XDI CROSS DEPENDENCY INITIATIVE

XDI Single Company Intelligence Report

Sample Corporation Report

Overall Risk Profile

Assets Risk Distribution

Climate Change Hazards

XDI PLATFORM

XDI Globe globe.xdi.systems / Easy XDI easyxdi.com / XDI Company Portal

Prepared for: SAMPLE

Date: March 2021

REPORT CONTENTS

The Earth could be just 10 years from heating by more than 1.5 degrees Celsius — a threshold beyond which even more serious and frequent fires, droughts, floods and cyclones are expected to wreak havoc on humanity.

IPCC 2021

IMPORTANT INFORMATION

WHAT PRODUCTS AND SERVICES IN THIS REPORT DO AND NOT DO

The Products and Services use the Climate Risk Engines operated by Climate Risk P/L that process information and return results. Generally, users select or create Representative Assets which are synthetic representations of a real or hypothetical asset which may include real estate properties, infrastructure or other physical objects. Information about this Representative Asset is processed together with other relevant information such as location, age or value. The Climate Risk Engines integrate the information sent to it with information from a large number of national and international datasets from government institutions, universities and private companies to provide a generalised model of how climate change may affect a number of physical risks to the Representative Asset, all else being equal. The physical risks covered by the analysis will be displayed where the results are presented (on a Site or in a Report). However, the Climate Risk Engines do not provide a forecast, prediction or projection based on any real or planned asset.

The analysis does not purport to 'cover the field' of all potential risks associated with climate change nor to address coincidence or correlation between such risks. For example, extremes of precipitation and flooding may be coincident with extreme wind-storms which can damage a building making it more vulnerable to damage. The Climate Risk Engines do not necessarily take into account the impact of any actual built infrastructure, modifications, adaptations or resilience-building measures (public or private) that have been, or may be, applied that reduce (or exacerbate) the relevant hazard. The representation is made in relation to the availability or coverage of insurance to a real or planned asset.

NOT FORECASTS OR PREDICTIONS

XDI does not purport to generate statements of fact, forecasts or predictions, nor imply any representation regarding the likelihood, risk, probability, possibility or expectation of any future matter. To the extent that any statements made or information contained or generated might be considered forward-looking in nature, they are subject to physical, political, regulatory, technological and stakeholder-related variables and uncertainties that could cause actual results to differ materially. You are cautioned not to place undue reliance on any such forward-looking statements, which reflect assumptions and information available only as of the date of modelling. No explicit or implicit assumption is made in relation to the current or future alignment of any climate change-related scenarios with climate- related policies of any government at international, national or sub-national level. The impacts of climate change analysed are only for a range of greenhouse gas emission and global warming scenarios presented in the Intergovernmental Panel on Climate Change Assessment Report (IPCC 2014, IPCC 2007).

NOT FINANCIAL ADVICE

The information presented does not comprise, constitute or provide, nor should it be relied upon as, investment or financial advice, credit ratings, an advertisement, an invitation, a confirmation, an offer or a solicitation, or recommendation, to buy or sell any security or other financial, insurance, credit or lending product or to engage in any investment activity, or an offer of any financial service.

This information does not purport to quantify risk to the subject land, infrastructure, buildings or other physical assets or any part thereof, nor make any representation in regards to the saleability, mortgage ability, insurability, or defects, of any subject property, nor its suitability for purchase, holding or sale. The Modelling Outputs presented are provided with the understanding and expectation that each user will, with due care, conduct their own investigation and evaluation of any real or planned asset at a specific location.

EXCLUSION OF LIABILITY

To the extent permitted by law XDI and Climate Risk P/L and our data and analytic suppliers will not be liable for any loss or damage whether in contract, tort (including negligence), breach of statutory duty or otherwise, even if foreseeable, arising under or in connection with use of or reliance on any information, data or content obtained via our services, including (without limitation) the modelling outputs presented.

SCIENTIFIC LIMITATIONS

The information presented has been generated using an expert selection of the scientific methods and computational modelling techniques available at the time of creation. However, at any time there are known limitations of which you should make yourself aware. These are constantly refined and updated and are clearly specified on the Xdi.systems and EasyXDI site

SCOPE OF MODELLING AND SCENARIOS

Science is not able to definitively predict the exact range or rate of future global warming; or the scale and rate of change of atmospheric and oceanic processes that may be hazardous, including temperatures, precipitation, wind and the rise in sea levels that result from this warming. Many variables will determine society's continuing rate of emission of 'greenhouse gases' (including political, regulatory, technological and behavioural factors), and how the Earth's natural systems respond. However, we can estimate a range of potential impacts across what mainstream science considers to be a plausible set of scenarios for future ocean and atmospheric behaviour. The scenarios used are specified in the relevant Scenarios sections of websites and reports where the Climate Risk Engines are used.

While every effort has been made to ensure that this document and the sources of information used herein are free of error, the authors: Are not liable for the accuracy, currency and reliability of any information provided in this publication; Make no express or implied representation of warranty that any estimate of forecast will be achieved or that any statement as to the future matters contained in this publication will prove correct; Expressly disclaim any and all liability arising from the information contained in this report including, without, errors in, or omissions contained in the information; Except so far as liability under any statute cannot be excluded; Accept no responsibility arising in any way from errors in, or omissions contained in the information; Do not represent that they apply any expertise on behalf of the reader or any other interested party; Accept no liability for any loss or damage suffered by any person as a result of that person, of any other person, placing any reliance on the contents of this publication; Assume no duty of disclosure or fiduciary duty to any interested party.

THIRD PARTY ASSETS

XDI's Third Party analysis products are based on assets derived through deep searches of public and private databases. This is not company verified asset data unless specified. Data will change constantly as assets are acquired and divested. There are also grey areas around shared assets and assets outside standard geocoding systems. Therefore such datasets should be treated as time-specific ranges of data, that may over or under represent actual assets for each included company.

CAVEATS AND LIMITATIONS

Excluded Hazards: The analysis only includes hazards specified – does not include hurricane/cyclone, landslip, erosion, lightening or any other hazards apart from those specifically identified.

Non-Accessible Assets: The analysis Is based on synthetic representations of owned and/or operated assets with identifiable address such as shops, offices, branches, factories. This may not include all non-physically accessible assets until and unless they have been provided/confirmed by company.

Mortgages and Equities: The analysis does not include investment or lending portfolios such as mortgages or equity portfolios. Unless otherwise noted, the analysis has been undertaken without the participation of the company at this stage.

EXECUTIVE SUMMARY

COMPANY REPORT OVERVIEW

Sample Corporation returned 3,053 assets for analysis during asset discovery. The assets are located globally. Sample Corporation assets belong to diverse industries.

METHODS AND ASSUMPTIONS

This Single Company Physical Risk Report has been generated using XDI's patented Climate Risk Engines. The Climate Risk Engines analyse an assets vulnerability to hazards using a representative archetype; Modern Commercial Building. A representative archetype is used to provide insights into the assets failure modes and damage thresholds.

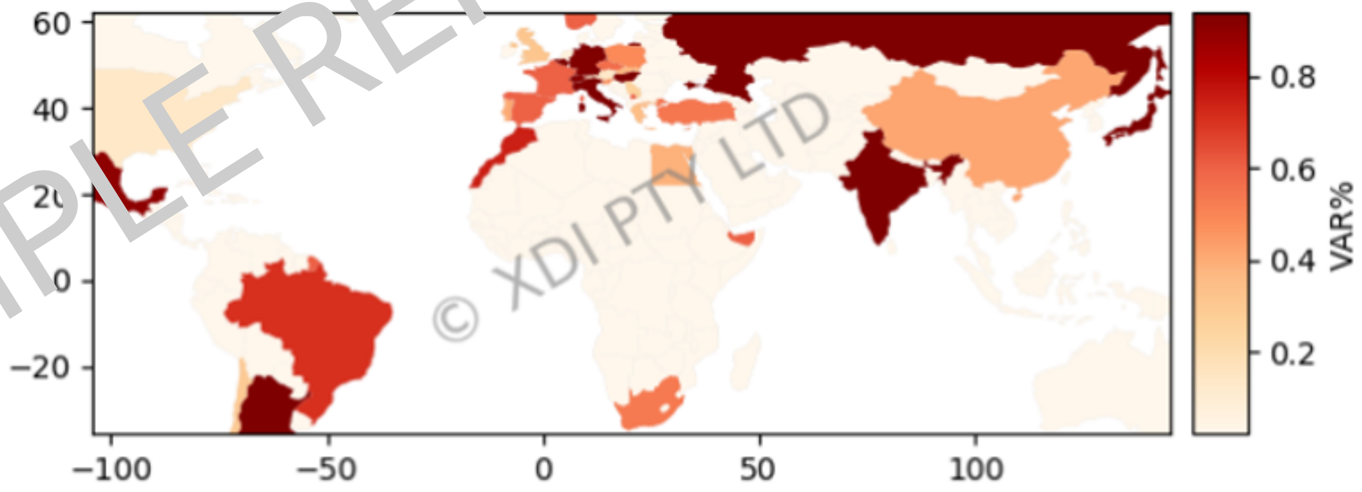
Extreme weather and climate change drive a range of hazards which cause damage. In this report, the assets derived from asset discovery have been analysed against six extreme weather and climate change hazards; Riverine Flooding, Surface Water Flooding, Coastal Inundation, Forest Fires, Soil Subsidence and Extreme Wind events.

These hazards have then been tested using a range of climate change models under RCP8.5 scenario (representing a warming of 3.2-5.4 degrees by 2100). Physical risks have been calculated using a combination of engineering, climate science, weather and financial data.

THE SIGNIFICANCE & TIMING OF THE EXTREME WEATHER AND CLIMATE RISKS FOUND

Based on the selection of climate change models used, the Value-At-Risk (VAR) is projected to increase by 250% between 2021 and 2100. Over the same time period, the number of High Risk Properties (greater than 1% VAR) are projected to increase from 129 to 335, which represents approximately 10% of the company's portfolio.

DISTRIBUTION OF VAR% GLOBALLY IN 2100



THE RELEVANT HAZARDS

The driving hazards behind the Value-At-Risk (VAR%) results are Riverine Flooding, Surface Water Flooding and Soil Subsidence. The hazard with the greatest change in VAR% is Riverine Flooding. Riverine Flooding shows a 0.25% increase over the reporting period, from average asset VAR% in 2021 , increasing to % in 2100 (see *Hazard Breakdown*).

While the long-term empirical data suggests the probability of Extreme Wind and Forest Fire is low or insignificant over the reporting period.

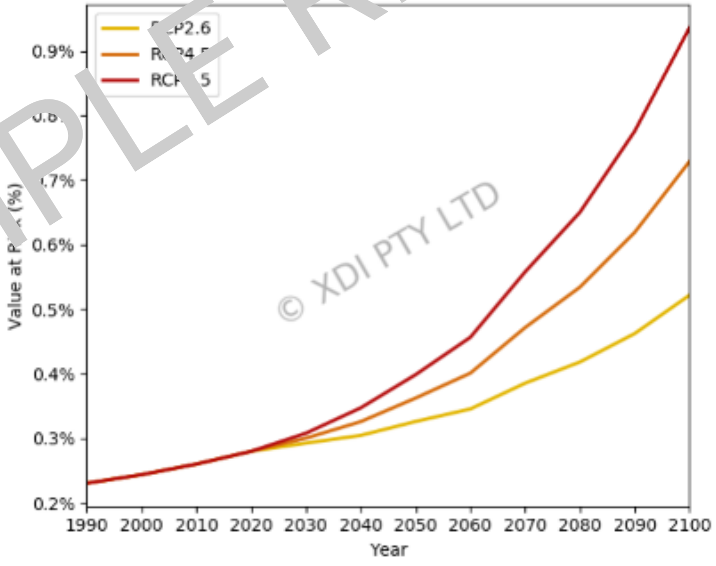
THE RELEVANT HAZARDS

Productivity Loss (PL) assumes a reduction in company revenue associated with extreme weather events interrupting day to day business. The annual average Productivity Loss from extreme weather and climate change related hazards under a RCP8.5 scenario increases from 0.17% in 2021 to 0.41% in 2100. This increase in Productivity Loss amounts to approximately 240% PL% increase from 2021 to 2100).

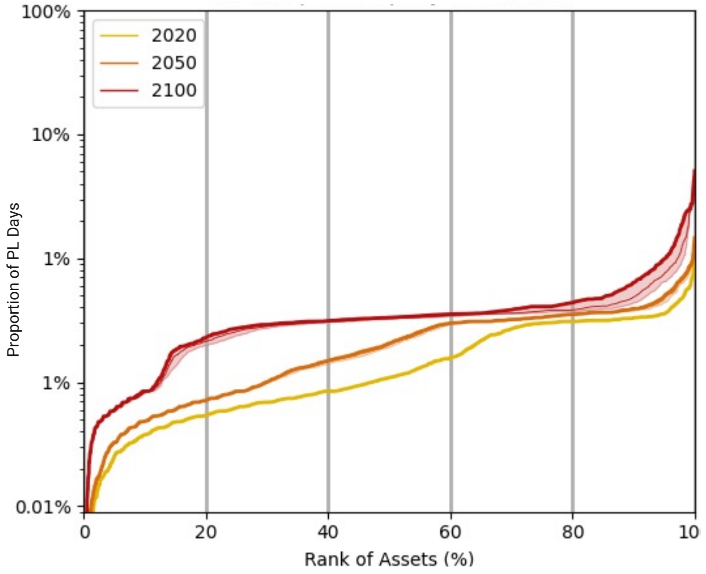
RECOMMENDATIONS

1. **RECOMMENDATION A:** This recommendation will be specific to the company results that are deemed to be critical. XDI will endeavour to list recommendations that are industry relevant and have real world applications.
2. **RECOMMENDATION B:** This recommendation will be specific to the company results that are deemed to be critical. XDI will endeavour to list recommendations that are industry relevant and have real world applications.
3. **RECOMMENDATION C:** This recommendation will be specific to the company results that are deemed to be critical. XDI will endeavour to list recommendations that are industry relevant and have real world applications.

COMPANY PORTFOLIO CHANGE IN VAR% OVER TIME



COMPANY PORTFOLIO DISTRIBUTION OF PL DAYS



INTRODUCTION

Third Party Analysis

Data Solutions For Investors And Owners

Climate risk impacts business continuity and asset performance. Institutional investors, owners and verifiers are seeking insights into the cost of extreme weather and climate change to portfolio performance. Practically, XDI can provide an independent assessment of a single company's or group of companies' climate risk with XDI's own asset discovery methodology. Investors with a portfolio of equities can now obtain intelligence on the climate resilience of any number of companies worldwide for due diligence, investment decision making, or to compile risk ratings.

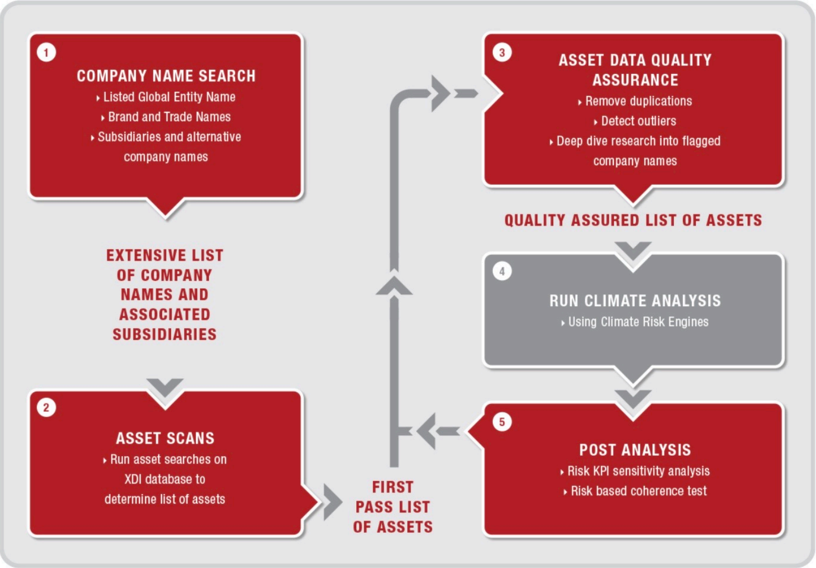
XDI'S THIRD PARTY COMPANY ANALYSIS IS USED INDUSTRY WIDE FOR ASSESSMENT OF CLIMATE PHYSICAL RISK

Multiple Companies Intelligence Data Set

XDI provides financial and investor organisations information on climate risks to thousands of companies' owned and operational assets world wide. Multiple Companies Intelligence is delivered in a data format compiled per company, per country. XDI works closely with approved resellers to provide data that can be integrated into external systems.

Single Company Intelligence Report

Analysis is available in a PowerPoint format suitable for presentation in the Single Company Intelligence Report. Data is visualised for ease of use in charts, graphs and spatial mapping according to key financial metrics, per country, per hazard.



**XDI's Third Party analysis products are based on assets derived through deep searches of public and private databases. This is not company verified asset data unless specified. Data will change constantly as assets are acquired and divested. There are also grey areas around shared assets and assets outside standard geocoding systems. Therefore such datasets should be treated as time-specific ranges of data, that may over or under represent actual assets for each included company.

GLOSSARY

TERM	DESCRIPTION
Archetype	An archetype is a representative asset class that allows the use of general or repeatable information and avoids having to uniquely specify all the characteristics of each individual asset analysed.
Failure Probability (FP)	Failure Probability is the annual probability of a climate hazard causing the asset to stop working with or without damage. This is reliant on the vulnerability of an archetype's element to a particular hazard.
High Risk Property Count (HRP#)	The total count of properties in the year specified that are 'high risk' i.e. over 1% VAR, consistent with US Federal Emergency Management Agency (FEMA) definitions.
Medium Risk Property Count (MRP#)	The total count of properties in the year specified that are 'medium risk' i.e. between 0.2% and 1% VAR.
Low Risk Property Count (LRP#)	The total count of properties in the year specified that are 'low risk' i.e. less than 0.2% VAR.
Productivity Loss (PL)	Productivity loss considers the effects of different types of disruption, including periods of closure associated with different hazard events. PL% are based on Failure Probability, which includes both the annual average probabilities of event occurrence and the vulnerability of the asset and its components.
Technical Insurance Premium. (TIP)	The VAR per asset for all hazard impacts (damage) combined. The TIP is based on the cost of damage to a property, using the replacement cost, expressed in current day dollars with no discounting or adjustments for other transaction costs.
Value-At-Risk (VAR)	In each analysed year, an asset's overall VAR is the potential damage costs caused by climate-related hazards, as a proportional of the total asset value.

ACRONYM	DESCRIPTION
BES	The Bank of England's discussion paper for the 2021 biennial exploratory scenario on the financial risks from climate change
CMIP	Coupled Model Inter-comparison Project
CMSI	Climate Measurement Standards Initiative
CORDEX	Coordinated Regional Downscaling Experiment
FSB	Financial Stability Board of the G20
GCM	Global Circulation Model
IPCC	Intergovernmental Panel on Climate Change
RCM	Regional Climate Model
RCP	Representative Concentration Pathway. An emission scenario as defined by the Intergovernmental Panel on Climate Change (IPCC). In this project the high global emissions (or 'business as usual') scenario known as RCP 8.5 and the low emissions scenario known as RCP 2.6 have been analysed.
RCP8.5	The default climate change scenario used in this study. Refers to a concentration of greenhouse gases that cause global warming temperature increase of between 3.2°C to 5.4°C by the end of 2100.
TCFD	Taskforce on climate-related financial disclosure

TERM	DESCRIPTION
Coastal Inundation	Sea water flooding due to high tides, wind, low air pressure and waves can damage coastal land, infrastructure and buildings.
Extreme Heat	Electrical and mechanical components can fail or send spurious signals when their design temperature is exceeded.
Extreme Wind	Changes in wind regimes, sea surface temperature and wind speeds. High-wind conditions that may exceed a building's design specifications.
Freeze-Thaw	Changes in the annual freeze and thaw cycles resulting from winter periods that trend close to freezing point. Saturated building materials freeze, expand and crack facades and structural elements.
Riverine Flooding	Riverine (Fluvial) flooding can damage low-lying building or infrastructure assets. Changes in precipitation in a catchment that causes a river to exceed its capacity, inundating nearby areas.
Soil Subsidence	Soil contraction due to less rainfall causing subsidence damage to structures.
Surface Water Flooding	Surface Water (Pluvial) flooding can damage low-lying building or infrastructure assets. Increased frequency of extreme rainfall leading to overland flooding.

ANALYSIS SETTINGS

RANGE SETTINGS

INTRODUCTION

The details of the settings used to derive the analysis for this Single Company Intelligence report for Sample Corporation, are below.

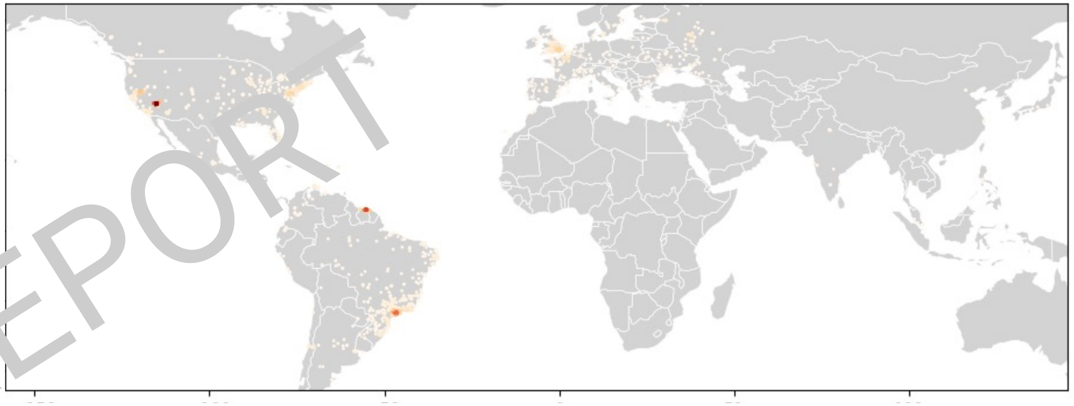
NUMBER OF UNIQUE ENTRIES SUPPLIED:
3,053

NUMBER OF ASSETS MATCHED TO EXACT ADDRESS:
3,053

NUMBER OF ASSETS MATCHED TO PROXY:
0

COMPANY NAME:	Sample Corporation
BRANDS AND TRADING NAMES:	Sample Corporation Pty Ltd
ISIN:	UK000000AB01
INDUSTRY:	Diversified
HEAD QUARTERS:	1 SAMPLE STREET, SAMPLETON - GLOBAL
ASSET DATA PROVIDED BY:	XDI Internal Databases
ASSESSED COUNTRIES:	All Countries
ASSET DATA VALIDATED BY COMPANY:	No

Geographical Distribution of Assets



HAZARDS ANALYSED

- ✓ COASTAL INUNDATION
- ✓ EXTREME HEAT
- ✓ EXTREME WIND
- ✓ FOREST FIRE
- x FREEZE-THAW
- ✓ RIVERINE FLOODING
- ✓ SOIL SUBSIDENCE
- ✓ SURFACE FLOODING

MODELLED SCENARIOS & SETTINGS

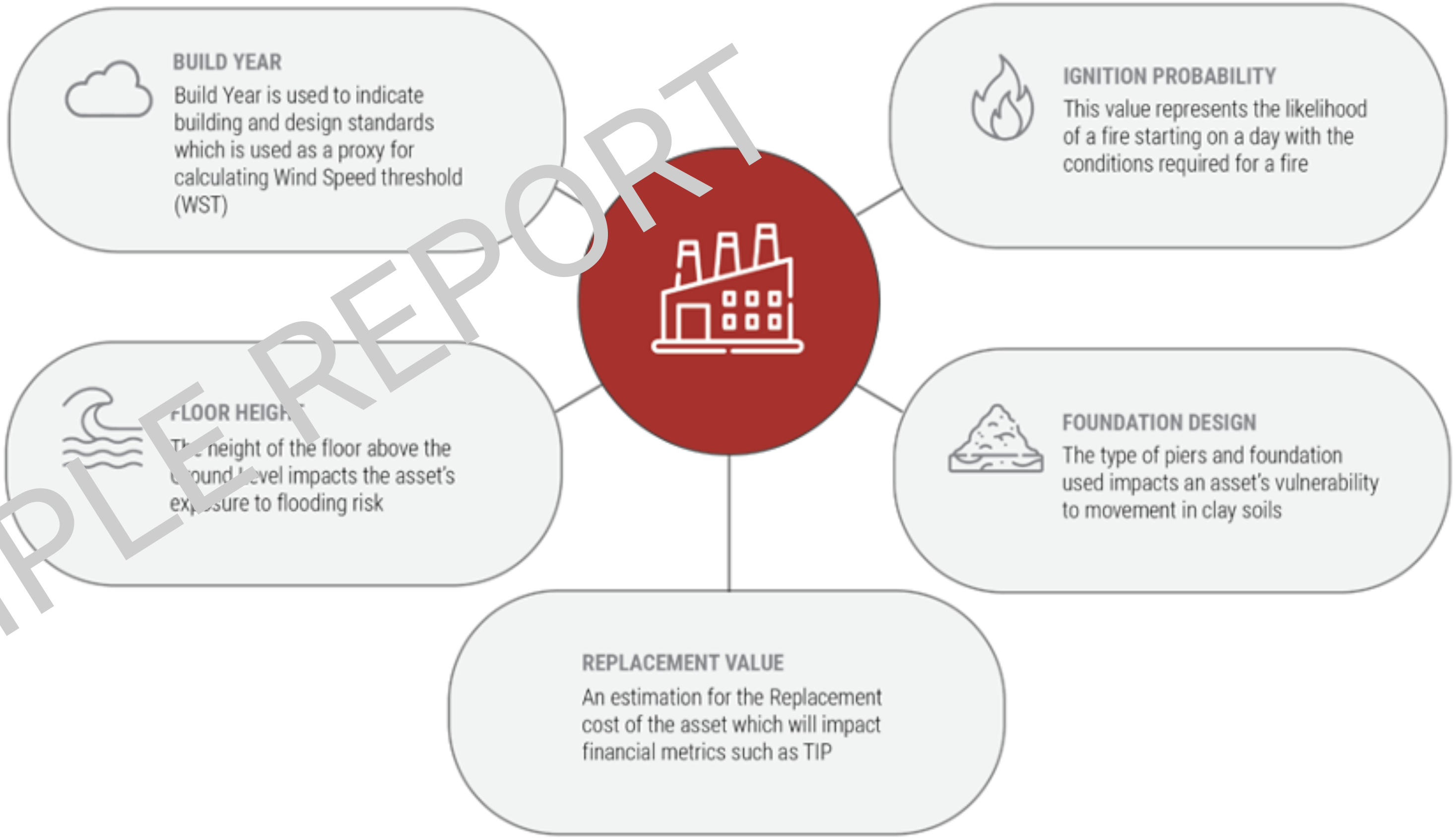
DATA, SETTINGS AND SCENARIOS	THIS REPORT'S SETTINGS
Primary RCP:	RCP 8.5
Secondary RCPs:	RCP 2.6 & 4.5
Archetype used:	Modern Commercial Building
Number of Assets analysed in portfolio:	3,053
Number Countries Analysed:	All Countries
Sensitivity Testing Conducted:	Yes

HAZARD	REGIONAL CLIMATE MODELS
Coastal Inundation	1.5m by 2100 (midway IPCC high and NOAA high)
Extreme Heat	Multiple Cordex CMIP5
Extreme Wind	Multiple Cordex CMIP5 - MET/HDW
Forest Fire	Multiple Cordex CMIP5 – CRE FOREST AND URBAN
Riverine Flood	Multiple Cordex CMIP5 - JBA
Soil Subsidence	Multiple Cordex CMIP5 - NASA
Surface Water Flood	Multiple Cordex CMIP5 - JBA

Asset archetypes, with corresponding design and construction settings, are used as a stand in for the actual asset to enable analysis within the Climate Risk Engines. The analysis in this report is based on the following **Modern Commercial Building** archetype. The characteristics of this archetype are detailed below.

These design and construction settings materially impact the vulnerability of the "Asset" to the hazards to which it is likely to be exposed.

ARCHETYPE CHARACTERISTIC	ARCHETYPE SETTINGS
Replacement Value	USD$10m
Build Year	Year 2000
Floor Height	0.5m
Ignition Probability	Average Protection
Foundation Design	Rigid Reinforced Concrete
Wind Speed Threshold (WST)	1 in 500 years
Temperature Exposure	42 degrees



DETAILED RESULTS

PORTFOLIO OVERVIEW

PORTFOLIO OF HIGH RISK ASSETS

KEY TAKEOUT

In the current year, under the RCP8.5 scenario, 4.2% portfolio is deemed to be at high-risk from physical climate change impacts. This is expected to increase to 11% by the year 2100.

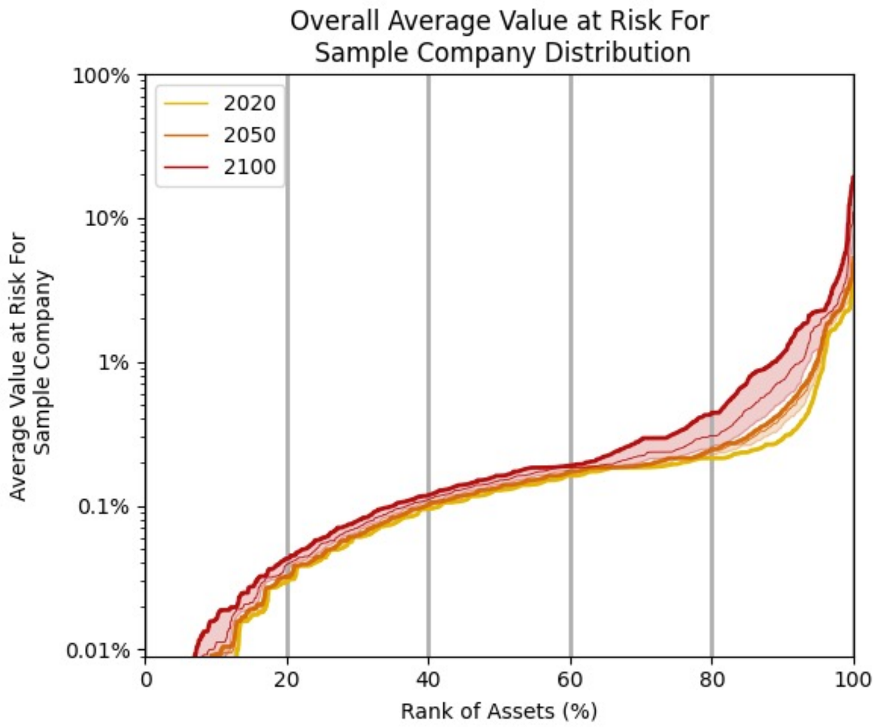
WHY IS THIS RESULT USEFUL

This distribution curve provides a overarching insight into the extent to which the company's portfolio is exposed to extreme weather damage and how that will evolve over time. The proportion of the portfolio which is high risk (Value-At-Risk > 1.0%) is especially important as this can lead to loss of productivity and asset value.

OBSERVATION

In the current year 2021, 4.2% of the portfolio is deemed to be at high-risk from physical climate change impacts. This represents over 129 assets that will suffer damages greater than or equal to 1.0% of the replacement cost of the asset. This is expected to increase from 2020 to 161 portfolio in the year 2050 and 335 portfolio assets in the year 2100.

AVERAGE VAR% DISTRIBUTION



This graph shows the distribution of Value-At-Risk across the portfolio under the RCP8.5 scenario. The vertical axis is Value-At-Risk % and the horizontal axis is the percentile of the company's assets in that VAR band.

CHANGE IN VALUE-AT-RISK % OVER TIME

KEY TAKEOUT

The company's average Value-At-Risk % increases by 205% from 1990 to 2100 under RCP8.5 scenario. This is driven by increased risks from a range of hazards.

WHY IS THIS RESULT USEFUL

This graph helps identify the extent to which climate change is contributing to asset risk across the portfolio under three different RCP scenarios and how that risk is expected to change over time without adaptation or intervention. The shape of the curve reflects different levels of climate forcing of the hazard.

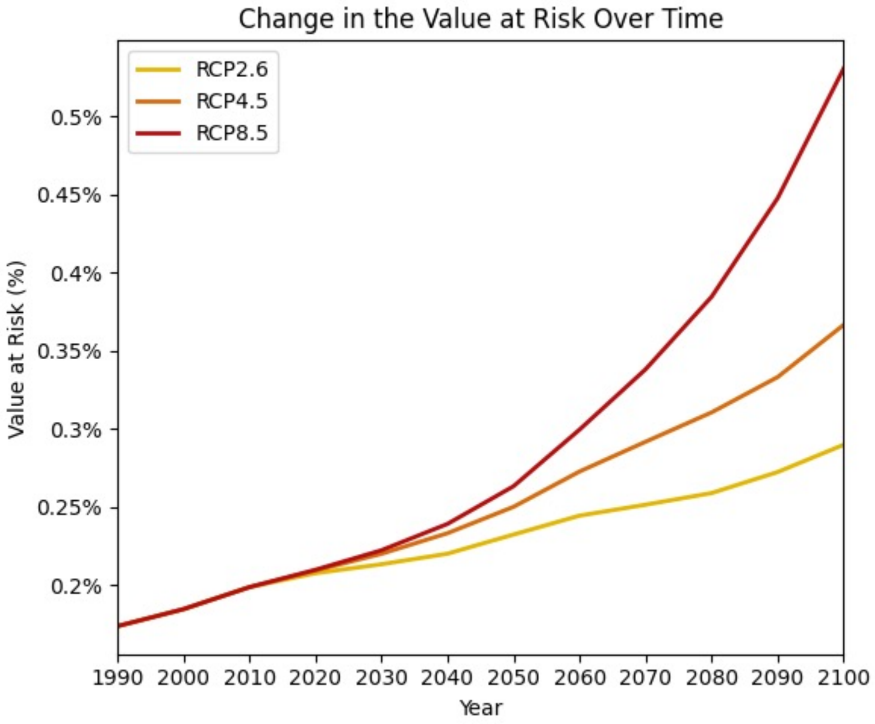
OBSERVATION

The average Value-At-Risk % for the company portfolio rises increases by 205% from 1990 to 2100. Under lower emission pathways the increase is curbed but still rises as some hazards have long term inertia.

CHANGE IN VAR OVER TIME

Year	1990	2020	2030	2050	2080	2100
Avg VAR%	0.17%	0.21%	0.22%	0.26%	0.38%	0.53%

This table shows the average VAR% for the entire portfolio under the RCP 8.5 scenario.



This graph illustrates the changes in the Value-At-Risk% over the period analysed, for all three scenarios RCP 2.6, 4.5 and 8.5.

THE NUMBER OF LOW, MODERATE & HIGH RISK PROPERTIES

KEY TAKEOUT

Under the RCP8.5 scenario, the number of High Risk Properties (HRP#) in the company's portfolio rises exponentially. Approximately 136 of the the company's owned and leased asset portfolio will be categorised as high risk from physical climate change impacts within the next 10 years. This will increase to over 335 by the year 2100. These represent the assets most at risk of unaffordable or unavailable insurance, as well as productivity loss and business disruption.

WHY IS THIS RESULT USEFUL

It is useful for companies to identify the number of assets in their portfolio that are classified as low, moderate and high risk and how this is likely to change over time. When applied to financial exposure, these figures may indicate the level of credit risk to the company now and in the future, as well as the timelines for the financial impacts expected.

OBSERVATION

Based on the 3,053 assets analysed, using an interpretation of the US Government's FEMA index used for insurance, the company's portfolio risk under RCP8.5 scenario, is:

- High Risk: 129 properties in 2021, to 335 by 2100.
- Moderate Risk: 609 properties in 2021, to 818 by 2100.
- Low Risk: 2,317 properties in 2021, to 1902 by 2100.

COUNT OF LRP, MRP, HRP

Year	LRP#	MRP#	HRP#
1990	2,774	164	117
2021	2,317	609	129
2030	2,264	655	136
2050	2,197	697	161
2080	2,047	746	262
2100	1,902	818	335

This table shows the number of assets in the portfolio that are classified as low, moderate and high risk at each time interval under the RCP8.5 scenario (using a modern commercial building archetype.

THE PERCENTAGE OF LOW, MODERATE & HIGH RISK PROPERTIES

KEY TAKEOUT

The majority of the the company's portfolio can be considered LOW risk today, but by 2050, 23% will be at Moderate risk (Value-At-Risk >0.2%) and 5% of the company's portfolio will be deemed to be at High risk from physical climate change impacts (Value-At-Risk > 1.0%).

WHY IS THIS RESULT USEFUL

It is useful for companies to identify the portion of their portfolio that is classified as low, moderate and high risk and how this is likely to change over time. These figures may indicate the level of risk to the company now and in the future, as well as the timelines for the portfolio's deterioration.

OBSERVATION

Based on the 3,053 assets analysed, using an interpretation of the US Government's FEMA index used for insurance, the company's portfolio risk under RCP8.5 scenario, is:

- High Risk: 4% in 2020, to 11% by 2100
- Moderate Risk: 20% in 2020, to 27% by 2100
- Low Risk: 76% in 2020, to 62% by 2100

PERCENT OF LRP, MRP, HRP

Year	LRP%	MRP%	HRP%
1990	91%	5%	4%
2021	76%	20%	4%
2030	74%	21%	4%
2050	72%	23%	5%
2080	67%	24%	9%
2100	62%	27%	11%

This table shows the % of the portfolio that is classified as low, moderate and high risk at each given time interval under the RCP8.5 scenario (using a modern commercial building archetype).

CHANGE IN PERCENTAGE OF HIGH RISK PROPERTIES OVER TIME

KEY TAKEOUT

Under the RCP8.5 scenario, the number of High Risk Properties (HRP) in the company's portfolio rises exponentially from the year 2050 onwards. Approximately 4% of the the company's owned and leased asset portfolio will be categorised as High risk from physical climate change impacts within the next 10 years. This will increase to 11% by the year 2100. These represent the properties most at risk of unaffordable or unavailable insurance, as well as productivity loss and production disruption.

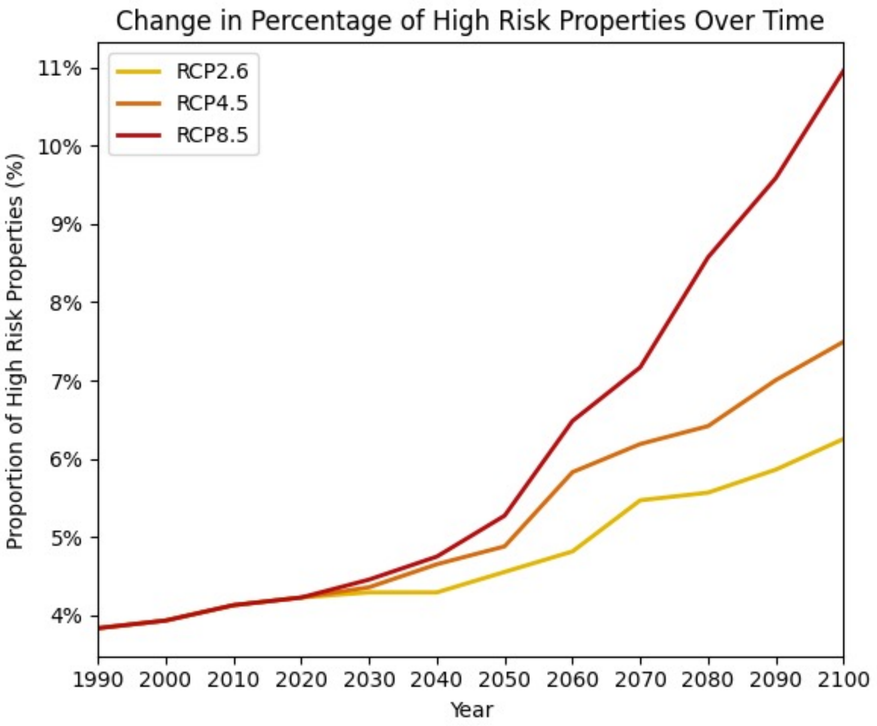
WHY IS THIS RESULT USEFUL

It is useful for companies to identify the portions of their portfolio that are classified as low, moderate and high risk and how they are likely to change over time. These figures may indicate the level of risk to the company now and in the future, as well as the timelines for the portfolio's deterioration. The proportion of the portfolio which is High Risk is particularly important, impacting default and present credit risk to the company.

OBSERVATION

For the company's portfolio under RCP8.5 scenario, 4% of the company's assets are deemed high risk in 2020, rising to 11% in 2100.
It is quite common that there is not a uniform change, as different hazards impact different assets at different time periods. For the company, the point of divergence begins around 2030 as Flooding risks become more prevalent.

CHANGE IN % HRP OVER TIME



This graph illustrates the changes in the percentage of high risk properties over the period analysed, for all three scenarios RCP 2.6, 4.5 and 8.5.

CHANGE IN PERCENTAGE OF MODERATE RISK PROPERTIES OVER TIME

KEY TAKEOUT

Under the RCP8.5 scenario, 21% of the the company's owned and leased asset portfolio will be categorised as Moderate risk from physical climate change impacts within the next 10 years. This will increase to 27% by the year 2100 as more assets move from the low risk category.

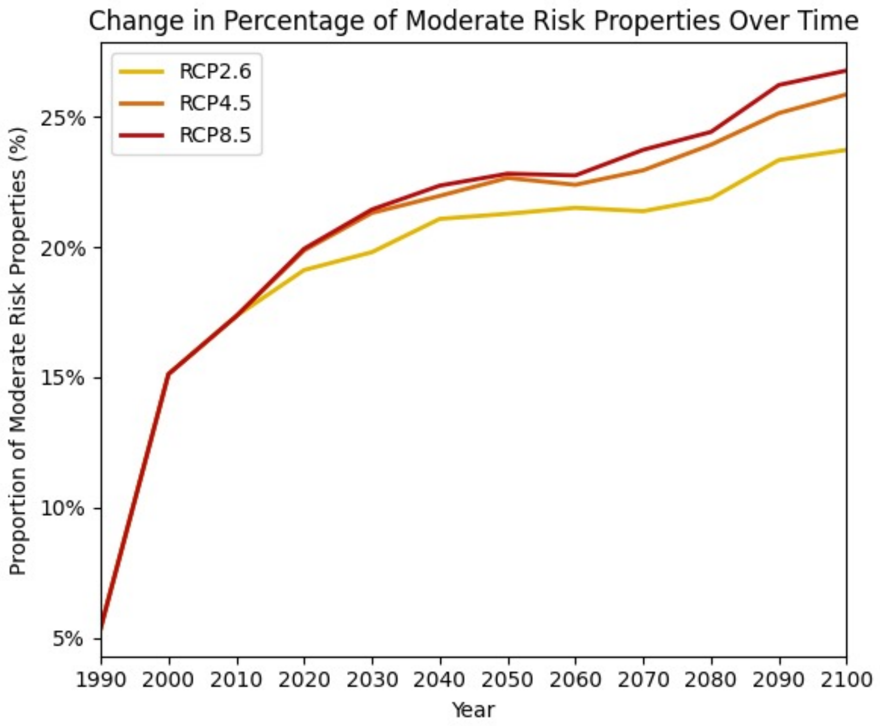
WHY IS THIS RESULT USEFUL

It is useful for companies to identify the portions of their portfolio that are classified as low, moderate and high risk and how they are likely to change over time. These figures may indicate the level of risk to the company now and in the future, as well as the timelines for the portfolio's deterioration. The properties that are classified as moderate risk may still be insurable but at a higher cost.

OBSERVATION

Under the RCP8.5 scenario, 20% of the company's portfolio is deemed moderate risk today, rising to 21% by 2030 and to 27% by 2100.

CHANGE IN % MRP OVER TIME



This graph illustrates the changes in the percentage of moderate risk properties over the period analysed, for all three scenarios RCP 2.6, 4.5 and 8.5.

PORTFOLIO TECHNICAL INSURANCE PREMIUM (TIP) OVERVIEW

KEY TAKEOUT

Based on an assigned replacement cost for each asset, the average Technical Insurance Premium (TIP) for extreme weather across the company portfolio is currently around $2,100 per asset. Note that this has increased significantly from 1990 levels, which is the data upon which the market still prices many insurance premiums today. By the end of the century, TIP due to climate change and extreme weather risk are expected to increase to and average TIP of $5,307.

WHY IS THIS RESULT USEFUL

This result may help the company infer the sorts of insurance costs to be expected, and in turn, how these costs may impact the profitability of business operations and serviceability of any loans outstanding on the assets.

OBSERVATION

Under the RCP8.5 scenario, the company's portfolio has a Average TIP of $2,100, rising to an average TIP $2,225 in 2030 and to $5,307 in 2100.

(See Archetype Settings for Replacement Cost).

CHANGE IN TIP OVER TIME

Year	Average TIP	Total TIP
1990	$1,739	$5,312,382
2021	$2,100	$6,414,995
2030	$2,225	$6,796,750
2050	$2,634	$8,048,343
2080	$3,847	$11,751,441
2100	$5,307	$16,213,951

This table shows the change in average Technical Insurance Premium per property, as well as the total Technical Insurance Premium expected across the entire portfolio.

CHANGE IN TOTAL TECHNICAL INSURANCE PREMIUM (TIP)

KEY TAKEOUT

This graph shows the change in Total Technical Insurance Premium (TTIP) over time, thereby helping the company infer the sorts of insurance costs to be expected, and in turn, how these costs may impact the profitability of business operations and serviceability of any loans outstanding on the assets.

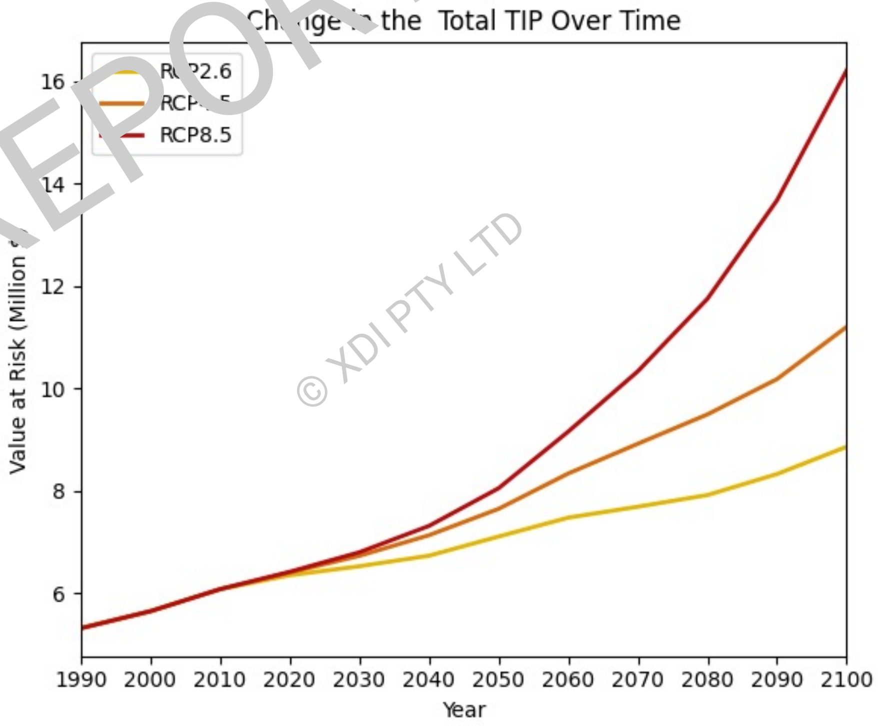
WHY IS THIS RESULT USEFUL

The Technical Insurance Premium (TIP) is defined as the Annual Average Loss (AAL) per Representative Asset for all hazard impacts. For each asset, TIP is calculated based on the probability of a hazard exceeding the damage threshold of an asset component and the consequential damage costs to each component. Total TIP (TTIP) is the sum of all asset TIPs within the portfolio.

OBSERVATION

Under the RCP8.5 scenario, the company's portfolio has an expected changed in TTIP from $6,414,995 currently, to $8,048,343 in 2050 and $16,213,951 by 2100.

CHANGE IN TTIP OVER TIME



This graph shows the change Total Technical Insurance Premium expected across the entire portfolio under PCR 8.5, 4.5 & 2.6.

ASSET PORTFOLIO RANKED BY ANNUAL FAILURE PROBABILITY (FP%)

KEY TAKEOUT

This result shows the proportion of assets which are at risk of disruption from extreme weather and climate change as Failure Probability provides an insight into impacts on an asset which may cause the asset to stop working, but not cause damage.

WHY IS THIS RESULT USEFUL

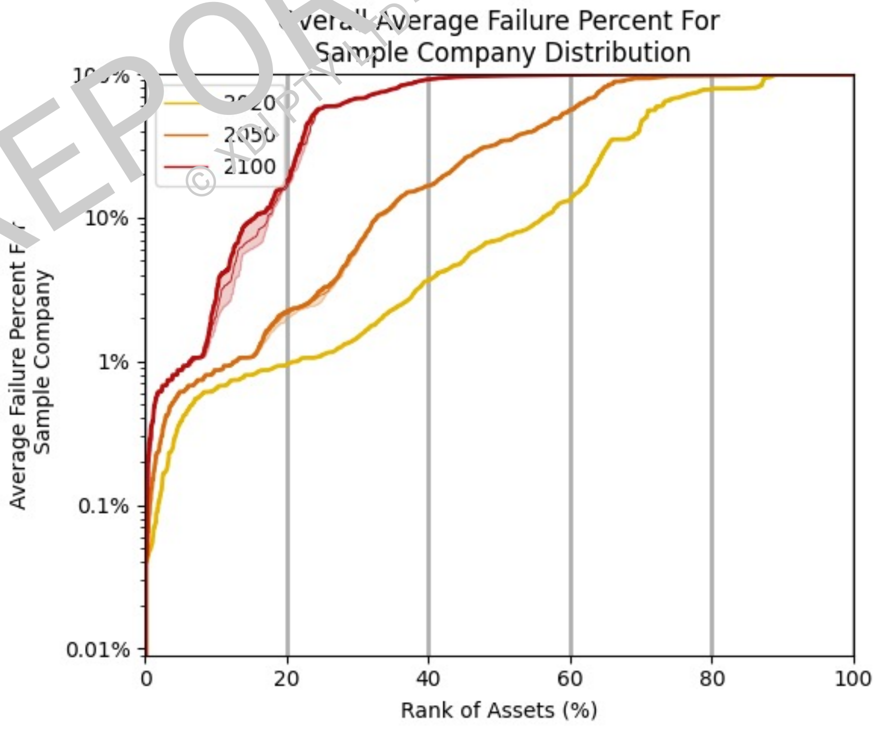
The probability of failure threshold exceedance for each asset's component (with respect to each hazard) is computed for each year. Aggregating each assets components, Failure Probability (%) is then computed for each asset for each year. The assets are then ranked from lowest to highest annual FP% for each RCP scenario. For ease of comparison, the x-axis shows the ranking as a percentage of all assets rather than number of all assets.

OBSERVATION

Under the RCP8.5 scenario, the average Failure Probability % for the company portfolio rises increases by 311% from 1990 to 2100.

DISTRIBUTION OF AVERAGE FP%

	RCP2.6	RCP4.5	RCP8.5
FP% incr (1990-2100)	[illegible]	309%	311%



This graph shows assets ranked by annual probability of an Asset Failure event across all hazards for RCP8.5.

ASSET PORTFOLIO RANKED BY ANNUAL PRODUCTIVITY LOSS (PL%)

KEY TAKEOUT

This result shows the proportion of assets which are at risk of different levels of disruption from extreme weather and climate change and provides an insight into the portfolio's productivity loss risk. This metric is potentially the most useful when assessing the possible impact to company revenues.

WHY IS THIS RESULT USEFUL

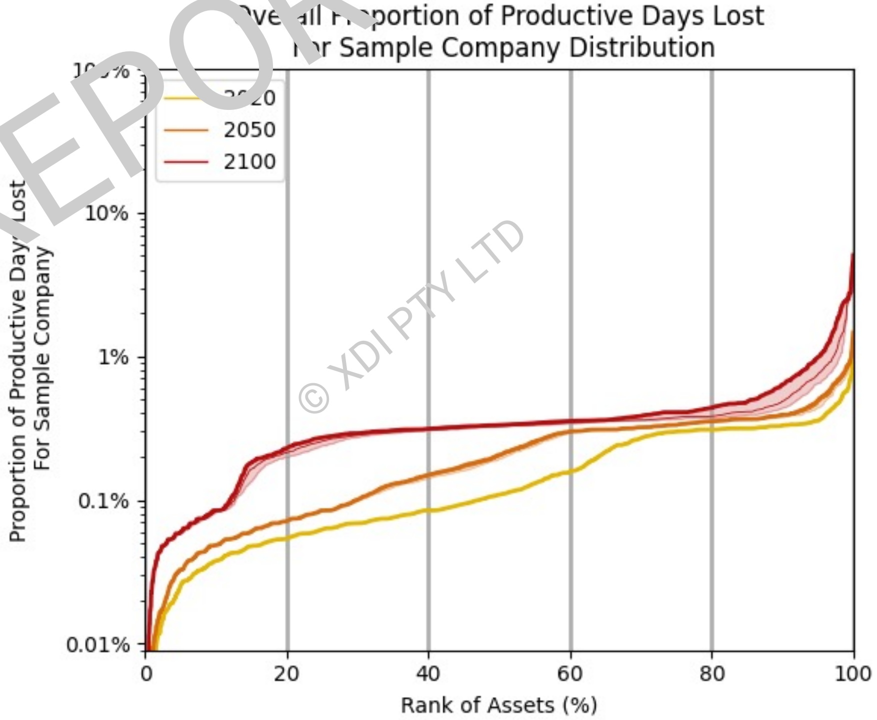
To calculate Productivity Loss, each asset's failure probability (corresponding to each relevant hazard) is combined with the estimated duration of outage associated with that failure for each RCP scenario. For ease of comparison, the x-axis shows the ranking as a percentage of all assets rather than number of all assets.

OBSERVATION

Under the RCP8.5 scenario, the average Productivity Loss % for the company portfolio rises increases by 232% from 1990 to 2100.

DISTRIBUTION OF PL

	RCP2.6	RCP4.5	RCP8.5
PL% incr (1990-2100)	171%	190%	232%



This graph shows assets ranked by annual probability of productivity loss events occurring in the years 2020, 2050 and 2100 for all hazards for RCP 8.5.

SPATIAL RISK MAPPING

KEY TAKEOUT

This physical distribution of total assets can be compared to maps of the distribution of various risk indicators (later in this report) to help visualise the difference between locations where risk is dominated by asset density and those dominated by hazard exposure.

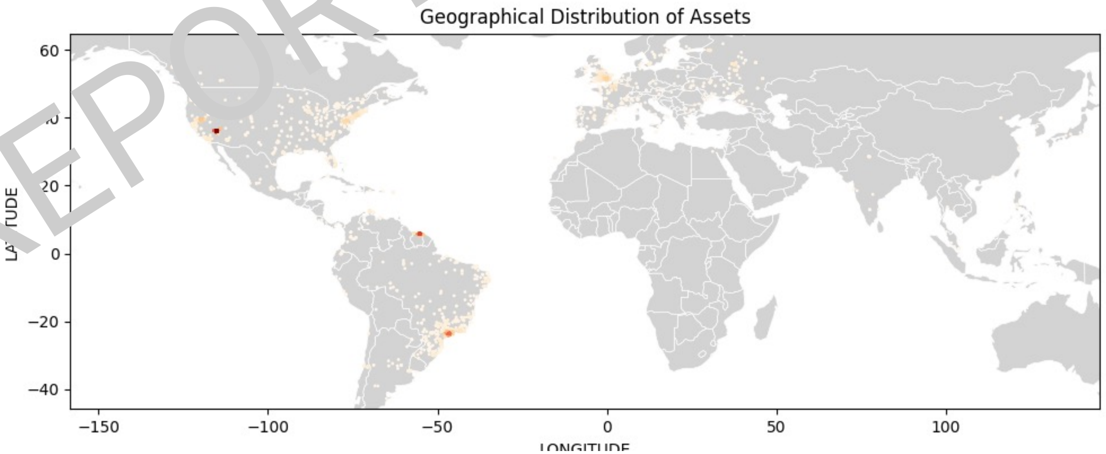
WHY IS THIS RESULT USEFUL

This map plots a total of 3,053 assets identified within the company's portfolio. The distribution is global not localised to any one specific region.

OBSERVATION

The company portfolio of owned and leased assets consists of 3,053 identifiable assets.

SPATIAL DISTRIBUTION OF ASSETS



This map shows the locations and density of the properties identified as associated with the company's current portfolio. The intensity of the colour represents the density of assets in that location (darker colour=higher asset density).

GEOGRAPHICAL DISTRIBUTION OF VALUE AT RISK (VAR%)

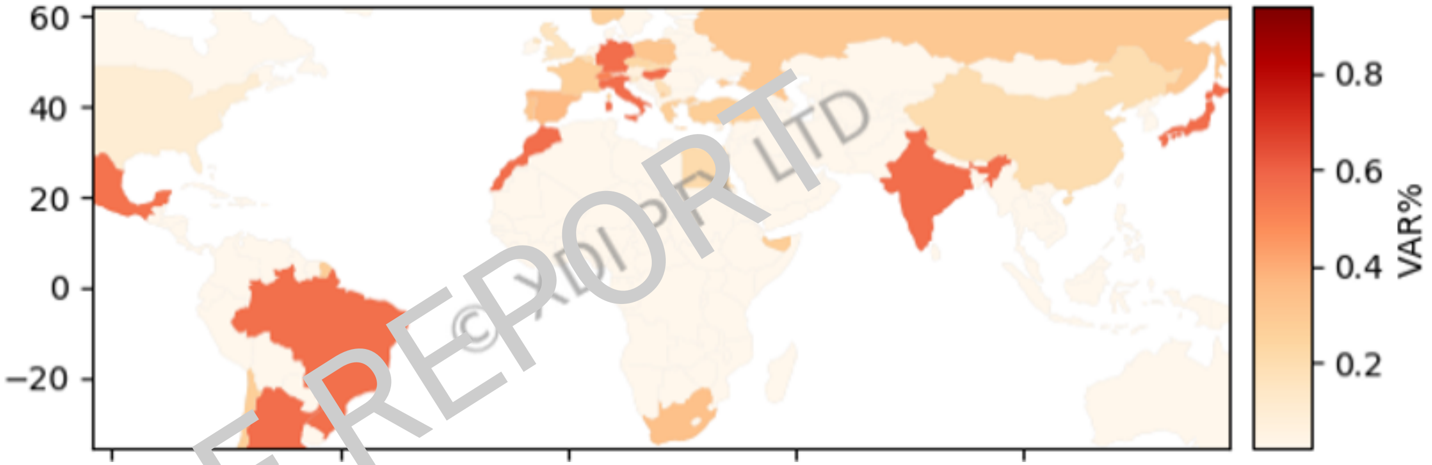
KEY TAKEOUT

These maps of average Value-at-Risk (VAR%) intensity for the years 2020, 2050 and 2100 show a trend in the increase of average physical risk over time in all areas. These maps demonstrate that climate risk distribution is not necessarily proportionate to the number of properties in that area.

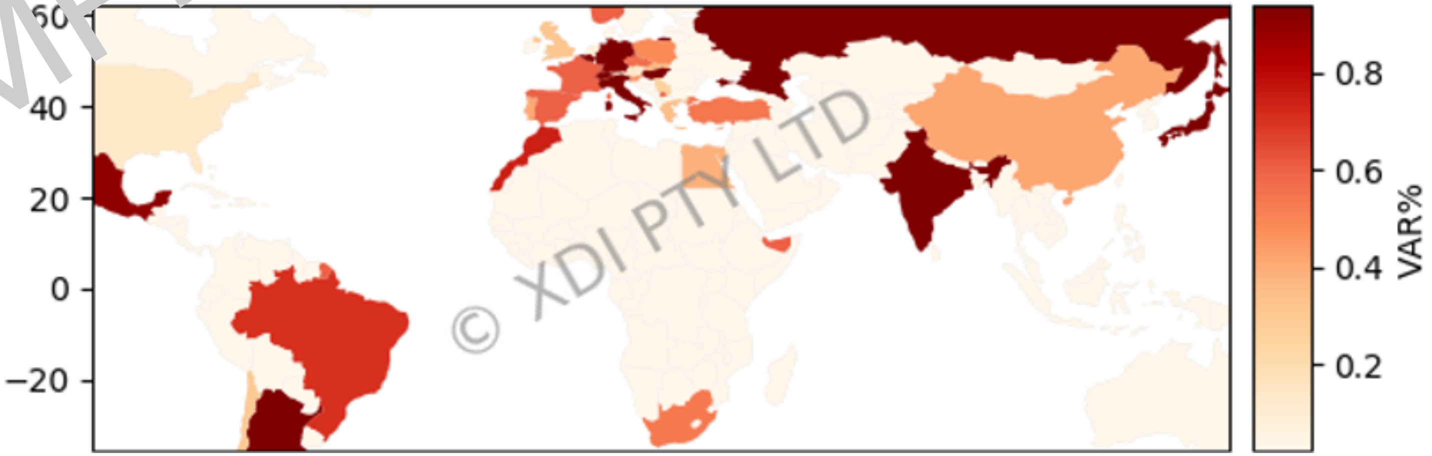
WHY IS THIS RESULT USEFUL

These maps show the locations and density of the company's average Value-At-Risk (VAR%) across several time periods. It focusses attention on where risks of damage are highest and avoids property value bias, and may therefore be a useful indication of the regions where the company needs to focus risk management attention.

DISTRIBUTION OF AVG PROPORTATIONAL VAR% IN 2050



DISTRIBUTION OF AVG PROPORTATIONAL VAR% IN 2100



CHANGE IN AVERAGE VALUE AT RISK (VAR%) SINCE 1990

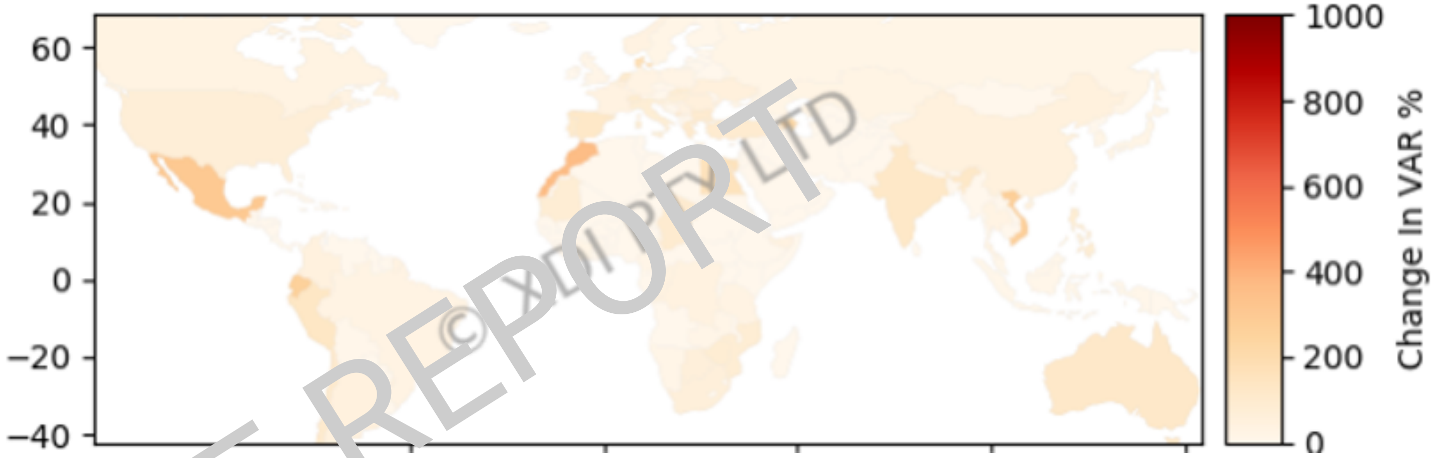
KEY TAKEOUT

The greatest increase in physical risk to the the company portfolio is seen to be geographically spread, with a high proportion of locations notably closer to the coast. The majority of regions will see more than 200% increase in Value-At-Risk over the century.

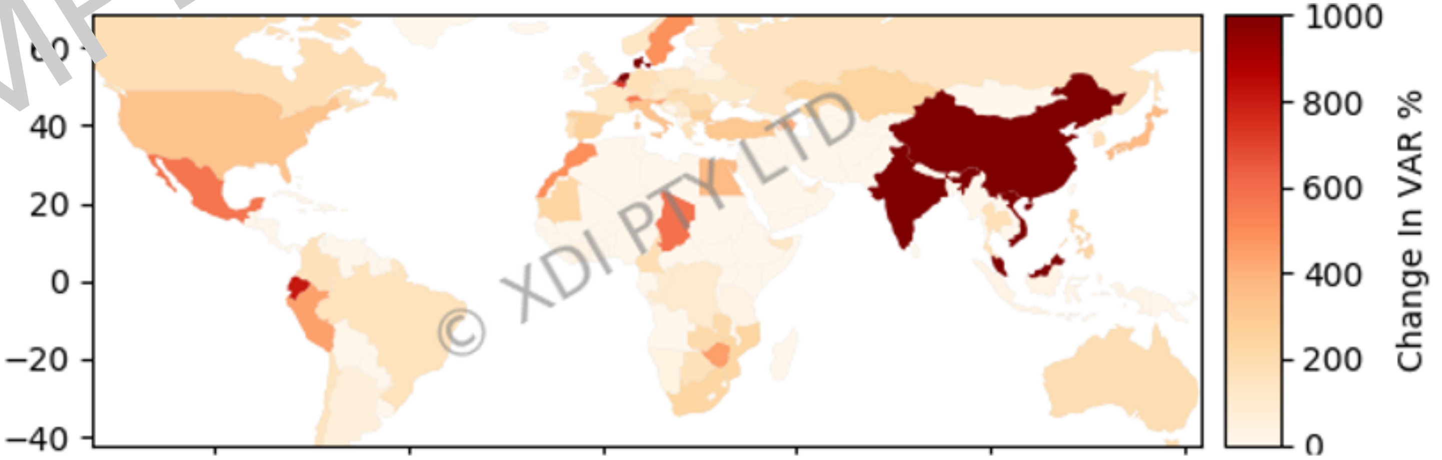
WHY IS THIS RESULT USEFUL

These maps show change in average Value-At-Risk% from a baseline of 1990, focusing attention on areas of high VAR% concentration. The results may be a useful indication of abnormally high climate change impacts in different regions.

DISTRIBUTION OF RELATIVE CHANGE VAR% IN 2050



DISTRIBUTION OF RELATIVE CHANGE VAR% IN 2100



GEOGRAPHICAL DISTRIBUTION OF HIGH-RISK PROPERTIES (HRP#)

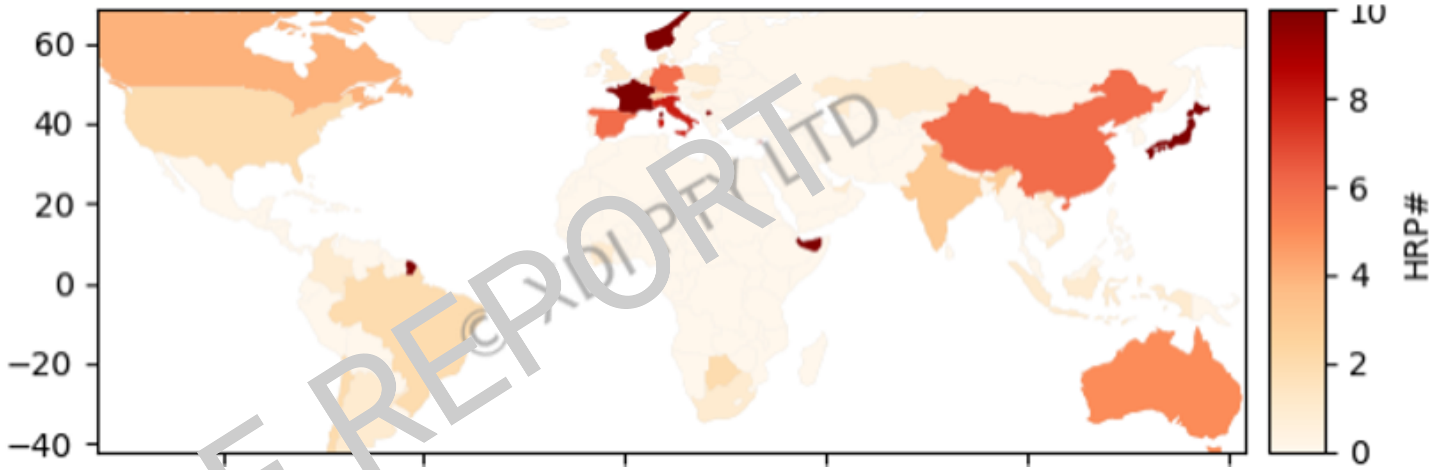
KEY TAKEOUT

These maps show the locations and density of the company's High Risk Properties (HRP#) in years 2020, 2050 and 2100 for all properties within its owned and leased asset portfolio.

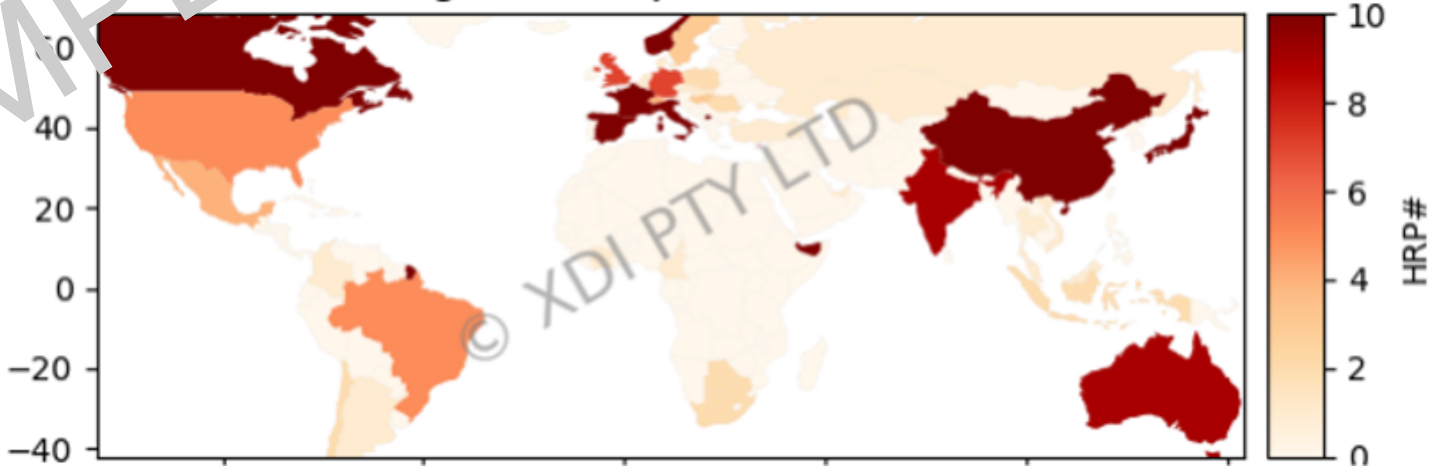
WHY IS THIS RESULT USEFUL

These maps focus attention on high risk concentration areas. These maps could be used as a proxy, indicating regions where high levels of default and credit risk may be expected.

DISTRIBUTION OF HRP# IN 2050



DISTRIBUTION OF HRP# IN 2100



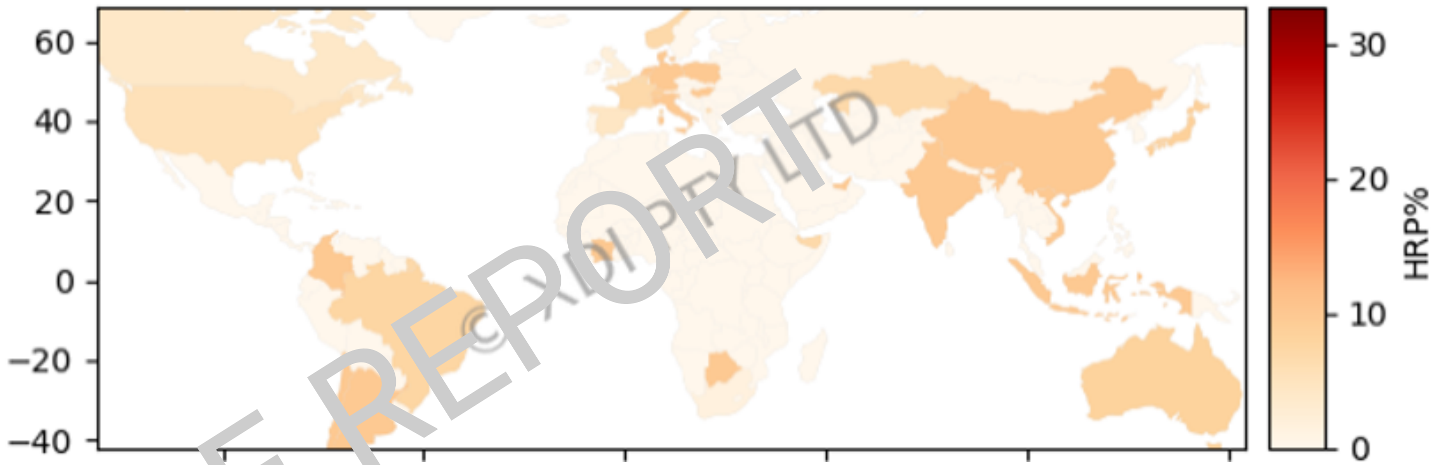
KEY TAKEOUT

The modelling suggests that a large number of areas will have a significant increase in the proportion of high-risk properties with majority of change concentrated around low lying coastal and inland regions with exposure to flooding. This could have potential negative effects on the local economy leading to these areas becoming undesirable for buyers and insurers.

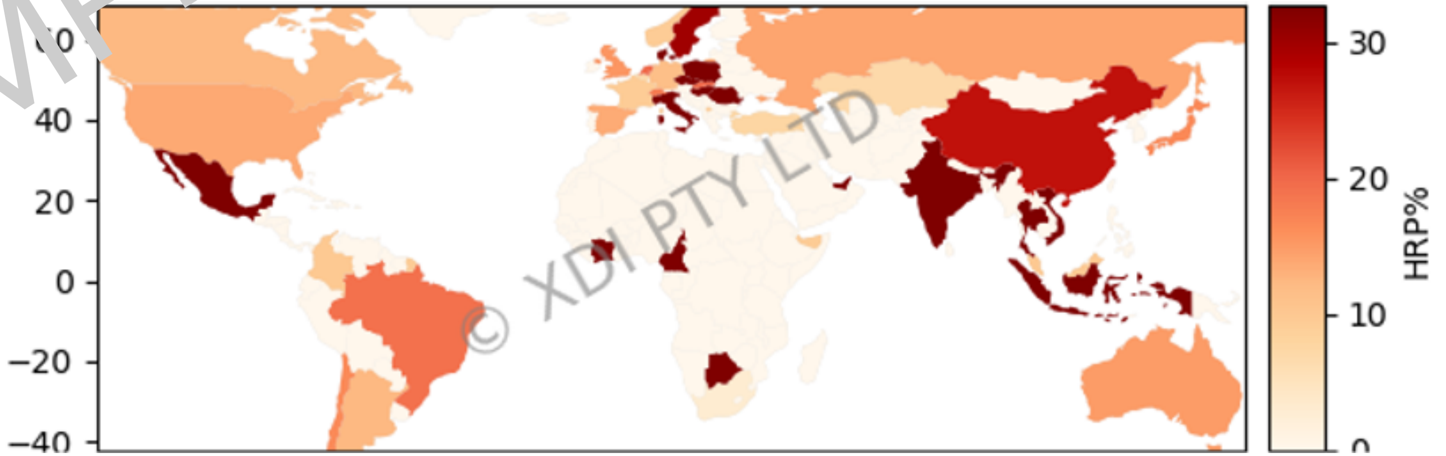
WHY IS THIS RESULT USEFUL

These maps show the areas which have the highest proportion of high risk properties as a percentage of all of the properties in that area. The high risk properties are those at most risk of under insurance, devaluation and serviceability stress. These maps could be used as a proxy for regions where high levels of default and credit risk may be expected.

DISTRIBUTION OF HRP% IN 2050



DISTRIBUTION OF HRP% IN 2100



GEOGRAPHICAL DISTRIBUTION OF FAILURE PROBABILTY

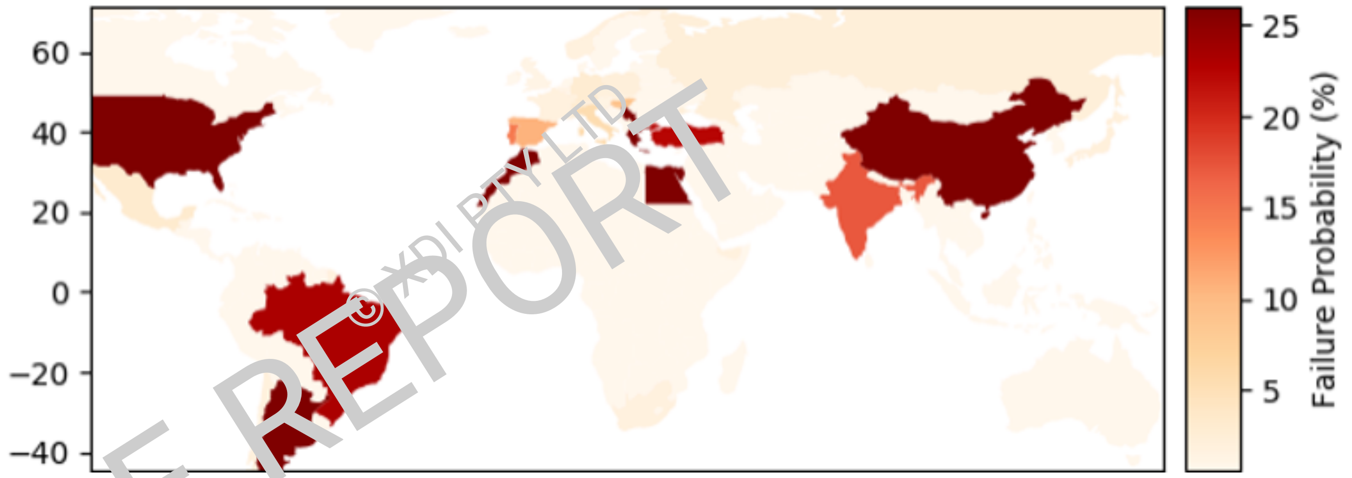
KEY TAKEOUT

The maps of average Failure Probability for the years 2050 and 2100 show an increasing trend in several areas. These maps demonstrate that the average severity of climate risk does not necessarily correspond to spatial asset density for a given area

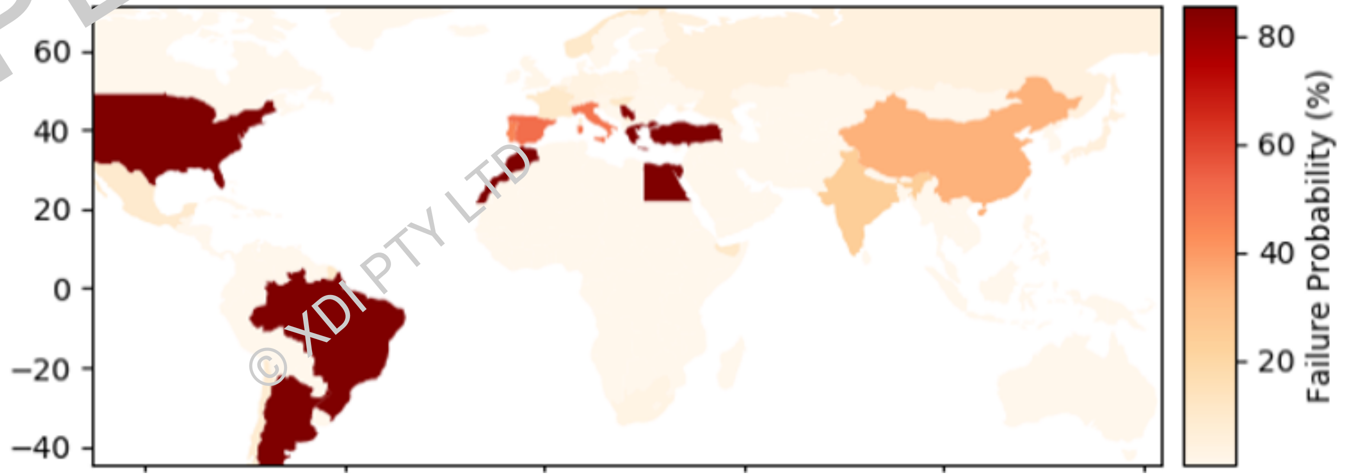
WHY IS THIS RESULT USEFUL

These maps show the locations and density of the company's average Failure Probability in 2050 and 2100, focusing attention on areas of high failure probability concentration.

DISTRIBUTION OF AVERAGE FP% IN 2050



DISTRIBUTION OF AVERAGE FP% IN 2100



GEOGRAPHICAL DISTRIBUTION OF PRODUCTIVITY LOSS

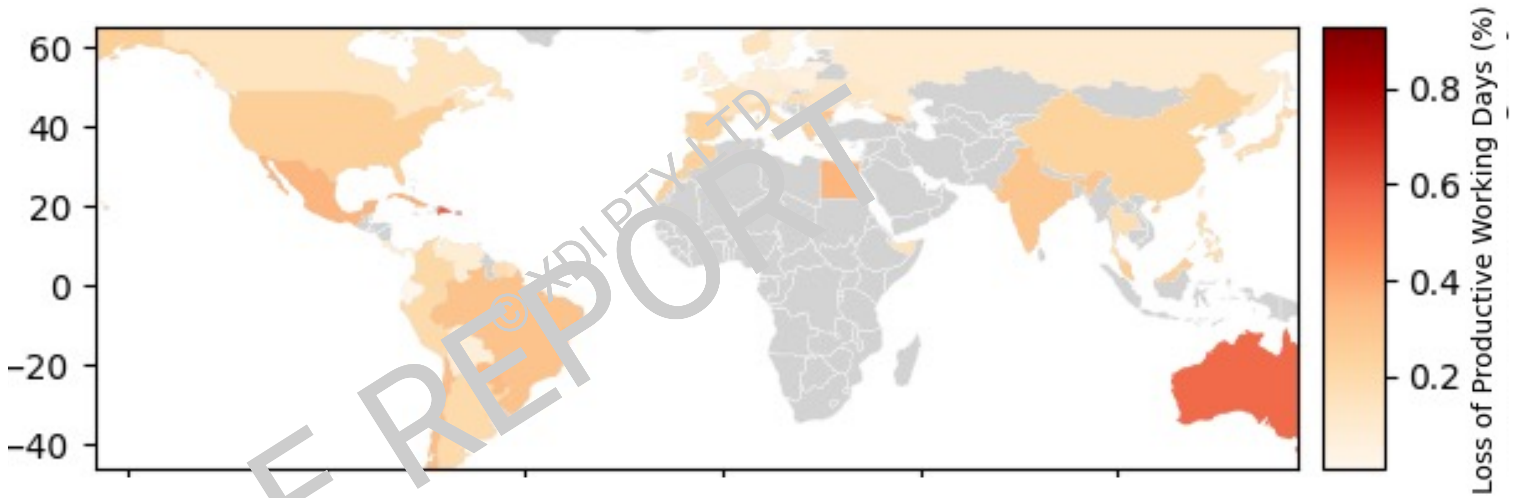
KEY TAKEOUT

The maps of average Productivity Loss % for the years 2050 and 2100 show an increasing trend in several areas. These maps demonstrate that the average severity of climate risk does not necessarily correspond to spatial asset density for a given area.

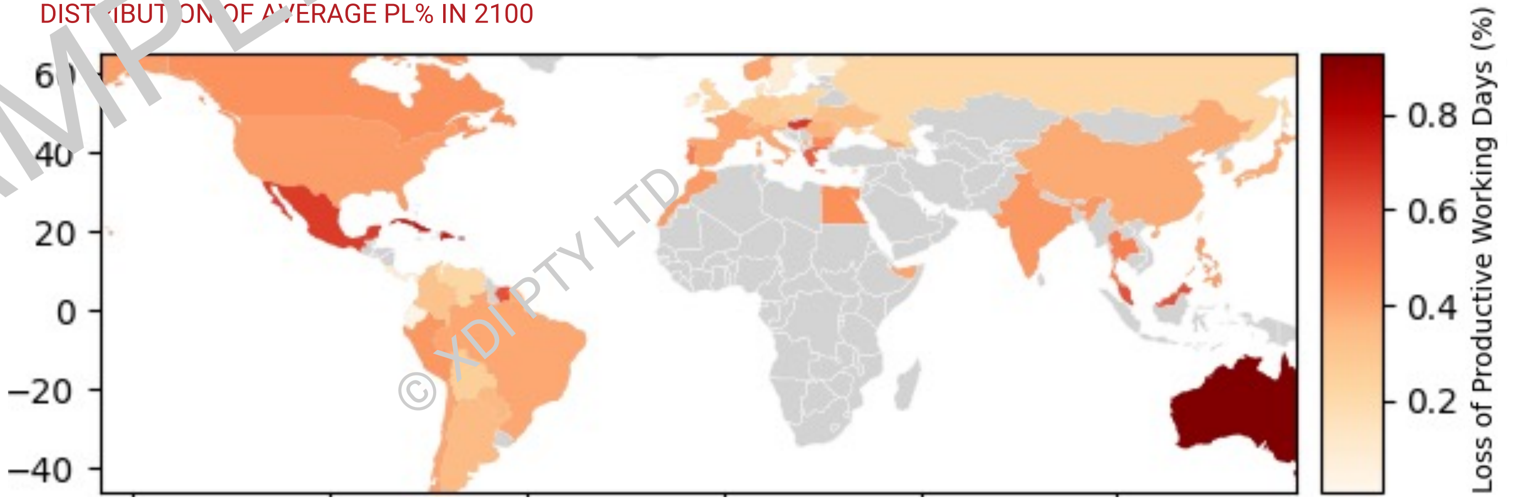
WHY IS THIS RESULT USEFUL

These maps show the locations and density of the company's average Loss of Productive Working Days in 2050 and 2100, focusing attention on areas of high probability concentration.

DISTRIBUTION OF AVERAGE PL% IN 2050



DISTRIBUTION OF AVERAGE PL% IN 2100



HAZARD BREAKDOWN

NUMBER OF ASSETS EXPOSED TO EACH HAZARD

KEY TAKEOUT

Hazards such as Coastal Inundation and Riverine Flooding are only relevant to a very small percentage of the company properties, where as most properties have some amount of clay in the soils and all properties are exposed to extreme wind conditions at some point. This is commonly seen across all national addresses and does not indicate the severity of the risk to the bank.

WHY IS THIS RESULT USEFUL

This table provides an insight into the portfolio's underlying hazard exposure which is a useful reference point when considering overall risk results. It helps explain why hazards like soil subsidence can often contribute significantly to average VAR%, as such hazards typically affect a large number of assets without necessarily

OBSERVATION

Before calculating vulnerabilities and risk levels, the Climate Risk Engines address (a) spatial context-related exposure, such as proximity to forests or presence of moveable soils, and (b) the degree of that exposure, such as the amount of canopy cover or concentration of clay in the soil. In this table the percentage of assets exposed to each hazard are shown – even if damage risks from those hazards are small.

PERCENTAGE AND COUNT EXPOSED IN 2100

Hazard	Assets Exposed in 2100 (%)	Assets Exposed in 2100 (#)
Coastal Inundation	9%	290
Extreme Wind	100%	3053
Forest Fire	9%	281
Riverine Flooding	24%	726
Soil Subsidence	9%	282
Surface Water Flooding	84%	2573

The table shows the total count and percentage of assets exposed in 2100 to each of the hazards analysed.

HAZARD CONTRIBUTION TO TOTAL VAR%

KEY TAKEOUT

Flood, both Riverine and Surface Water, and Soil Subsidence are the highest contributors to Value-At-Risk% in each year of the four years shown below. Therefore, while coastal inundation affects a small volume of properties, those that are affected have very high associated damage. On the other hand, soil subsidence and extreme wind impact a larger volume of properties but, when examining the associated damage risks, the expected cost and corresponding portion of Value-At-Risk% for every given year is lower.

WHY IS THIS RESULT USEFUL

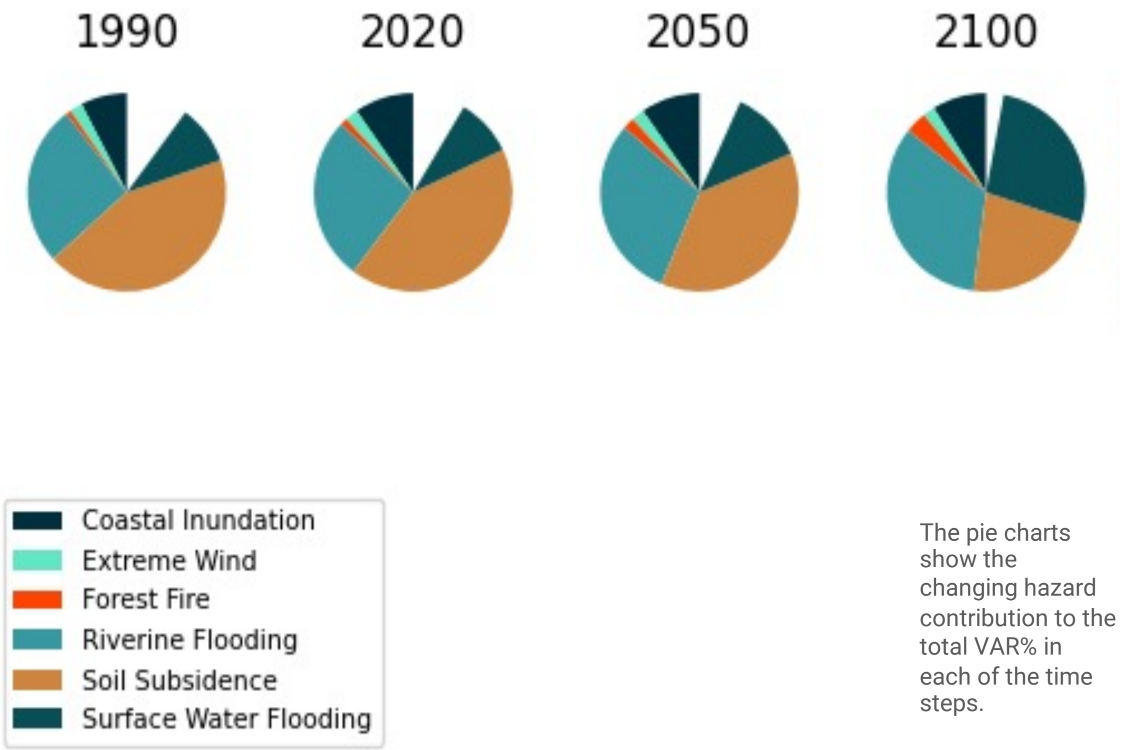
These pie charts show the portion of the total Value-At-Risk% (100%) represented by each hazard in each of the four chosen years. They identify which hazards contribute most to the portfolio's climate-related financial risk, regardless of the number of assets impacted.

OBSERVATION

The largest contributor to the overall risk in 2100 is Surface Water Flooding, followed by Riverine Flooding, which is inverted from the start of the century.

See the individual Hazard breakdowns for more detailed results.

HAZARD CONTRIBUTION TO VAR% OVER TIME



The pie charts show the changing hazard contribution to the total VAR% in each of the time steps.

KEY TAKEOUT

Under RCP8.5 scenario, the company's average Value-At-Risk from Coastal Inundation is expected to increase by around 0.01% between 1990 and 2050. The impacts of this hazard can be seen to exponentially increase over the century.

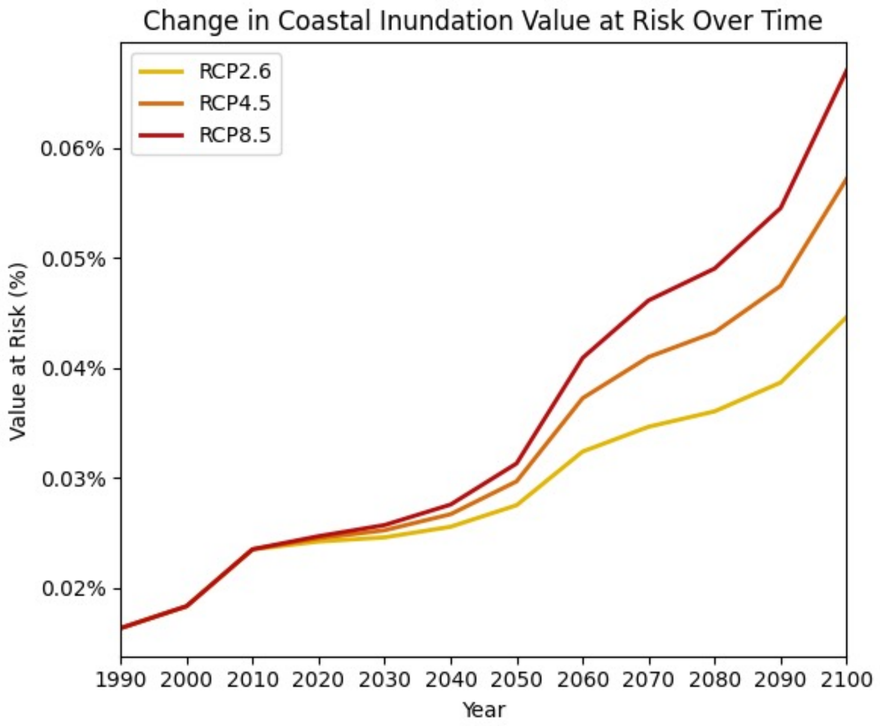
WHY IS THIS RESULT USEFUL

For each emissions scenario, this graph shows the average Coastal Inundation VAR% over the course of the century. This is useful in determining the severity of the financial risk present to the portfolio from the coastal inundation hazard.

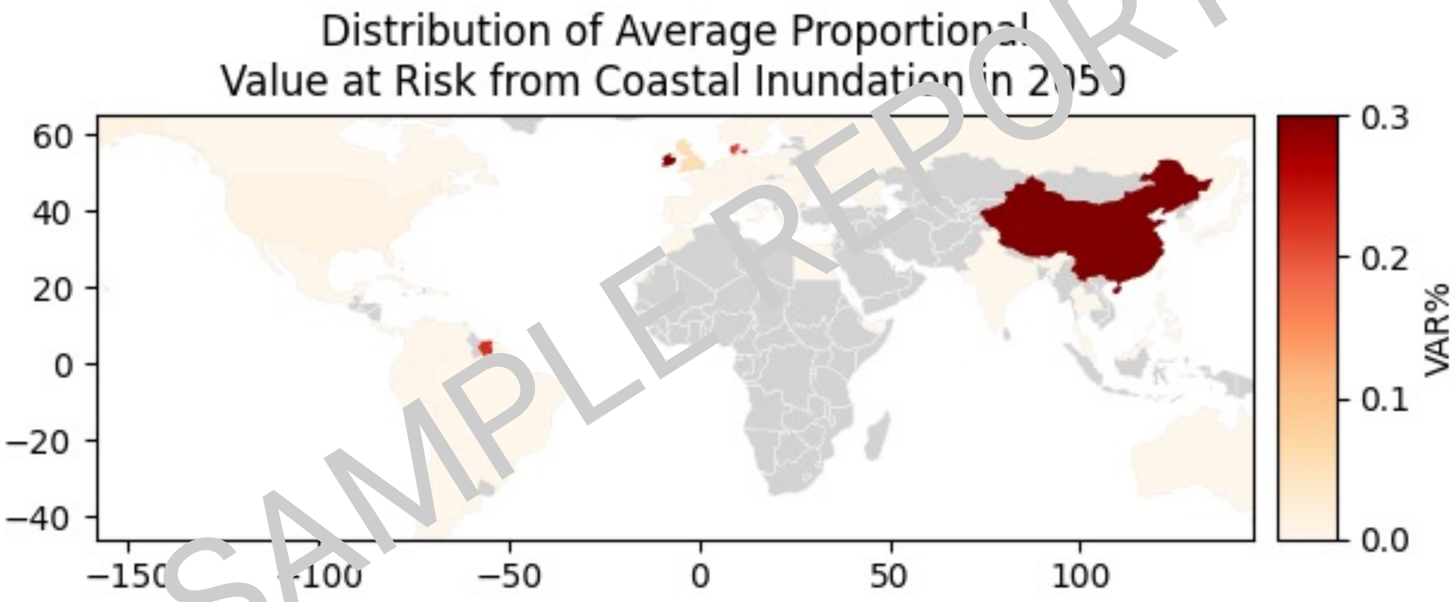
OBSERVATION

Unlike many other climate exacerbated hazards, Coastal Inundation increases exponentially over time. There has already been a small increase from 0.07% VAR% in 1990 to 0.12% in 2021. This is projected to double to 0.32% in 2100. Note that sea levels will continue to rise for some time, even after global greenhouse gas concentrations have been stabilised, thus damage from coastal inundation is evident in the portfolio regardless of which RCP is selected.

VAR% COASTAL INUNDATION OVER TIME



This graph shows the change in the VAR% from Coastal Inundation over time under RCP 8.5, 4.5 and 2.6.


Distribution of Average Proportional
Value at Risk from Coastal Inundation in 2050
60
40
20
0
−20
−40
−150
−100
−50
0
50
100
0.3
0.2
0.1
0.0
VAR%

EXTREME WIND – CHANGE IN VAR%

KEY TAKEOUT

Overall the projected VAR% and the subsequent risks have increased with climate change, they are projected to remain well below levels that could impact insurance. Beyond the current modelling, there is a risk that rising Pacific and Indian ocean temperatures could cause cyclones to reach further south in future, exceeding the design standard of buildings in southern parts of the globe.

WHY IS THIS RESULT USEFUL

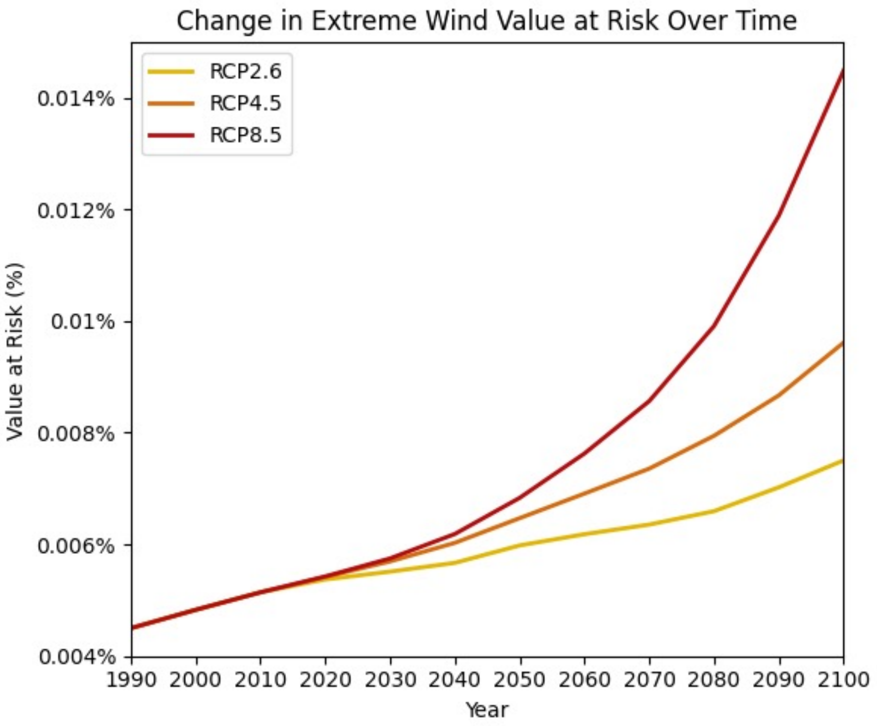
For each emissions scenario, this graph shows the average Extreme Wind VAR% over the course of the century. This is useful in determining the severity of the financial risk present to the portfolio from the extreme wind hazard.

OBSERVATION

Wind risks to the portfolio from the climate models start low but increase sharply from 2080. However the VAR% remains well below the critical risk thresholds.

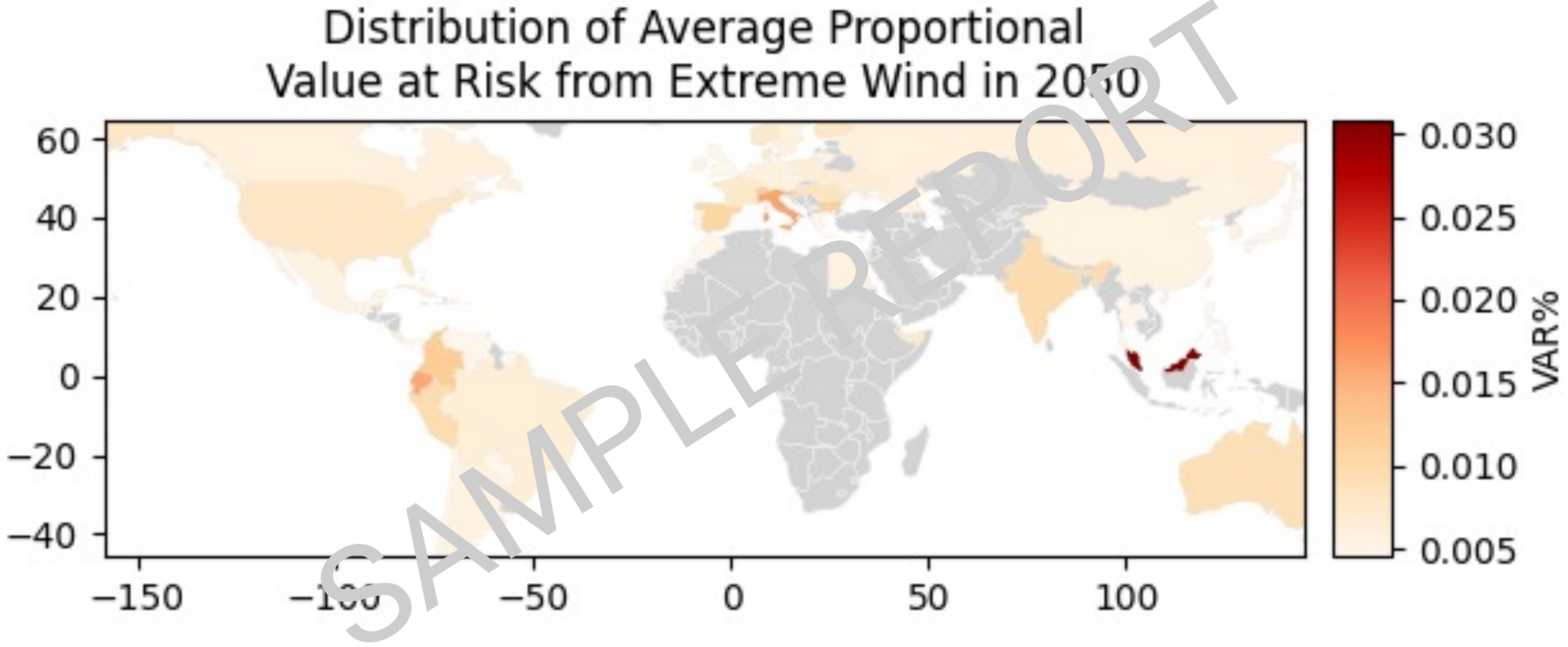
Most climate models have limitations with regard to wind, (a) they do not yet model small convective storms and (b) they do not yet model the creation of cyclones caused by warming.

VAR% EXTREME WIND OVER TIME



This graph shows the change in the VAR% from Extreme Wind over time under RCP 8.5, 4.5 and 2.6.

EXTREME WIND – GEOGRAPHIC DISTRIBUTION



FOREST FIRE – CHANGE IN VAR%

KEY TAKEOUT

Forest Fire risk is driven by the confluence of low humidity, temperatures and high winds. These are conditions are projected to increase exponentially under RCP 8.5 scenario, and be significantly contained under a the RCP 2.6 emission scenario.

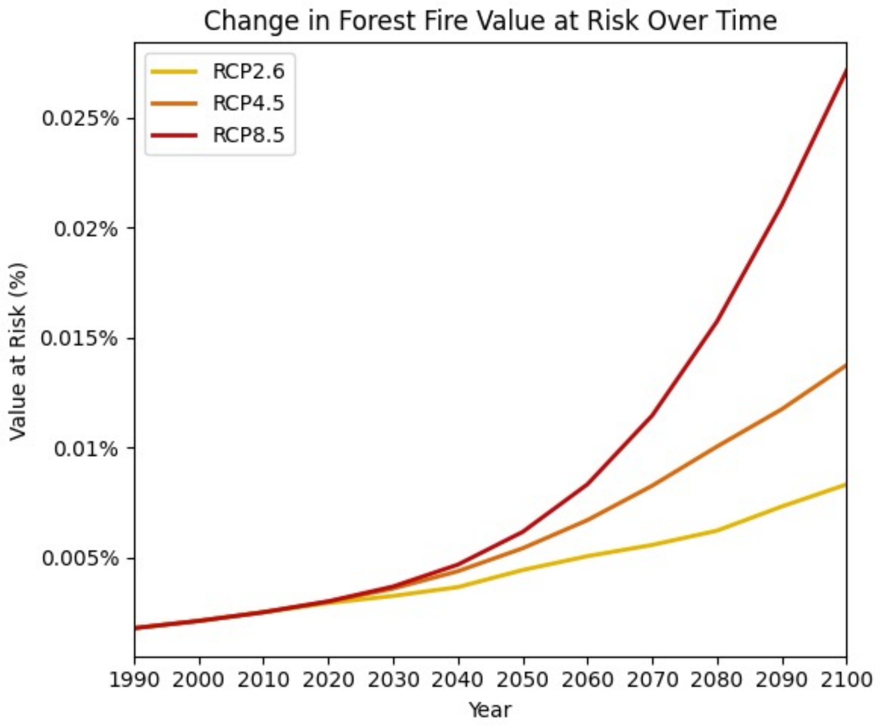
WHY IS THIS RESULT USEFUL

For each emissions scenario, this graph shows the average forest fire VAR% over the course of the century. This is useful in determining the severity of the financial risk present to the portfolio from the forest fire hazard.

OBSERVATION

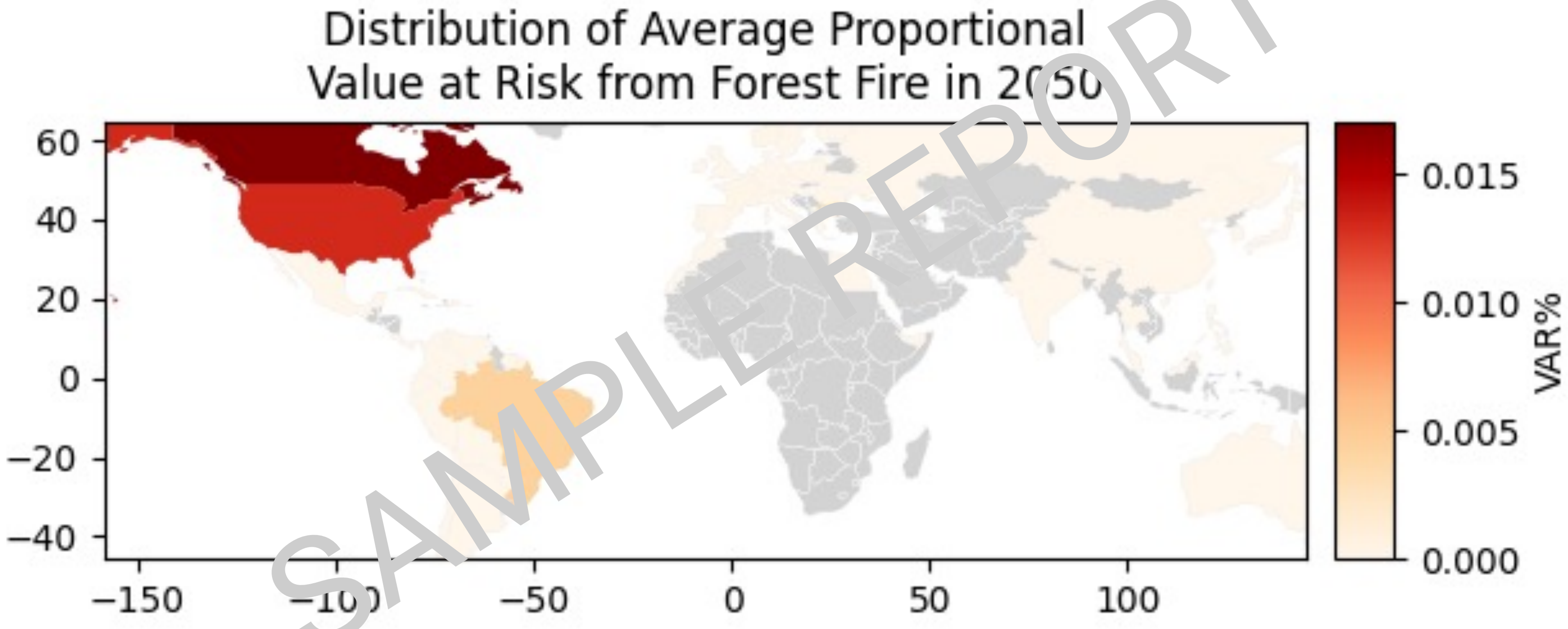
Forest Fire risk is driven by the confluence of low humidity, temperatures and high winds. These are conditions are projected to increase exponentially under RCP 8.5 scenario, and be significantly contained under a the RCP 2.6 emission scenario.

VAR% FOREST FIRE OVER TIME



This graph shows the change in the VAR% from Forest Fire over time under RCP 8.5, 4.5 and 2.6.

FOREST FIRE – GEOGRAPHIC DISTRIBUTION



RIVERINE FLOODING – CHANGE IN VAR%

KEY TAKEOUT

The company's aggregate Value-At-Risk from Riverine Flooding under RCP8.5, shows significant growth, leading to 200% increase between 1990 and 2100. Lower emission pathways lower or curb the long term growth in flood risks.

WHY IS THIS RESULT USEFUL

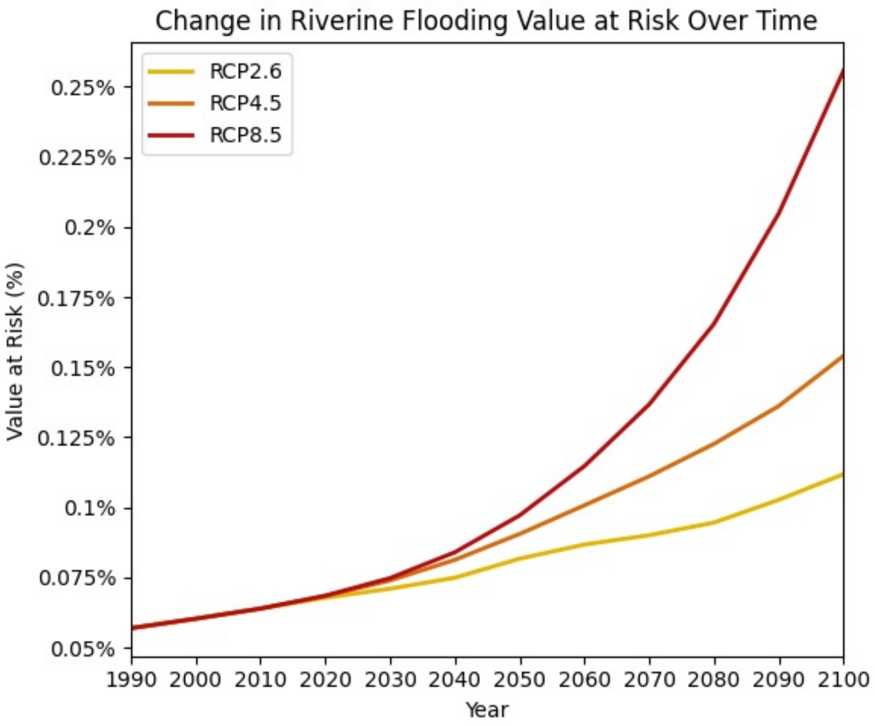
For each emissions scenario, this graph shows the average Riverine Flooding VAR% over the course of the century. This is useful in determining the severity of the financial risk present to the portfolio from the riverine flooding hazard.

OBSERVATION

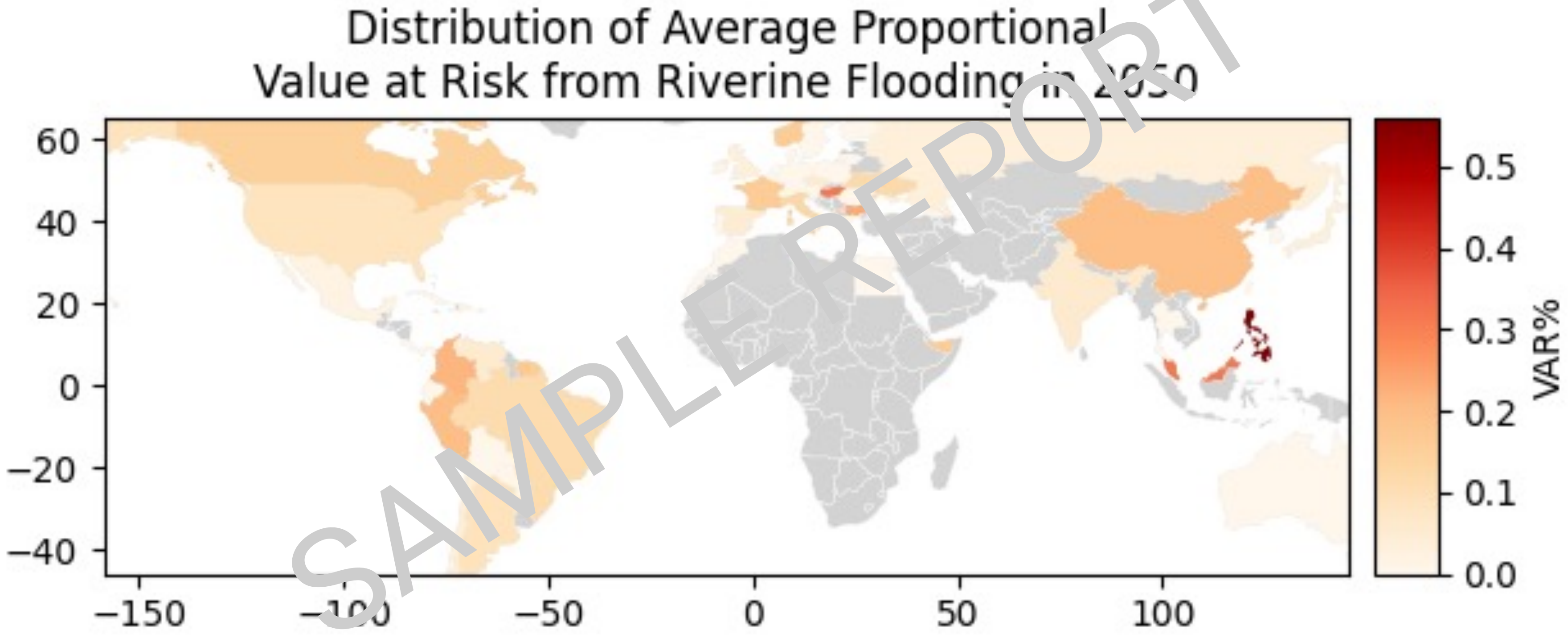
The company's aggregate Value-At-Risk from Riverine Flooding under the RCP8.5 scenario, shows significant growth, leading to 200% increase by 2100. Lower emission pathways lower or curb the long term growth in flood risks (100% increase for RCP4.5).

Note that 40 years of change in risk probability between 1990 and 2030 appear to be unavoidable.

VAR% RIVERINE FLOODING OVER TIME



This graph shows the change in the VAR% from Riverine Flooding over time under RCP 8.5, 4.5 and 2.6.


Distribution of Average Proportional
Value at Risk from Riverine Flooding in 2050
60
40
20
0
−20
−40
−150
−100
−50
0
50
100
0.5
0.4
0.3
0.2
0.1
0.0
VAR%

SOIL SUBSIDENCE – CHANGE IN VAR%

KEY TAKEOUT

The modelling suggests Soil Subsidence Value-At-Risk in the company's portfolio has already increased due to an increased probability of droughts and this is projected to increase over the century. These risks are generally non-catastrophic for an individual property, but can be widespread. Majority of insurers do not currently offer coverage for damage due to soil subsidence.

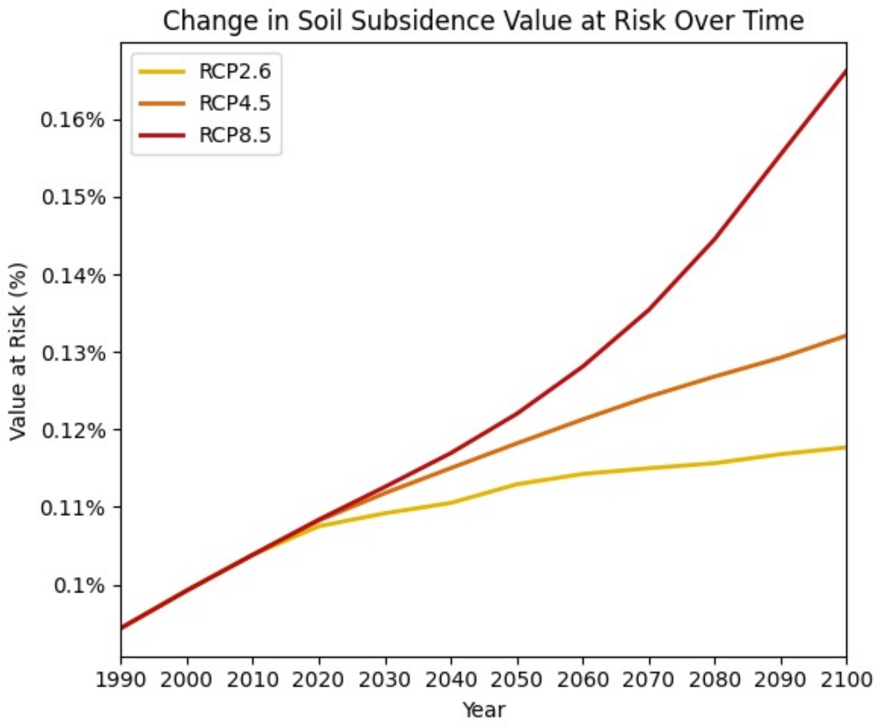
WHY IS THIS RESULT USEFUL

For each emissions scenario, this graph shows the average soil subsidence VAR% over the course of the century. This is useful in determining the severity of the financial risk present to the portfolio from the soil subsidence hazard.

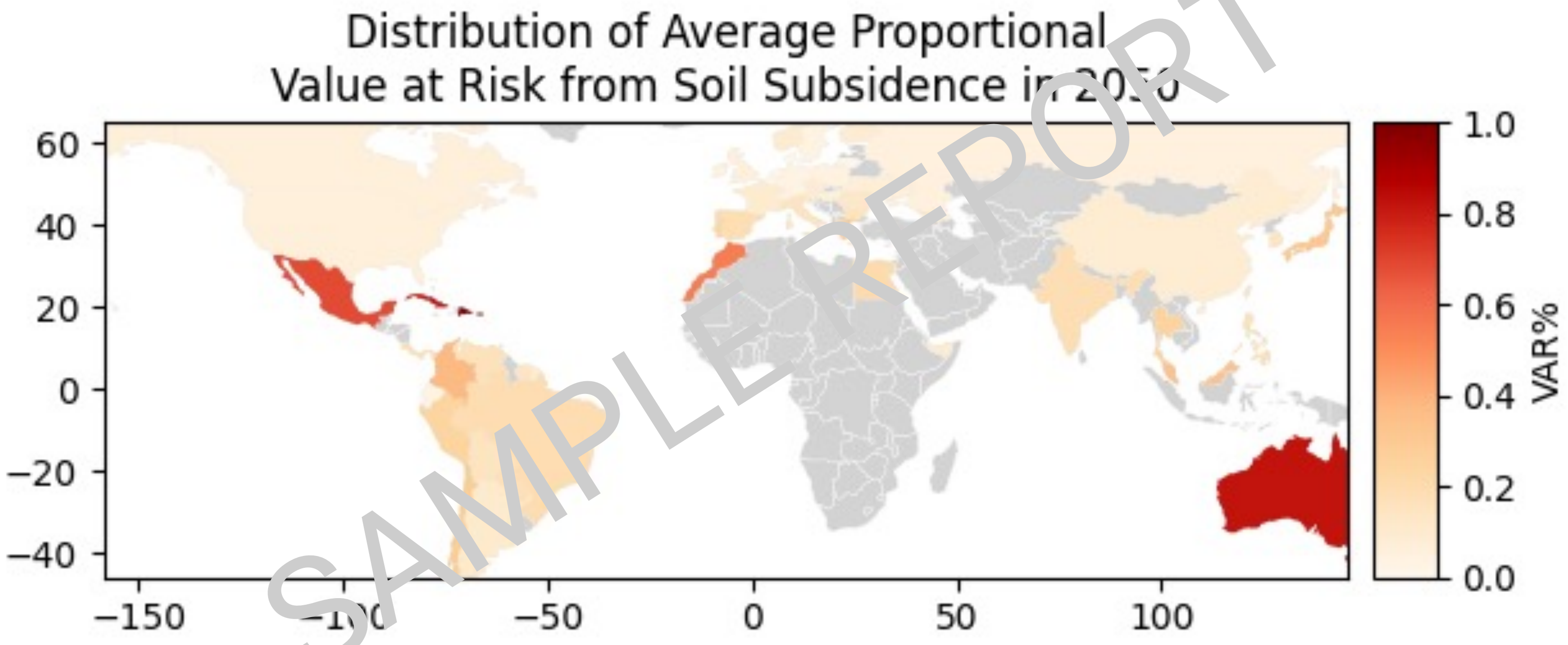
OBSERVATION

Under RCP8.5, the modelling suggests the company's aggregate Value-At-Risk from Soil Subsidence has already increased from 1990 to 2020 due to increased probability of droughts. This is projected to continue increasing over the century however most change will occur before 2030.
These risks are generally non-catastrophic for an individual property, but can be widespread.

VAR% SOIL SUBSIDENCE OVER TIME



This graph shows the change in the VAR% from Soil Subsidence over time under RCP 8.5, 4.5 and 2.6.


Distribution of Average Proportional
Value at Risk from Soil Subsidence in 2050
60
40
20
0
−20
−40
−150
−100
−50
0
50
100
1.0
0.8
0.6
0.4
0.2
0.0
VAR%

SURFACE WATER FLOODING – CHANGE IN VAR%

KEY TAKEOUT

The company's aggregate Value-At-Risk from Surface Water Flooding under RCP8.5, shows significant growth, leading to 800% increase between 1990 and 2100. Lower emission pathways don't change the future trajectory.

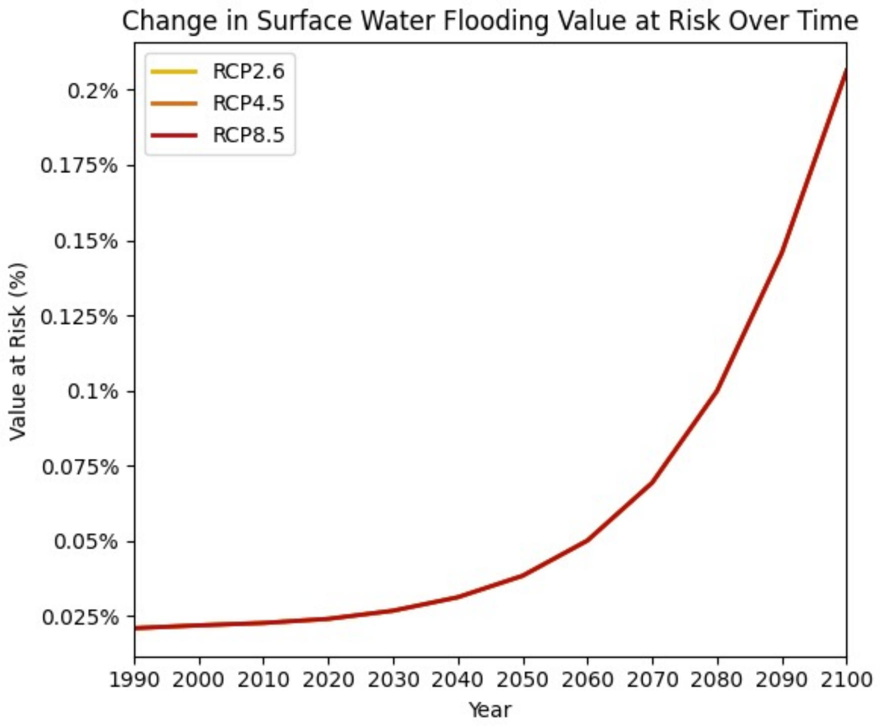
WHY IS THIS RESULT USEFUL

For each emissions scenario, this graph shows the average Surface Water Flooding VAR% over the course of the century. This is useful in determining the severity of the financial risk present to the portfolio from the Surface Water Flooding hazard.

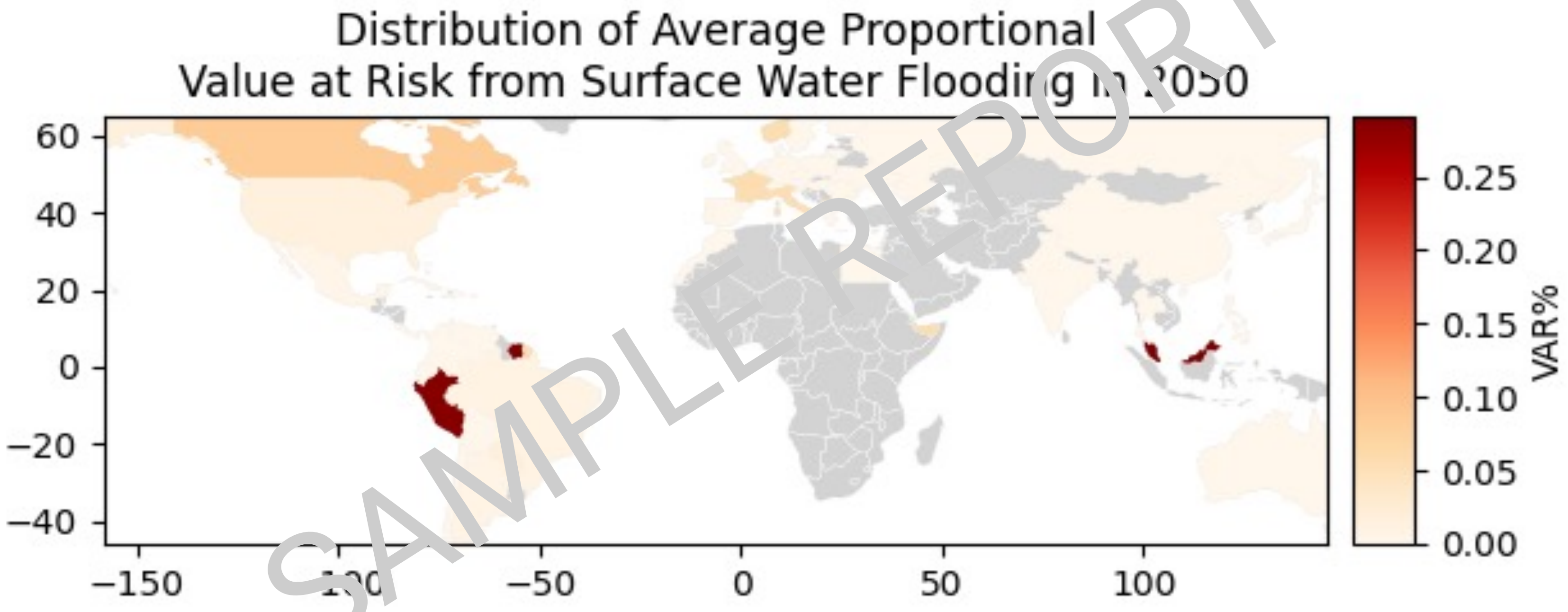
OBSERVATION

The company's aggregate Value-At-Risk from Surface Water Flooding under RCP8.5, shows significant growth, leading to 800% increase between 1990 and 2100.

VAR% SURFACE WATER FLOODING OVER TIME



This graph shows the change in the VAR% from Surface Water Flooding over time under RCP 8.5, 4.5 and 2.6.


Distribution of Average Proportional
Value at Risk from Surface Water Flooding in 2050
60
40
20
0
−20
−40
−150
−100
−50
0
50
100
0.25
0.20
0.15
0.10
0.05
0.00
VAR%

APPENDIX

METHODS USED FOR ANALYSIS

These results have been generated using purpose-built software running on an array of high- speed servers provided by Climate Risk Pty Ltd. The Climate Risk Engines assess climate impacts by placing an archetype at each address analysed. Using the design specifications and materials typical of a recent building, the Climate Risk Engines compute the threshold at which its various key components would fail if exposed to hazards such as flooding, subsidence and forest fires.

Using this information, the annual probability of damage caused by such events is calculated by gathering a range of data on forests, soils, floods, elevations, tides, and waves, then coupling this with long term data from local meteorological stations. Finally, the future probabilities of damage are calculated by extracting the changes in the statistical distribution of key parameters such as heat, precipitation, wind and humidity from global climate change models.

THE CLIMATE RISK ENGINES

The Climate Risk Engines are purpose built to compute hypothetical future risks to a modelled asset (synthesised with engineering data) that is designed to represent property and infrastructure. The system enables each such asset to be stress-tested against a wide range of extreme weather and extreme sea events typical of its location. A range of future-looking scenarios can be applied that are consistent with different greenhouse gas emission scenarios, atmospheric sensitivity and response, adaptation pathways, building standards and planning regimes.

The Climate Risk Engines combine engineering analysis with statistical analysis of historical weather and climate projections, and probabilistic methods for financial analysis of risk and value. It's important to note that these results apply to a synthetic 'Representative Asset' (see 3.3 below) under a range of future scenarios. The results cannot therefore be taken as representations of the actual future risks to, or value of, a real or planned property or infrastructure asset.

RISK ENVELOPE APPROACH

This analysis uses an IPCC greenhouse gas emission scenario that follows business-as-usual (RCP8.5), with climate modelling from CSIRO, UNSW, UQ, IPCC and NOAA used to indicate the impacts on weather parameters and sea levels (a full list of agencies accessed for data is provided in the appendix).

Models come from a short list of those that are known to perform well across a multitude of countries. Specific models are selected to 'stress test' each hazard - thus a model which tends to predict a drier future is used to consider drought, and a model which predicts a wetter future is used to test flood risk. This selection process avoids masking risks or diluting impacts through averaging an ensemble of models, however results should be interpreted as a stress- test, not a mean projection.

A REPRESENTATION ASSET

Initially the system creates a synthetic representation of an asset that is based on nominal industry archetypes, but may include some customisation by the user. This 'Representative Asset' could be selected and tailored to mimic a real asset at the same location – such as a house, road or phone tower – or be created as an entirely hypothetical asset being placed in that location.

INCLUDED HAZARDS

This analysis covers extreme heat, riverine flooding, coastal inundation, forest fires, wind gusts and subsidence of clay soils. It does not cover other hazards such as flash flooding (pluvial), coastal erosion, grass fires, land slip, cyclones or hail.

MATHEMATICAL ANALYSIS

The extreme weather and climate risks to an asset will depend on its exposure and vulnerability to each hazard, as well as the current and future severity and frequency of the hazard that may alter with climate change. How each of these are handled by the Climate Risk Engines is discussed below.

HAZARD EXPOSURE

To understand if the Representative Asset is exposed to a hazard or not, contextual information about each location is gathered by the Climate Risk Engines. This may include information about the soils, tree cover, topology, elevation, flood plains, local tides or waves. Contextual information may even extend to current or historical national design standards for buildings or infrastructure.

Data is gathered on these contextual features from national and international sources selected on the basis of scientific methods used, accuracy, spatial resolution, completeness and the standing of the institution that has generated the information. The organisations from which data have been used are set out in the appendix of this document.

VULNERABILITY ANALYSIS; DAMAGE AND FAILURE THRESHOLDS

Each asset is tested for its ability to withstand the hazards to which it is likely to be exposed each year. The system tests both failure thresholds and damage thresholds.

A damage threshold is breached when an asset is affected by a hazard such that it is broken or excessively weakened. Examples might be flood waters damaging an electrical control system, or a wind storm blowing the roof off a house.

A failure threshold is breached when an element of the asset prevents the asset from performing is function. For example, when the roof is blown off in a storm it is both damaged and it fails to protect its occupants from the weather. However, it is possible to have failure without damage, for example an electrical control system that exceeds its operating temperature in a heat wave may stop the asset working, but there will be no damage (when the temperature drops it will start working again).

WEATHER DATE

To establish the precise probability that a hazard will exceed the coping threshold of an asset or element, information about the driving weather indicators may be needed, for example the likelihood of flooding is linked to the likelihood of extreme precipitation.

The Climate Risk Engines have access to 100,000 national weather stations around the world. Internal algorithms are used to select which stations to use when testing an asset based on proximity, data quality, duration and completeness. In some cases, the Climate Risk Engines may use a combination of data from more than one station or gridded data sets made by national meteorological centres.

CLIMATE CHANGE MODELLING

Changes in the composition of the atmosphere due to greenhouse gas emissions will change how the atmosphere and oceans behave. Therefore, the historical weather station statistics need to be adjusted to allow for climate change.

The Climate Risk Engines have access to a large number of data sets from the Coupled Model Inter-comparison Project (CMIP) in which participant organisations model the atmosphere under various Representative Concentration Scenarios (RCP). At a whole of atmosphere scale the General Circulation Models (GCMs) have a resolution down to about 100km3.

With downscaling, Regional Climate Models (RCMs) include local topology and land surface information to provide weather parameters at higher spatial resolutions - between 5km3 and 50km3.

In the XDI Platform, users can select the GCM/RCM they wish to apply to the analysis of the Representative Asset. In this Physical Risk Report, the Climate Risk Engines select by default the most appropriate climate modelling to use based on: the models available in the region; the 'skill' of the model in capturing typical weather behaviour in a certain region; the range of parameters included or reported; the spatial resolution; and how the results of the model fit within the ensemble of other models for the region. The CORDEX set of projections has been used for all assets analysed in this project.

APPENDIX 2 - LOCATING XDI ANALYSIS IN TCFD LEADING PRACTICE

SUMMARY TABLE: XDI DELIVERY OF TCFD REPORTING RECOMMENDED PRACTICE

ELEMENTS OF PHYSICAL RISK ASSESSMENT	GUIDANCE AND RECOMMENDATIONS	WHAT XDI DELIVERS
HAZARDS	Storms, extreme rainfall, extreme heat, heatwave, flood, drought and wildfire, variability in precipitation and temperature, water stress, sea- level rise, land degradation (IIGCC 2020a). Heat stress, extreme rainfall, drought, cyclones, rising sea levels, wildfire and other industry-relevant and/or locally specific climate hazards across the corporate value chain (EBRD 2018).	XDI modelling incorporates eight climate hazards: coastal inundation (sea level rise), riverine flooding and pluvial flooding (extreme rainfall), extreme heat, wind (storms), soil contraction (effect of drought), freeze/thaw (effect of temperature) and forest fire.
TIMEFRAMES	Short and medium term: 2020-2040 (IIGCC 2020a, EBRD 2018). For this time frame, the EBRD recommends probabilistic risk analysis. Longer term: 2040-2100 (IIGCC 2020a, EBRD 2018). For this time frame, the EBRD recommends scenario-based analysis. The BOE's biennial exploratory scenario will model 2020-2050 but for the "no policy action" scenario, physical impacts in 2050 will represent expected physical impacts in 2080 (BOE 2019b).	The analysis is probabilistic from 2020 to 2100 for multiple climate scenarios ranging from "no policy action" (RCP8.5) through to "extreme policy action" (RCP2.6). Results can be presented in different decadal time steps (e.g. 2030, 2050 and 2100) depending on client requirements.
SCALE	Location (country or city) of key supplier facilities and critical business facilities with evaluation of their importance (EBRD 2018). Asset-level data and assessment with attention to downscaling limitations of models (IIGCC 2020a, CISL 2019).	XDI works at address and site level, data is aggregated from suburbs to national as required. Regional Climate Models (RCMs) include local topology and land surface information to provide spatial resolutions to between 5 and 50km square resolution. Further hazard layer context includes local weather data, elevation data, vegetation maps and wind zones with resolutions between 5 and 250 metres.
SCENARIOS	Most guidance for physical risk assessment recommend use of 2°C and 4°C pathways (CISL 2019, IIGCC 2020a). Consistent with IIGCC recommendation, the TCFD 2019 Status report indicates that RCPs 2.6 and RCP8.5 are commonly being used as best and worst case 2°C scenario and 4°C scenarios respectively.	XDI can model comparative effects of RCP2.6 and RCP8.5 and can also include RCP4.5 as a moderate mitigation pathway (which still results in average warming over 2°C).
DIRECT AND INDIRECT PHYSICAL CLIMATE IMPACTS	Direct and first-order: damage and loss of real assets, disruption to value chains, supply chain costs, lost hours of staff (IIGCC 2020a, EBRD 2018). Indirect and second-order: Insurance costs, energy costs, regulatory change, legal liabilities, market changes, borrowing costs, social license (IIGCC 2020a, EBRD 2018).	Direct and first-order: damage and loss of real assets, lost hours of staff, customer impact. Indirect and second-order: insurance premiums.

APPENDIX 2 - LOCATING XDI ANALYSIS IN TCFD LEADING PRACTICE

SUMMARY TABLE: XDI DELIVERY OF TCFD REPORTING RECOMMENDED PRACTICE

ELEMENTS OF PHYSICAL RISK ASSESSMENT	GUIDANCE AND RECOMMENDATIONS	WHAT XDI DELIVERS
METRICS AND OUTPUTS	Data: Most guidance recommended climate data overlaid with business data, within a socio-economic and regulatory context. Recent and historic impacts: EBRD recommends firms estimate current costs of extreme weather events, including days of business interruptions and associated costs, costs of repairs or upgrades, fixed-asset impairment, supply chain disruptions and lost revenues. Average Annual Loss (CISL 2019, BOE 2019b, EBRD 2018). Number of sites and business lines exposed to relevant climate impacts (EBRD 2019). Value-At-Risk (EDRB 2018). Identification of critical thresholds (IIGCC 2020a).	Climate data overlaid with business asset data. Possible outputs include: • Average Annual Loss. • Total Technical Insurance Premium (TTIP), (total annual cost of damage assuming all hazards are insured) • Percentage of Value at Risk (VAR%), (TTIP as a percentage of the replacement cost of the property). • Number of High-Risk Properties (HRP#), (property assets where the VAR is greater than 1%). • Percentage of High-Risk Properties (HRP%), (HRP# expressed as a percentage of all properties in the LGA). • Failure Probability. • Productivity Loss.
ADAPTATION MEASURES	Inclusion of asset-level and broader adaptation options in model (CISL 2019, BOE 2019b, IIGCC 2020a) including planned improvements, retrofits, relocations, or other changes to facilities.	In some projects, analysis of available adaptation measures at the address and locality scale and how they change risk profile. Evaluation of net risk exposure after adaptation applied.
STRATEGY, POLICY AND ADVOCACY	Supply-chain risk management strategy incl. engagement with suppliers on strategy (EBRD 2018). Engagement with local or national government and local stakeholders on local climate resilience (EBRD 2018).	In some projects, cross dependency analysis identifies shared risk with upstream infrastructure including road access, water and power supply.

REFERENCES

Task force on Climate-related Financial Disclosure: The 2017 Final Report from the Task Force for Climate-related Financial Disclosure (TCFD 2017)

European Bank for Reconstruction and Development (EBRD): Advancing TCFD guidance on physical climate risks and opportunities (EBRD 2018)

Cambridge Institute for Sustainability Leadership (CISL): Physical risk framework Understanding the impacts of climate change on real estate lending and investment portfolios. (CISL 2019).

TCFS 2019 Status Report 2019: (TCFD 2019).

Institutional Investor Group on Climate Change (IIGCC): Understanding physical climate risks and opportunities – a guide for investors (IIGCC 2020)

Bank of England (BOE): Discussion paper for the 2021 Biennial Exploratory Scenario (BES) on the financial risks from climate change. (BOE 2019b).

APPENDIX 2 – SCIENTIFIC UNCERTAINTY & CONFIDENCE

Risk analysis of any type has inherent uncertainties. This is compounded in climate related risk analysis, as risk calculations combine information from many different sources, many of which change over time. Each of these sources of information contain uncertainties of some kind, and only a few of these types of uncertainties are reasonably quantifiable. Key sources of uncertainty in the XDI analysis methodology include:

Climate projections: This includes quantifiable uncertainty in historical weather observations and in model behaviour in response to driving variables (including emissions scenarios), as well as unquantifiable uncertainty around model structure, and likelihood of socio-political trajectories associated with proposed emissions scenarios.

Geospatial context data: This includes uncertainties in observed and modelled data representing various physical quantities that affect an asset's exposure to various climate-related hazards.

Asset vulnerability data: Every asset is different, and asset-specific data (e.g. material and design information) usually only captures some aspects of that variance. Much information about an asset that might heavily impact its vulnerability (e.g. how often the gutters of a house in a fire zone are cleaned), is not practically available or estimable.

Impact model structure: Models that can estimate the damage, system failure, and financial and human impacts to an asset in the event of a climate event need substantial data (e.g. historical impact data) to adequately constrain their design. This data is often only sparsely available.

In this analysis, uncertainty is captured and addressed in two key ways:

Firstly, each asset is analysed using the IPCC's RCP8.5 scenario, which represents the most high-risk possible future for which projections are available. Developed by International Institute for Applied Systems Analysis (IIASA) Austria RCP 8.5 refers to a concentration of greenhouse gases that cause global warming temperature increase of between 3.2°C to 5.4°C by the end of 2100. RCP 8.5 represents the closest approximation to current business-as-usual socio-political outcomes, based on measured climate changes over the last few decades.

There are many modelling institutions around the world that have separately modelled the outcomes of an RCP8.5 concentration pathway. The Climate Risk Engines are programmed to select the climate model that represents the strongest driver for each hazard, for a given region of the globe. These projections are then adjusted to indicate the effects of lower emission pathways, according to calculated difference between using global projections for temperature for RCP8.5, RCP4.5, and RCP2.6. This enables a comparison with different socio-political scenarios.

Secondly, a representative sample of assets has been analysed using two different sets of assumptions about vulnerability, which help explore the uncertainty due to lack of asset-specific information. The VAR for both the high and low resilience assets is calculated, and the higher and lower boundaries of possible risk distribution are determined.

The position of the 'Modern Commercial Building' archetype used in this study is then located within the distribution to determine the appropriate range of uncertainty to apply to the results. While this sensitivity analysis includes the likely range of forward-looking resilience, it is not a dynamic projection that accounts for changes to building standards and possible vulnerability over time. In order to account for uncertainty, sensitivity testing has been executed across a sample of random assets within the portfolio, using both high and low resilience archetypes. The results from this sensitivity testing place the 'Modern Commercial Building' archetype (on which the body of the analysis was conducted) within the lower quartile of the risk distribution. By applying the results from this sensitivity test, its likely that the actual portfolio risk could be up to 30% higher than quoted results.

A sensitivity analysis suggests that the range of Value-At-Risk for the Portfolio sits between 22% and 30% either side of the median. The 'Modern Commercial Building' archetype used in this study is at the higher resilience end for flood, coastal inundation and wind–storms, but with no special provisions for subsidence or forest fire. Thus a high resilience asset would have approximately 22% lower Value-At-Risk than the 'Modern Commercial Building' archetype upon which this study was conducted. Similarly a low resilience asset would result in a VAR% approximately 50% higher than the 'Modern Commercial Building' archetype. A high confidence can be given to the VAR% range between the reference data contained within this report and a VAR% of 30% higher. This range should be assumed to apply to all other risk matrix provided throughout the report.

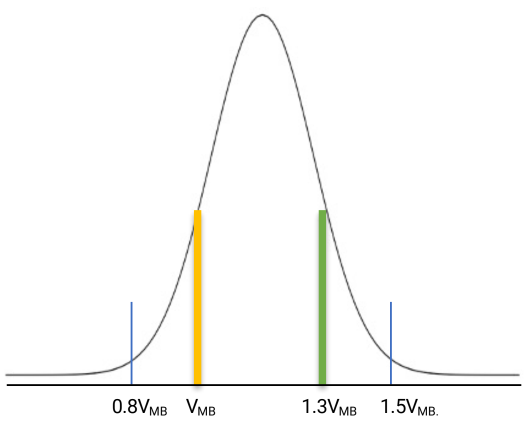
HOW IS THIS RESULT CALCULATED?

A sample set of high and low resilience assets are analysed individually. The average VAR for both is calculated, including median and difference. The position of the 'Modern Commercial Building' archetype is estimated within the distribution and a proposed uncertainty range around the reference archetype data is identified.

CAVEATS & ASSUMPTIONS

The mix of building designs and standards will change over time, and while this sensitivity analysis includes the likely range of forward looking resilience, it is not a dynamic projection changing in vulnerability over time. Assuming a normal distribution of VAR, the sensitivity analysis provides the results for the higher and lower resilience archetypes (blue lines). The actual position of the whole portfolio is likely to lie between the "Modern Commercial Building' archetype (red line) and up to 30% higher (green line).

Distribution of VAR% Based on Sensitivity Analysis



Schematic distribution of Value-at-Risk (VAR%) for the sensitivity analysis using the 'Modern Commercial Building' archetype (V_{MB}) as the reference.

COASTAL INUNDATION

OVERVIEW

Flooding caused by sea-water is referred to as Coastal Inundation. It can be caused by high tides in combination with elevated water levels driven by winds, low air pressure, waves and the dynamics at the sea-land interface. Over the course of the century, climate change is projected to result in elevated sea levels, which will increase the frequency and severity of coastal inundation events.

ASSET DATA

The vulnerability of an asset to coastal inundation is based on the elements present at the property, the relative elevations of each exposed element and the behaviour of the materials used in that element when exposed to water. Most critical is the elevation of the Civil element (e.g. floor heights), as empirical data shows a sharp increase in loss once water breaches the normal floor level. XDI can adjust elevations for individual assets (to override that of the archetype), or for sensitivity testing and adaptation planning.

CONTEXTUAL DATA

Coastal inundation levels are referenced relative to the national height datum taken from a range of international digital elevation models. In more populated areas, where airborne light detection and ranging (LIDAR) surveys have been conducted, these models typically have a 5X5 m horizontal resolution, and a height resolution of a few centimetres. In less populated areas, where the source of geospatial data is commonly satellite imagery, the resolution may be 30x30m, with uncertainty of at least 0.[illegible] m.

BASELINE HAZARD DATA

Seal level data is based on an array of national tidal gauges located around the world. These tide gauges provide a spectral probability distribution of tide levels, including during extreme sea events, based on empirical measurements.

CLIMATE CHANGE PROJECTIONS

Currently the average global sea level is rising by 3.2 mm per year (NASA, 2017). The IPCC has established a series of sea level rise projections for different emissions pathways (Church et al 2013) for the scenarios known as RCP 8.5, RCP 6.0, RCP 4.5 and RCP 2.6. These provide the Climate Risk Engines with a nominal 'likely' range of 0.28 m to 0.98 m of sea level rise by 2100 (including 95% confidence bounds). The system includes two projections from a United States National Oceanic and Atmospheric Administration (NOAA) report (Sweet et al 2017) outlining (less likely but still possible) 'High' (2 m) and 'Extreme' (2.5 m) 2100 average global sea level rise scenarios. Climate Valuation's analysis also includes an intermediate projection (Haigh et al 2014) and a 1.1 m by 2100 projection to match the Australian Government's research into coastal impacts (Department of Environment 2009).

EXTREME WIND

OVERVIEW

Air travelling at high speeds, even in short gusts, can cause direct damage to buildings and infrastructure assets. High winds can also cause indirect disruption when trees drop limbs onto power lines or debris puts life and property at risk. General increases in the amount of moisture in the air caused by warming can change convective forces in storms and the severity of down draughts.

XDI does not currently analyse risk associated with cyclones and convective storms, due to:

- unavailability of the very high resolution modelling outputs required
- difficulty in making clear statements about changes in cyclone frequency, duration or intensity, as for an individual given location a cyclone is actually quite a rare event.

ASSET DATA

The wind speed design threshold for each asset is assumed to follow national building code for the year of build or re-build. Increased design resilience may be applied for dwellings that have been built beyond code requirements to specific wind speed thresholds or return frequencies. Reduced resilience may be applied based on empirical wind performance data.

CONTEXTUAL DATA

No context data layers are used for the extreme wind hazard

BASELINE HAZARD DATA

Bias correction for wind damage is disabled by default, as wind data is only very sparsely available at the required record length and quality. This does not however pose a problem, as the Climate Risk Engines use asset-level probabilistic wind tolerance thresholds (such as 1:500 year), and calculates the physical wind speed threshold from this probabilistic threshold over the baseline period. This means that a bias in the wind data will not affect the results, as we are only looking at the trend in risk relative to the baseline, and the wind tolerance design threshold as specified by the relevant building code.

CLIMATE CHANGE PROJECTIONS

Climate projections are used to establish baseline wind gust speed for threshold return frequencies and then used to project how this speed changes over time. The main climate variable used is the 2-10 second wind gust speed or the 1-5 minute maximum wind speed, depending on how the relevant projection was produced.

FOREST FIRE

OVERVIEW

Forest fires can destroy buildings and infrastructure through direct flame or intense radiant heat. Assets considered to be at risk are those under or surrounded by trees, or close enough to trees to be affected by intense thermal radiation should the forest catch on fire. Grass fires are also a potential risk but are not covered by Climate Valuation's analysis.

ASSET DATA

The exposure of the elements of an asset (e.g. roof, walls, floor) to a forest-fire are defined within each asset archetype.

CONTEXTUAL DATA

Context layers used for the forest fire hazard are as follows:

- Global Land Analysis and Discovery's per pixel estimates of circa 2010 maximum tree canopy cover percentages (at growing season peak period), derived from cloud-free annual growing season composite Landsat 7 ETM+ data
- An economic activity intensity layer, used to moderate fire weather projections based on the assumption that more urbanised areas face lower overall fire risks as they have better fire prevention and suppression capabilities.
- An empirical ignition probability model, which is based on analysis of insurance loss data.

BASELINE HAZARD DATA

The driving parameters of forest fire are temperature, humidity, wind speed and forest fire prone land. The Hot-Dry-Windy index (HDW) is a new index of fire-weather based on maximum wind speed and vapour pressure deficit (VPD, the difference between the absolute humidity and the water vapour saturation point for a given temperature). The forest fire hazard layers in the Climate Risk Engines use forest canopy cover from satellite data in conjunction with algorithms to account for proximity and surrounded-ness for a specific location. The baseline annual probability of ignition draws upon empirical data on annual average forest fire extents, as well as on typical natural and human caused ignition rates.

CLIMATE CHANGE PROJECTIONS

Gridded projections for future epochs, based on GCM/RCMs from CORDEX are used to project the changes to the key inputs for the HDW index.

RIVERINE FLOODING

OVERVIEW

XDI computes fluvial flooding - also known as riverine flooding as opposed to sea water or surface level flooding.

ASSET DATA

The vulnerability of an asset to flooding is based on the elements present in each archetype, the relative elevations of each exposed element, and the assumed behaviour of the materials used in that element when exposed to water. Most critical is the elevation of the Civil element (e.g. floor heights), as empirical data shows a sharp increase in loss once water breaches the normal flood level (Bundaberg Regional Council 2011). XDI can adjust elevations for individual assets (to override that of the archetype), or for sensitivity testing and adaptation planning.

CONTEXTUAL DATA

Flood maps used in the Climate Risk Engine analysis contain water depths and flood extents for each of a number of flood events characterised by Return Periods (RPs - such as 1 in 100, 1 in 20 and 1 in 50). The Climate Risk Engines use flood data from multiple sources, including various commercial providers, as well as regionally specific flood data. In general these datasets contain information on water depths for 4-8 different RPs. The Climate Risk engines interpolate between these layers to estimate the return probability for a flood that would breach the asset floor height (and in some cases specific element heights). This return period is then used as a threshold for the climate projection risk estimates.

BASELINE HAZARD DATA

To consider changes to the probability of flooding due to climate change, projected changes to precipitation must be examined. For historical data, annual maximum 24-hour precipitation weather station data for the 30 years pre-2000 is used. Only data sets with at least 20 years of data are considered to have sufficient statistical depth. Regionalisation, which is the process of combining distant data sets to create longer time series for a given location, is not applied.

CLIMATE CHANGE PROJECTIONS

Climate change impacts on precipitation and flooding are computed through the locally downscaled modelling of future precipitation changes (using CORDEX GCMs/RCMs). A commonly used approximation for calculating increased flood risk is the application of a 5% increase in precipitation intensity for each degree rise in global mean temperature (Ball et al 2016). This factor can be applied to modelled or measured Intensity-Frequency (IF) curves for any given location.

SURFACE WATER FLOODING

OVERVIEW

XDI computes pluvial flooding - also known as surface water flooding as opposed to sea water or riverine flooding.

ASSET DATA

The vulnerability of an asset to flooding is based on the elements present in each archetype, the relative elevations of each exposed element, and the assumed behaviour of the materials used in that element when exposed to water. Most critical is the elevation of the Civil element (e.g. floor heights), as empirical data shows a sharp increase in loss once water breaches the normal flood level (Bundaberg Regional Council 2014). XDI can adjust elevations for individual assets (to override that of the archetype), or for sensitivity testing and adaptation planning.

CONTEXTUAL DATA

Flood maps used in the Climate Risk Engine analysis contain water depths and flood extents for each of a number of flood events characterised by Return Periods (RPs - such as 1 in 100, 1 in 20 and 1 in 50). The Climate Risk Engines use flood data from multiple sources, including various commercial providers, as well as regionally specific flood data. In general these datasets contain information on water depths for 4-8 different RPs. The Climate Risk engines interpolate between these layers to estimate the return probability for a flood that would breach the asset floor height (and in some cases specific element heights). This return period is then used as a threshold for the climate projection risk estimates.

BASELINE HAZARD DATA

To consider changes to the probability of flooding due to climate change, projected changes to precipitation must be examined. For historical data, annual maximum 24-hour precipitation weather station data for the 30 years pre-2000 is used. Only data sets with at least 20 years of data are considered to have sufficient statistical depth. Regionalisation, which is the process of combining distant data sets to create longer time series for a given location, is not applied.

CLIMATE CHANGE PROJECTIONS

Climate change impacts on precipitation and flooding are computed through the locally downscaled modelling of future precipitation changes (using CORDEX GCMs/RCMs). A commonly used approximation for calculating increased flood risk is the application of a 5% increase in precipitation intensity for each degree rise in global mean temperature (Ball et al 2016). This factor can be applied to modelled or measured Intensity-Frequency (IF) curves for any given location.

SOIL SUBSIDENCE

OVERVIEW

Low soil moisture within reactive clay soils is a trigger for major soil movement and cracking, as the process of lower level suction leads to clay soils drawing moisture away from the surface soils during drought. Shrinking and subsequent swelling can lead to extensive asset damage if the asset's foundations move. Buildings on light strip footings or unstiffened slabs are particularly vulnerable to soil movement.

ASSET DATA

The vulnerability of assets to severe soil movement is associated with the design of foundations, and less so with the type of materials used. Foundations can be designed to cope with soil movements and such designs are captured at the archetype level. For foundations vulnerable to soil movement, an empirical probability of damage is assigned to the civil elements.

CONTEXTUAL DATA

Assets are initially checked to test for the types of soils upon which they are located, and thereby the level of exposure to soil movement. Climate Valuation's analysis uses soil clay percentage (at 30 cm depth) data, derived from the International Soil Reference and Information Centre's Soil Grids global digital soil mapping system.

BASELINE HAZARD DATA

For the soil movement due to drought hazard, XDI assumes 'drought' to equate to 'serious rainfall deficiency', defined as the circumstance in which annual total rainfall is in the lowest decile (that is lowest 10%) of records for the local region (Bureau of Meteorology 2012). The probability of droughts occurring at an asset's location is based on interrogation of data from the nearest historical weather stations and rain gauges. The annual precipitation data is extracted, and the rainfall consistent with the lowest 10% of annual precipitation is analysed. This provides a base probability for drought conditions that may lead to soil movement.

CLIMATE CHANGE PROJECTIONS

Soil movement in reactive soil types is correlated with the amount of moisture within the soil. Most changes in soil moisture content are caused by seasonal climate variations and precipitation volumes. Downscaled data for 'drought' is drawn from the GCMs and RCMs. Generally, XDI selects the drier GCMs/RCMs which also have the highest spatial resolution.

XDI CROSS DEPENDENCY INITIATIVE