	Total Loss by 2050 SSP 5-8.5 (% of asset exposure)	Technical Insurance Premium by 2050 SSP 5-8.5 (%)	% of Total Portfolio CVaR	No. of days of interruption due to Storm Surge /Rainfall floods
1	Asset 1	Saudi Arabia	21	56.8	58.2	51.8	52.25	40 / 2.7
2	Asset 2	Saudi Arabia	16	52.7	69.5	29.3	32.77	23 / 2.2
3	Asset 3	UAE	20	16.5	17.1	47.6	6.36	40 / 4
4	Asset 4	Saudi Arabia	14	2.6	5.8	7.2	4.7	0 / 10
5	Asset 5	Saudi Arabia	8	1.5	3.4	2.3	0.98	0 / 4.9

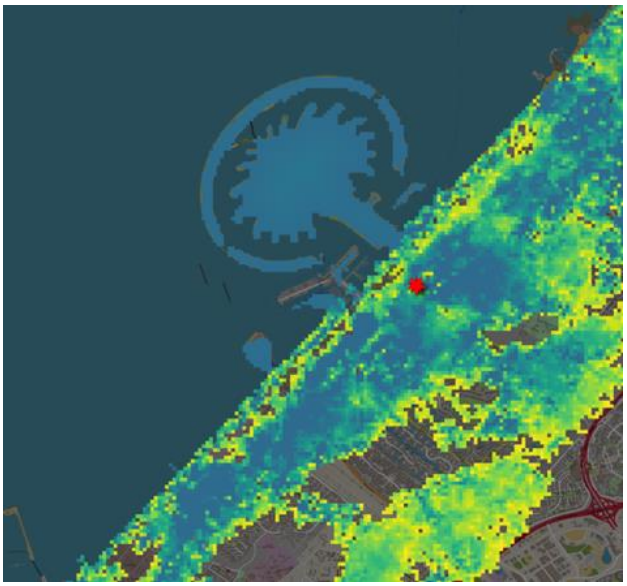
Asset table indicating the total loss (physical and operational in % terms of overall asset exposure) of the top 5 assets accounting for the largest fractions of portfolio CVaR by 2050, under a very high emissions scenario. The technical insurance premiums (TIP) of 9 assets out of 13 within the portfolio exceed a 1% threshold.

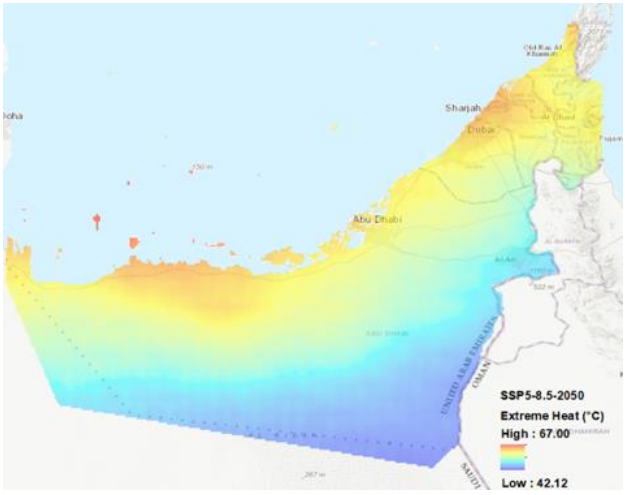
Each real asset or facility is exposed to a unique set of climate risks depending on their geographical location, and of varying severities. We find that Assets 1, 2 and 3 have the highest individual asset Technical Insurance Premiums (projected asset losses amounting to approximately 52%, 29% and 48% of individual asset replacement value respectively) within the portfolio, and account for 91.4% of total portfolio Climate Value-at-Risk, driven primarily by exposure to potential storm surges of 1.2-4.5 m in depth (corresponding to an estimated 23-40 days of business interruption).

Asset 3 (located in the vicinity of Dubai Marina), for instance, is exposed to a maximum storm surge severity of up to 4.5m by 2050 from 4.3m during baseline, and extreme heat index of up to 56.6 deg C (an indicator of the combined effects of temperature and humidity). While all other hazards remain at low to no exposures, resilience planning on site would require additional emphasis on addressing the increasing risks of storm surge and extreme heat over time.



Projected hazard severity breakdown of Asset 3 indicating exposure to storm surge and extreme heat of high severity comparing 2050 and baseline under a high emissions scenario SSP5-8.5 (above).





High-resolution maps of storm surge projections in Dubai (Asset 3) at 90m resolution by SSP5-8.5 2050 (upper right) and extreme heat projections of the overall UAE (bottom right) by 2050. (Source: Intensel)

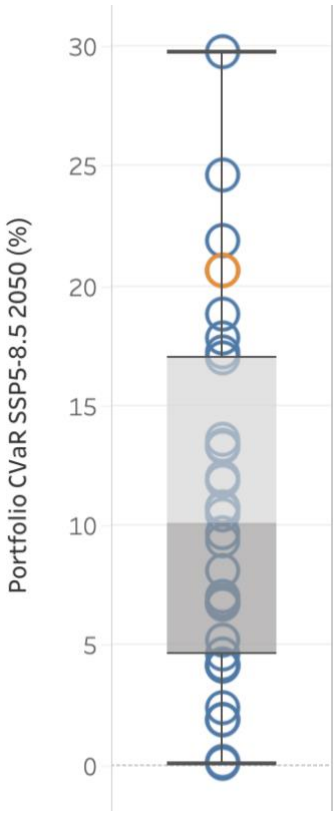
Overall, the expected annual losses due to physical damage and operational disruption within the portfolio are estimated to increase from 2030 to 2050 across all assets given the increasing hazard severities. Assuming no mitigative measures, we estimate a 75% increase in expected losses due to rainfall floods and a 10% increase in losses due to storm surges across all assets from baseline by 2050.

Above-median portfolio CVaR when benchmarked against S&P 500 real estate companies

Finally, when compared and benchmarked against the likes of similar real estate holdings from the S&P 500, we find that the portfolio's overall CVaR – 20.6% under a very high emissions scenario (SSP 5-8.5) by 2050 – is twice the median portfolio CVaR value of 10%.

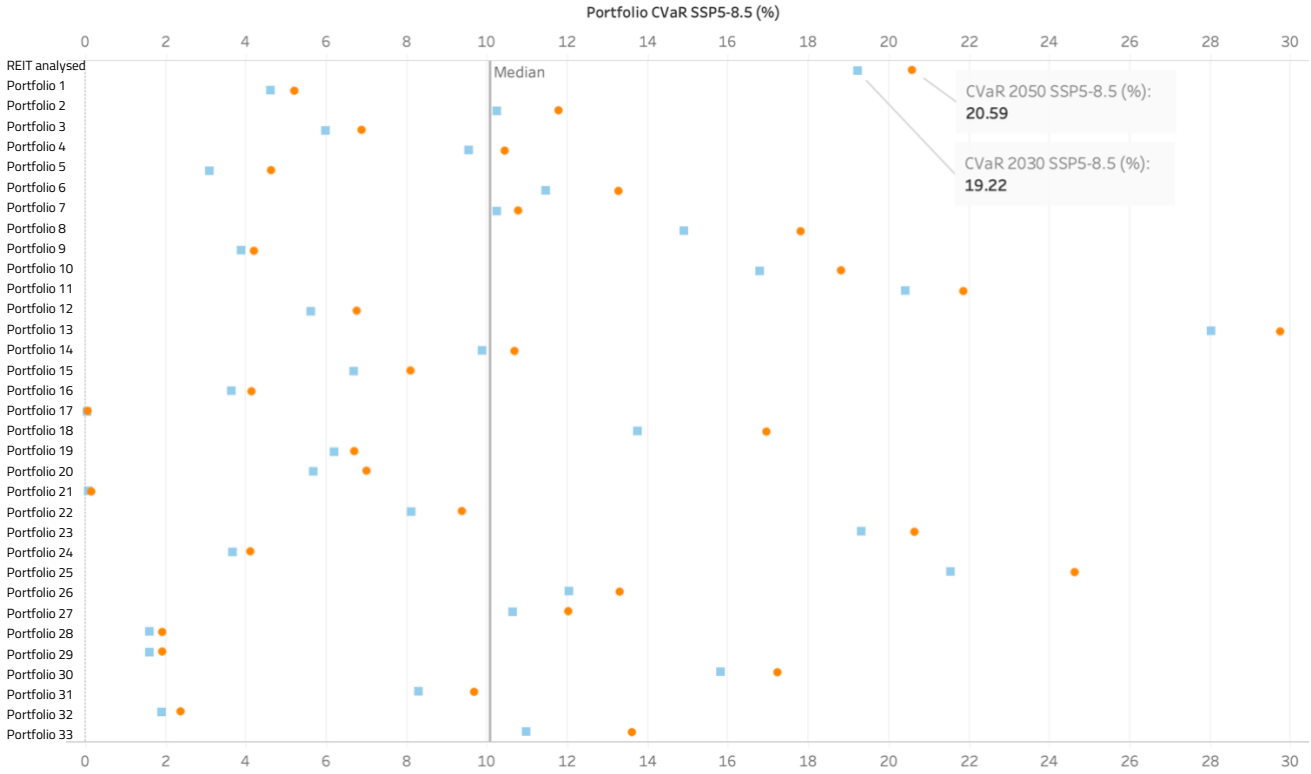
The CVaR for each real estate firm has been calculated based on Intensel's internal estimates on building valuations and revenues determined through proxies of economic activity at asset locations within each portfolio.

Benchmarking of portfolio CVaR (in %) under SSP5-8.5 2050



Benchmarking of REIT's portfolio CVaR vis-a-vis real estate firms within the S&P 500. The overall portfolio CVaR of this REIT at 20.6% by 2050 (in orange) sits is twice the median CVaR (10%) of 33 real estate firms.

Comparison of estimated portfolio CVaR (SSP5-8.5) by 2030 and 2050, across real estate firms in S&P 500



Benchmarking of REIT's portfolio CVaR (2030 and 2050 SSP5-8.5) against those of 33 real estate firms within the S&P 500. Overall CVaR is projected to increase across time horizons from 2030 (blue) to 2050 (orange) across portfolios, increasing from an average of 9.6% to 10.8% (1.2%) across all portfolios. The REIT's overall CVaR is likewise projected to increase from 19.2% to 20.6% (by a slightly larger margin of 1.4%) by 2050.

Implications for REIT managers / Asset owners

The findings of this Physical Climate Value-at-Risk analysis raise several implications for risk management and actions for consideration by managers of the REIT.

1. Risk Management Strategy

REIT managers would have to develop a comprehensive risk management strategy to address the identified climate risks, including but not limited to storm surges and extreme heat. This strategy should involve both short and long-term measures to mitigate the potential impact of these hazards on their portfolio, particularly for the top assets at-risk identified.

A comprehensive strategy may involve actively communicating the findings of the risk analysis and action measures to stakeholders, tenants and regulators to enhance trust and credibility around risk management and to meet industry expectations.

2. Asset-Specific Assessment and Risk Mitigation

Given that each asset within the portfolio faces unique climate hazards, REIT managers would have to consider tailoring resilience planning and mitigation efforts accordingly. This may involve zooming into and conducting detailed assessments for assets with Technical Insurance Premiums exceeding threshold values and/or those contributing to the largest fractions of overall portfolio Climate Value-at-Risk, with the assistance of in-depth hazard modelling or engineering consultants. Doing so provides opportunity to identify vulnerabilities and sites where specific mitigation measures, such as the installation of flood barriers or relocation of key equipment, are required.

3. Investment Decision-Making

REIT managers would have to factor in the projected increase in climate-related losses when making investment decisions. This includes evaluating the financial implications of implementing resilience measures versus the potential losses if no action is taken.

Given that the overall value-at-risk of this portfolio sits above the median when benchmarked against those of other real estate companies in the S&P500, asset managers should undertake proactive portfolio risk management to reduce overall risk. This may involve, for instance, prioritizing investments in assets or regions with lower climate risk exposure to reduce risks on the current and future portfolios.

Overall, the findings of the climate risk analysis underscore the importance of proactive risk assessment, management and resilience planning beginning from the asset-level. By taking appropriate actions to address climate risks, the REIT can better protect its assets, enhance long-term sustainability, and maintain investor confidence.

Conclusion

The Dubai floods in April 2024 clearly illustrate the vulnerability of the region to extreme climate events and chronic hazards. Current infrastructure is stressed under these conditions and Intensel's data indicates that climate hazard exposure will only increase in the coming years and decades.

Climate adaptation will be required to protect commercial portfolios and safeguard human populations in the region. The first step in adapting to climate change is acquiring a comprehensive understanding of asset-level climate exposure with in-depth climate simulation and mapping, followed by robust financial analysis to understand ROI on potential adaptive measures.

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