XDI CROSS DEPENDENCY INITIATIVE

LARGE SITE ANALYSIS REPORT

SAMPLE REPORT

PHYSICAL RISK REPORT

SAMPLE LOCATION

MVAR%

XDI PLATFORM

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

Client:	XDI	Created:	9.11.2021

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. The Climate Risk Engines use Representative Assets which are synthetic representations of a real or hypothetical asset which may include real estate, 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 an online interface 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, 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).

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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.

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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.

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CAVEATS AND LIMITATIONS

Excluded Hazards: The analysis does not include hurricane/cyclone, landslip, erosion, lightning or any other hazards apart from those specifically identified in the settings section of the report.

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.

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INTRODUCTION

Large Site Analysis

Physical Climate Risk for industrial scale sites.

An XDI Large Site Analysis assesses physical climate risk to a facility or property over an industrial or commercial scale site. For large sites, climate hazards will impact differently in different parts of the site when considering, for example, storm water drains or creeks present.

To create this analysis, XDI places a asset archetype at 20m intervals across the site and surrounding areas to create a detailed picture of climate vulnerability. Results show high, medium and low risk parcels for the asset type (archetype) tested. Users can choose to extend this analysis to the surrounding area to test spatial and linear dependencies, or compare results for a high vulnerability asset archetype to account for different asset types at the location.

Your Large Site Product

The Large Site Analysis can include:

1. Onsite Analysis
An Onsite Analysis grids a single archetype across the site that the client is interested in at a 20m interval.

2. Offsite Analysis
An Offsite Analysis grids a single archetype in a 2km radius around the Onsite nodes. This provides Cross Dependency insights.

3. Onsite Comparison
An Onsite Comparison Analysis grids both a 1) Low Vulnerability and, a 2) High Vulnerability archetype across the site that the client has provided at a 20m. The intention is to understand a range of vulnerability across the site.

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.
Moderate 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 MVAR 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.
Maximum Value-At-Risk (MVAR)	In each analysed year, an asset's overall MVAR 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.
Forest Fire	A destructive fire that spreads via trees and forest. This definition does not include grass fires. Flames and heat from burning vegetation can damage buildings and infrastructure. Increased incidence of fire weather due to confluence of days with higher temperatures, high wind speeds and drier conditions.
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.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

REPORT OVERVIEW

This Large Site Analysis (LSA) Report for **SAMPLE** location, analysed **361** nodes (see figure bottom right). The analysis is based on the archetype **Standard Building**.

A **Onsite analysis** has been completed for this Large Site Analysis Report.

METHODS AND ASSUMPTIONS

This LSA Report has been generated using XDI's patented Climate Risk Engines. The Climate Risk Engines analyse an asset's vulnerability to hazards using a representative archetype; **Standard 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 gridded across the site, are shown as 'nodes'. The nodes 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.

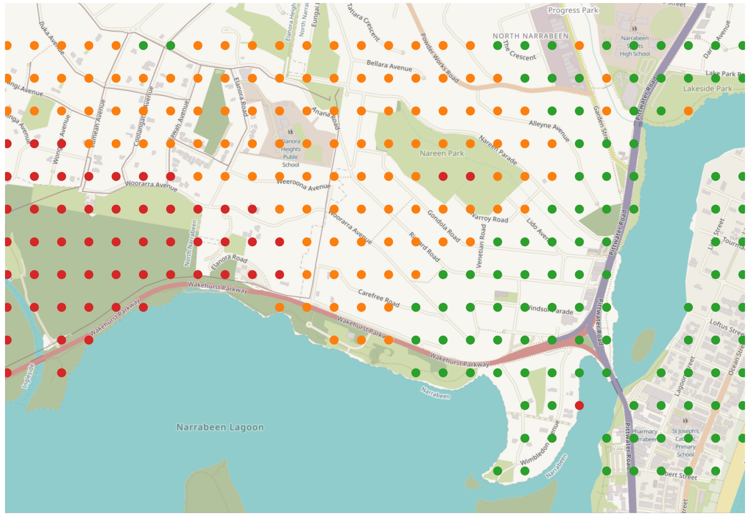
RESULTS OVERVIEW

The overall site average MVAR has **34%** B ranked nodes and **28%** C ranked nodes in 2050. The Average Ranking of the site in 2020 is **B**, in 2050 is **B** and in 2100 is **C**.

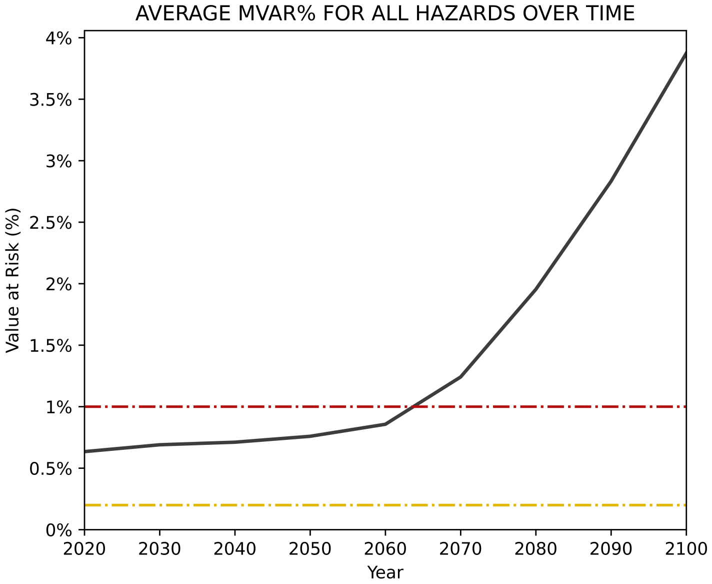
The driving hazards behind the Maximum Value-At-Risk (MVAR%) results are **Forest Fire, Riverine Flooding and Coastal Inundation**. The hazard with the greatest MVAR% in 2020 is **Forest Fire**. The hazard with the greatest change in MVAR% on site is **Coastal Inundation** in 2100. **Coastal Inundation** MVAR% in 2020 is **0.05%** and **3%** in 2100.

The long-term empirical data suggests the probability of extreme wind, soil subsidence and surface water flooding are low or insignificant over the reporting period.

GEOGRAPHICAL DISTRIBUTION OF AVERAGE MVAR IN 2050



AVERAGE MVAR OVERTIME

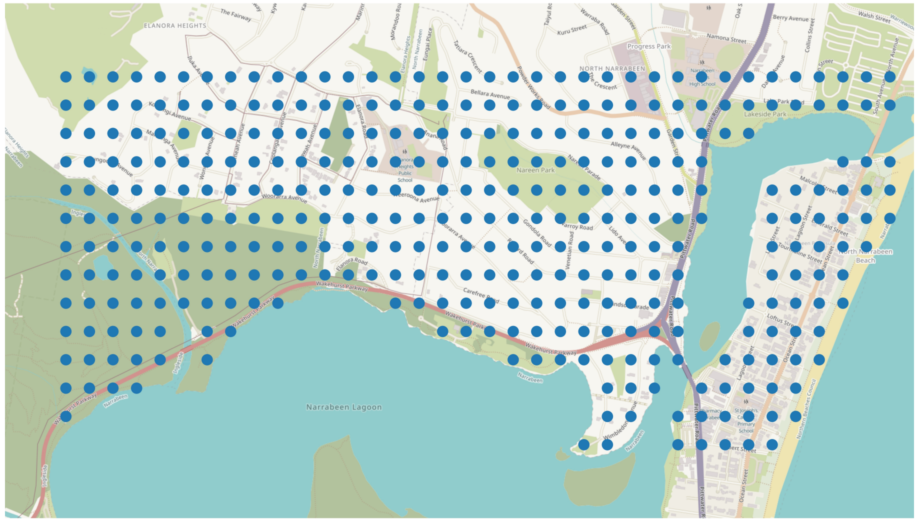


ANALYSIS SETTINGS

INTRODUCTION

This Large Site Report for Sample Corporation establishes a gridded onsite resolution of **20** metres, across the area of analysis.

The physical climate risk analysis uses a Standard Building archetype, to calculate the probability of damage or failure from each of hazards analysed.



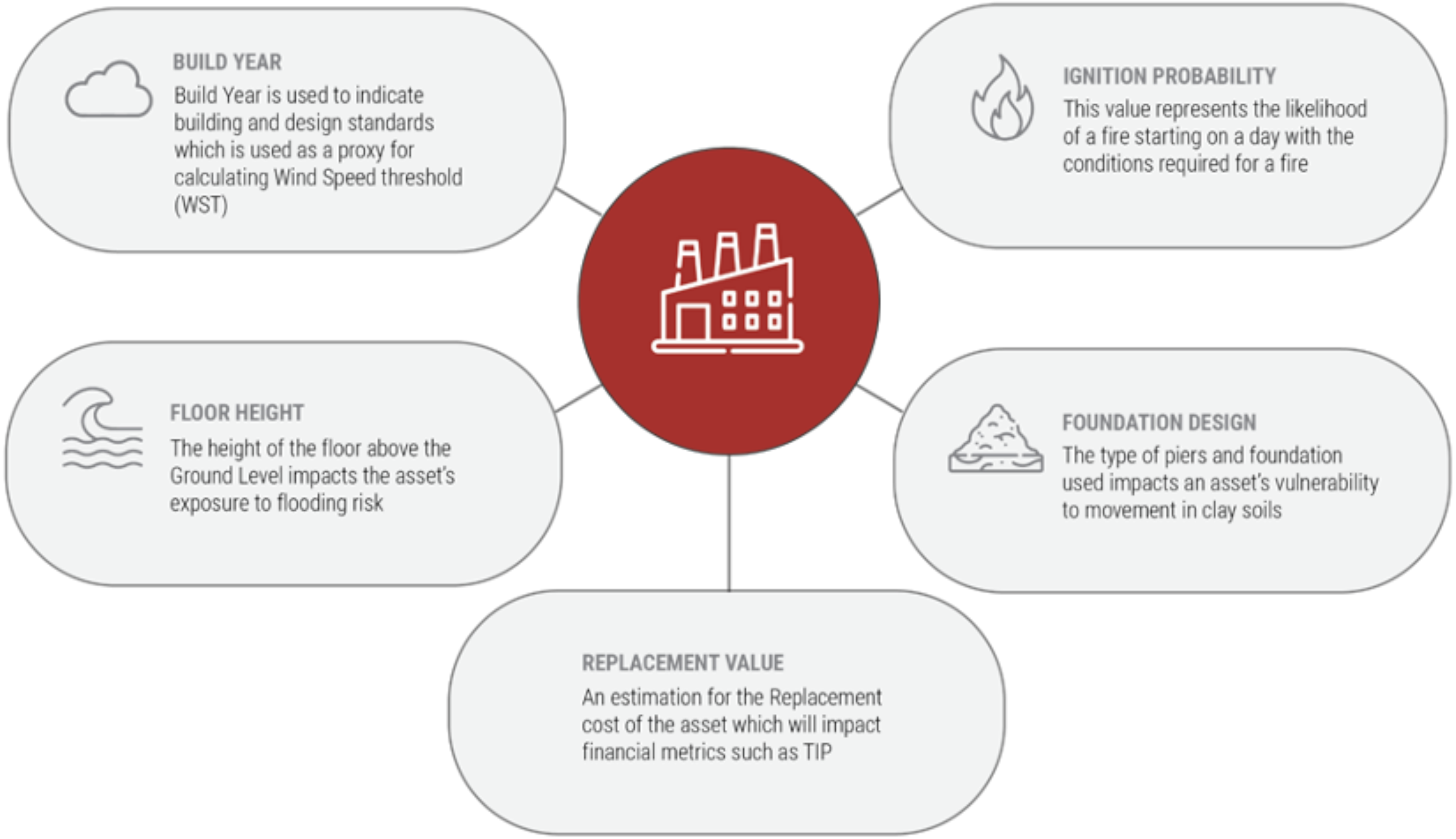
CLIENT	XDI
LOCATION ANALYSED	SAMPLE
ONSITE RESOLUTION + COUNT	20 metres 361
RCP	8.5

HAZARDS ANALYSED

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

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 standard building archetype, which includes design and construction materials with a wind rating for **1 in 500 year return frequency**, floor elevation of **0.5m**, **moderate-rigidity** foundations and **no** specialised forest fire protection. These design and construction settings materially impact the vulnerability of the "Asset" to the hazards to which it is likely to be exposed. The characteristics of this archetype are detailed below.

ARCHETYPE CHARACTERISTIC	ARCHETYPE SETTINGS
Replacement Value	USD$1,000,000
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 Celsius



RESULTS

ONSITE RESULTS

ONSITE RESULTS – MVAR%

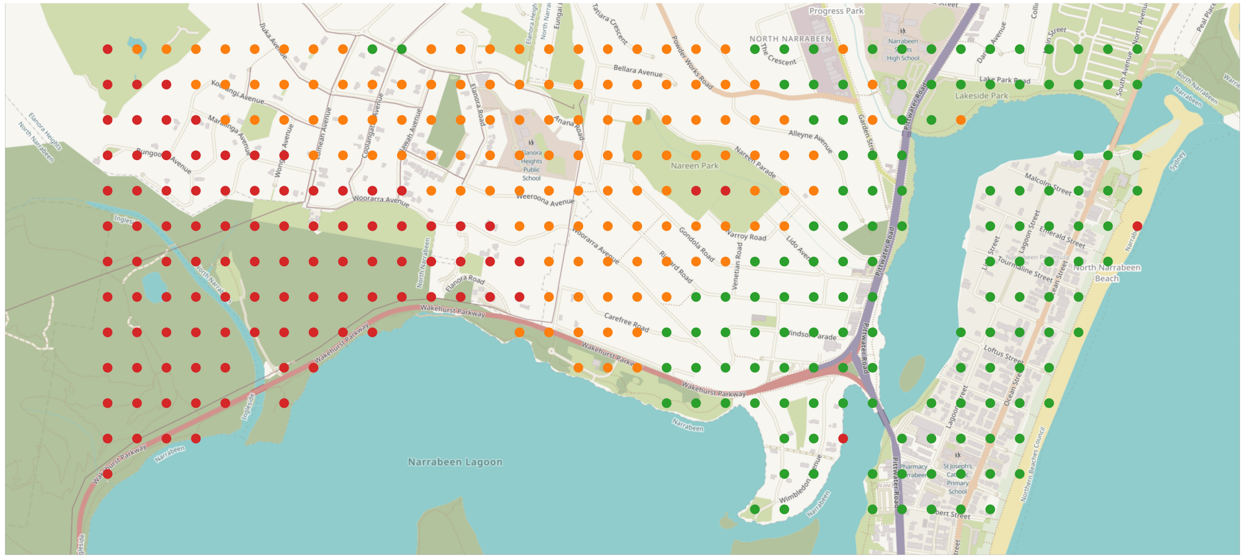
OVERVIEW

This page shows the risk ratings across the site according to the Maximum Value-At-Risk (MVAR). The MVAR% is the maximum VAR% reached throughout the period of analysis (i.e.: from 2020 to 2100). MVAR% can be thought of as the record reached by an athlete, which stays unchanged until the record is broken and pushed higher. MVAR% is an important reference for stress testing, because climate models may not be accurate at assessing the precise time at which climate indicators increase or decrease. Therefore, the MVAR will show the maximum impact a nod e or site may be subject to, regardless of whether hazard indicators subsequently decrease.

RANKING LEGEND

C	HIGH RISK = %MVAR > 1.0%
B	MODERATE RISK = 0.2% < MVAR <1.0%
A	LOW RISK = %MVAR , 0.2%

GEOGRPHICAL DISTRIBUTION OF RANKING IN 2050



2030	2050	2100	
C	C	C	HIGHEST RISK NODE ON SITE
A	A	A	LOWEST RISK NODE ON SITE
B	B	C	AVERAGE RISK NODE ON SITE
35.1%	34.0%	31.0%	PERCENTAGE OF B RANKED NODES
26.2%	28.2%	40.1%	PERCENTAGE OF C RANKED NODES

AVERAGE MVAR% FOR ALL HAZARDS

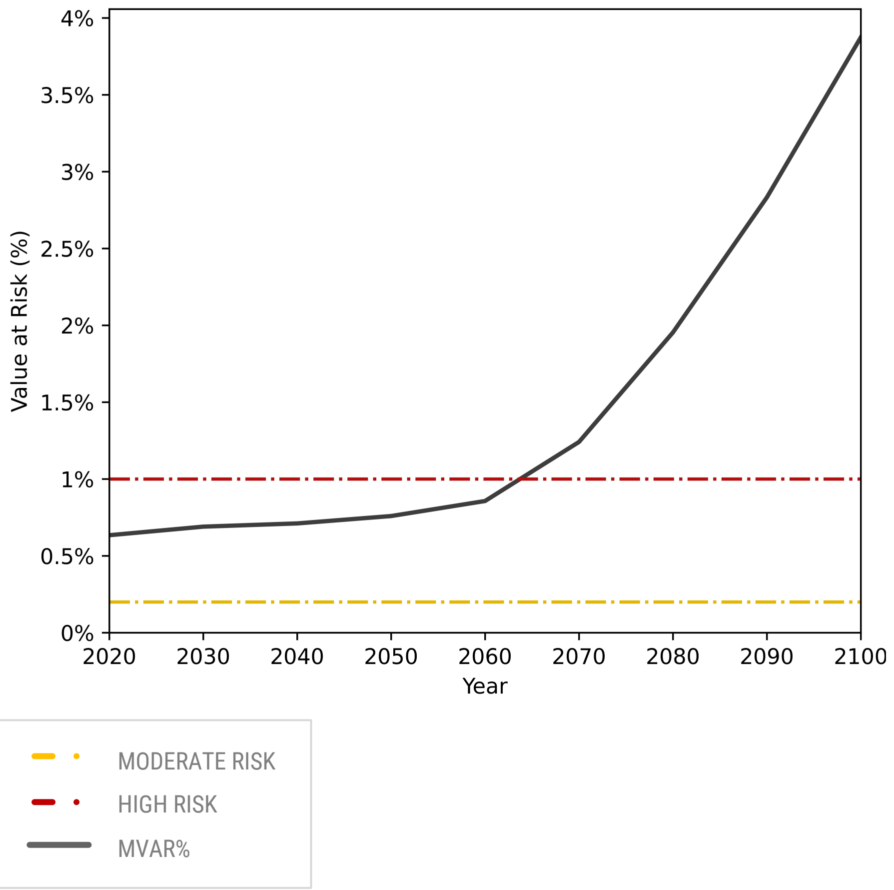
This section shows the average MVAR% across the entire site for all hazards. MVAR% shows the maximum VAR% reached up to a given date or over time.

- **Forest Fire** is the dominant hazard in the early part of the century, reaching moderate MVAR% figures in 2030.
- **Coastal Inundation** becomes the dominant hazard in the later part of the century, reaching high MVAR% in 2080.
- All other hazards remain insignificant across the century for the **SAMPLE location.**

AVERAGE MVAR% HAZARD BREAKDOWN

HAZARD	2020	2030	2040	2050	2060	2070	2080	2090	2100
Coastal Inundation	0.05%	0.08%	0.08%	0.10%	0.17%	0.52%	1.19%	2.02%	3.01%
Extreme Wind	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%
Forest Fire	0.55%	0.57%	0.59%	0.61%	0.64%	0.67%	0.71%	0.76%	0.80%
Riverine Flooding	0.02%	0.02%	0.02%	0.03%	0.03%	0.03%	0.03%	0.04%	0.04%
Soil Subsidence	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
Surface Water Flooding	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%

AVERAGE MVAR% FOR ALL HAZARDS OVER TIME



The black line shows the average MVAR% for the site analysed.
The orange and red lines show the values used by XDI to determine moderate and high risk (as per the legend below).

ONSITE RESULTS – MVAR% COASTAL INUNDATION

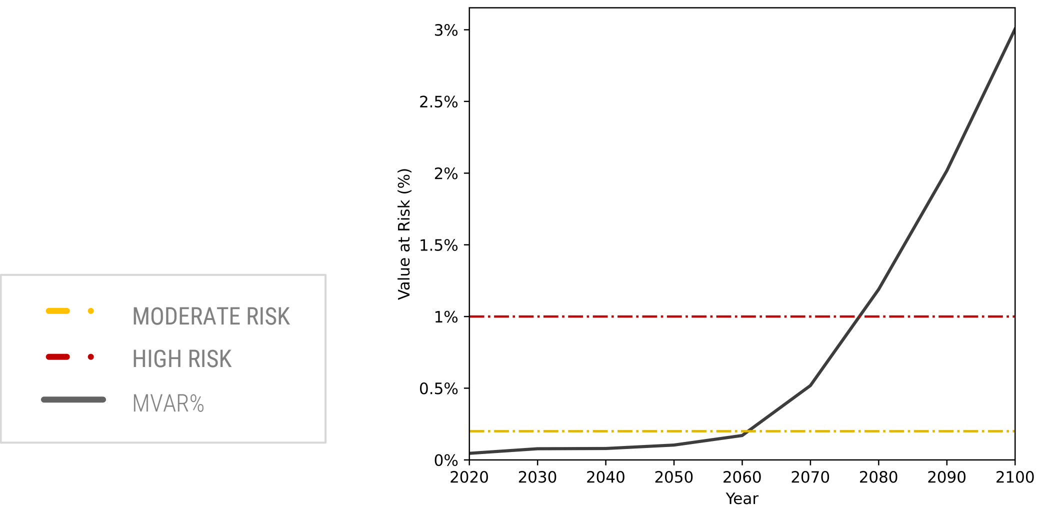
MVAR% COASTAL INUNDATION

The average MVAR% for Coastal Inundation **increases** between 2030 and 2100, particularly in 2100 in the node locations around the water body at the sample site.

The following figures show the distribution of the MVAR% from Coastal Inundation across hypothetical asset locations at **SAMPLE** for the years 2030, 2050 and 2100.
The figures show the colour coded risk ratings for MVAR% related to Coastal Inundation at **SAMPLE** over three time periods, where XDI has placed a node to test its vulnerability.

For more information on archetypes see slide 12.

AVERAGE MVAR% FOR COASTAL INUNDATION OVER TIME



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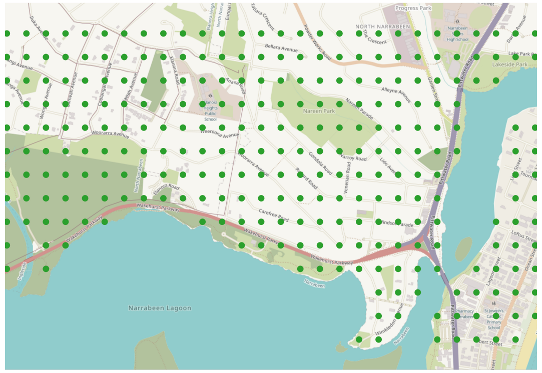
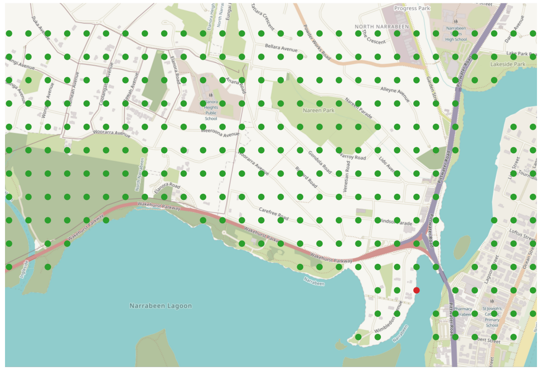
C	HIGH RISK = %MVAR > 1.0%
B	MODERATE RISK = 0.2% < MVAR <1.0%
A	LOW RISK = %MVAR , 0.2%

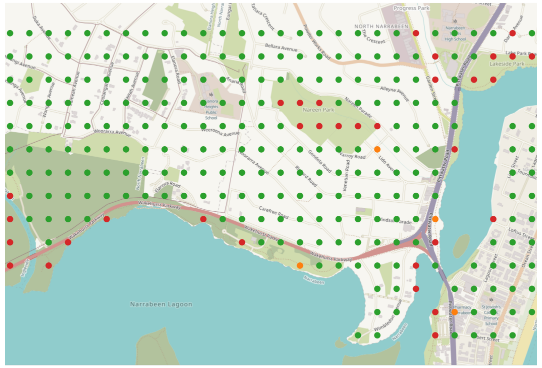
COASTAL INUNDATION 2030



COASTAL INUNDATION 2050



COASTAL INUNDATION 2100



ONSITE RESULTS – MVAR% EXTREME WIND

MVAR% EXTREME WIND

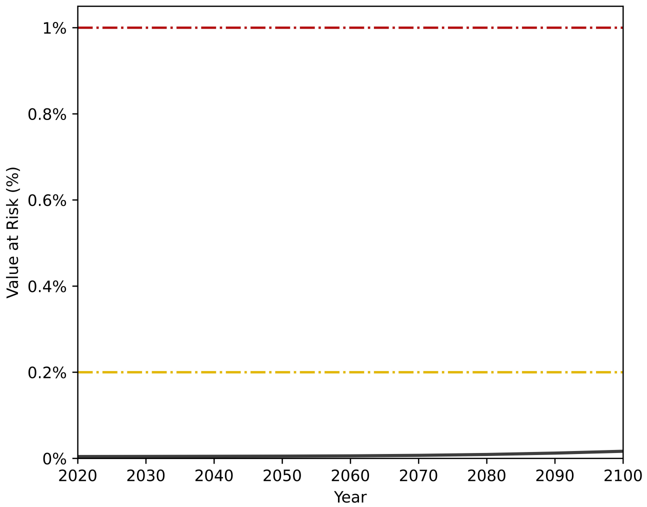
The average MVAR% for Extreme Wind **increases slightly,** though the risk is still low between 2030 and 2100.

The following figures show the distribution of the MVAR% from Extreme Wind across node locations at **SAMPLE** for the years 2030, 2050 and 2100.
The figures show the colour coded risk ratings for MVAR% related to Extreme Wind at **SAMPLE** over three time periods, where XDI has placed a node to test its vulnerability.

For more information on archetypes see slide 12.

AVERAGE MVAR% FOR EXTREME WIND OVER TIME

MODERATE RISK
HIGH RISK
MVAR%



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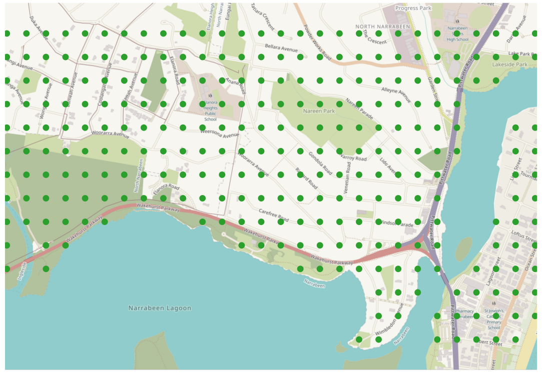
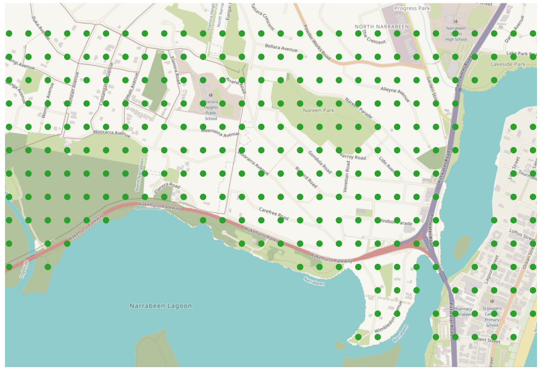
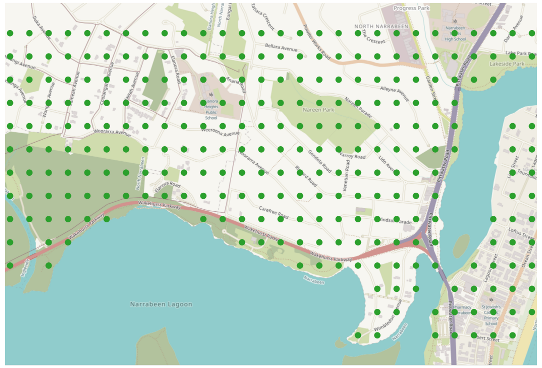
EXTREME WIND 2030



EXTREME WIND 2050



EXTREME WIND 2100



C	HIGH RISK = %MVAR > 1.0%
B	MODERATE RISK = 0.2% < MVAR <1.0%
A	LOW RISK = %MVAR , 0.2%

ONSITE RESULTS – MVAR% FOREST FIRE

MVAR% FOREST FIRE

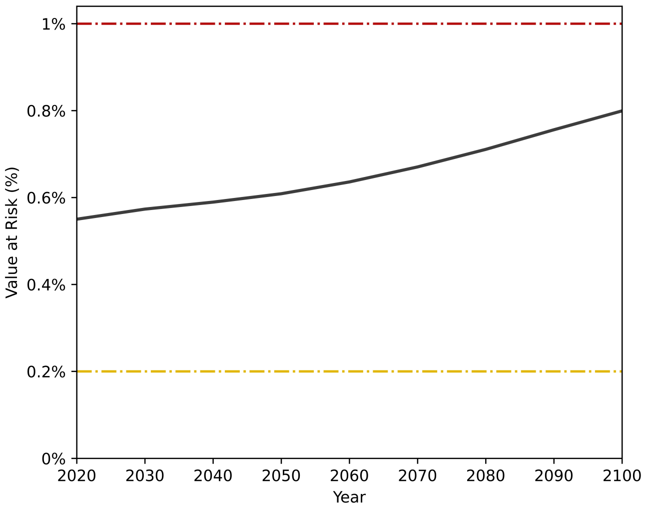
The average MVAR% for Forest Fire **increases** between 2030 and 2100, particularly in the **western side** of the **SAMPLE** site.

The following figures show the distribution of the MVAR% from Forest Fire across node locations at **SAMPLE** for the years 2030, 2050 and 2100.
The figures show the colour coded risk ratings for MVAR% related to Forest Fire at **SAMPLE** over three time periods, where XDI has placed a node to test its vulnerability.

For more information on archetypes see slide 12.

MODERATE RISK
HIGH RISK
MVAR%

AVERAGE MVAR% FOR FOREST FIRE OVER TIME



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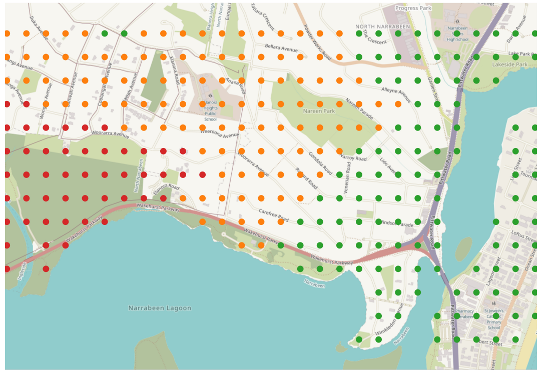
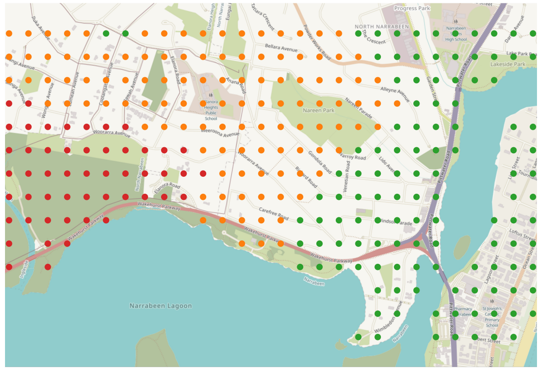
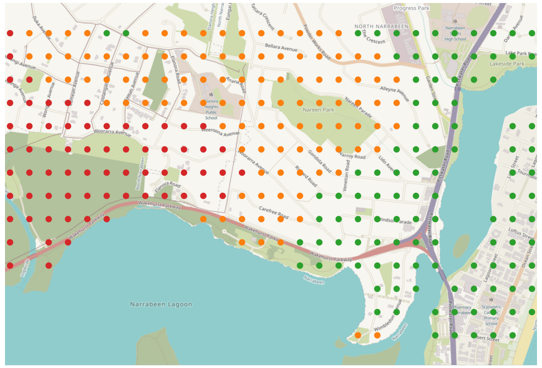
FOREST FIRE 2030



FOREST FIRE 2050



FOREST FIRE 2100



C	HIGH RISK = %MVAR > 1.0%
B	MODERATE RISK = 0.2% < MVAR <1.0%
A	LOW RISK = %MVAR , 0.2%

ONSITE RESULTS – MVAR% RIVERINE FLOODING

MVAR% RIVERINE FLOODING

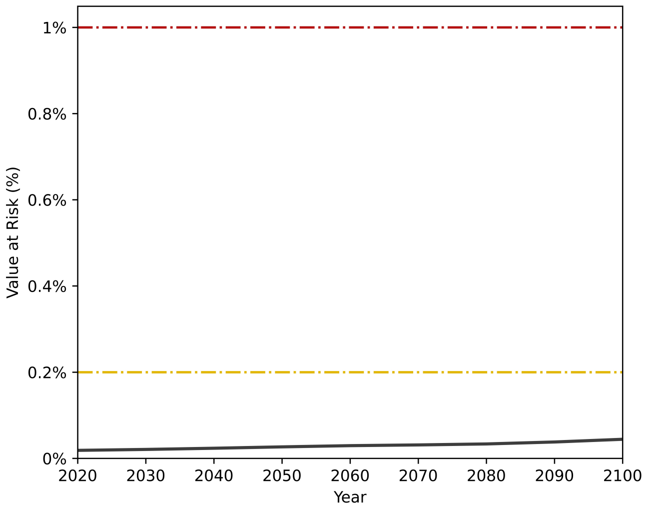
The average MVAR% for Riverine Flooding **increases slightly** between 2030 and 2100, particularly in the **north east region** of the **SAMPLE** site.

The following figures show the distribution of the MVAR% from Riverine Flooding across node locations at **SAMPLE** for the years 2030, 2050 and 2100.
The figures show the colour coded risk ratings for MVAR% related to Riverine Flooding at **SAMPLE** over three time periods, where XDI has placed a node to test its vulnerability.

For more information on archetypes see slide 12.

MODERATE RISK
HIGH RISK
MVAR%

AVERAGE MVAR% FOR RIVERINE FLOODING OVER TIME



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C	HIGH RISK = %MVAR > 1.0%
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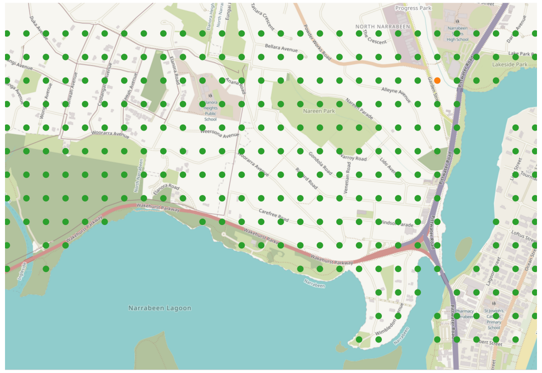
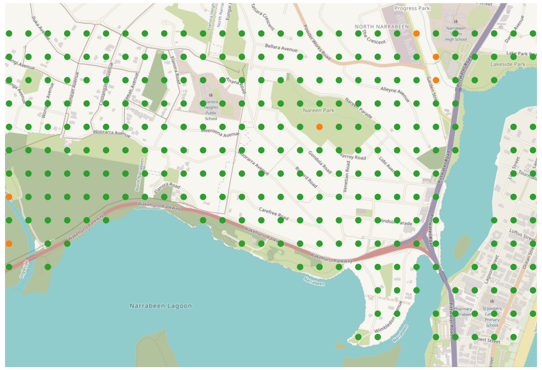
A	LOW RISK = %MVAR , 0.2%

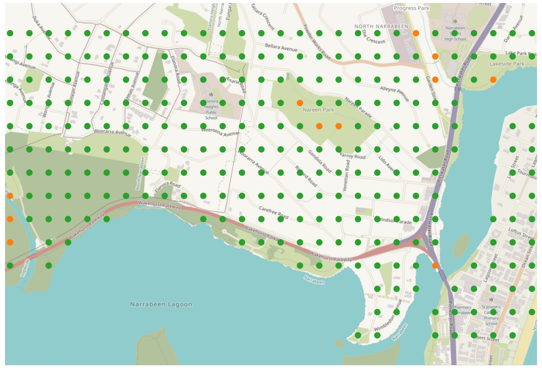
RIVERINE FLOODING 2030



RIVERINE FLOODING 2050



RIVERINE FLOODING 2100



MVAR% SURFACE WATER FLOODING

Surface Water Flooding MVAR% figures are **low** across the site in all years, with a very small increase in the average MVAR%.

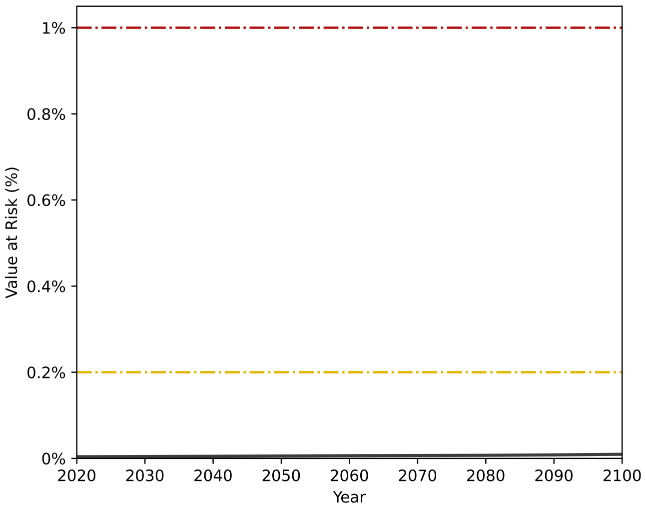
The following figures show the distribution of the MVAR% from Surface Water Flooding across node locations at **SAMPLE** for the years 2030, 2050 and 2100.

The figures show the colour coded risk ratings for MVAR% related to Surface Water Flooding at **SAMPLE** over three time periods, where XDI has placed a node to test its vulnerability.

For more information on archetypes see slide 12.

MODERATE RISK
HIGH RISK
MVAR%

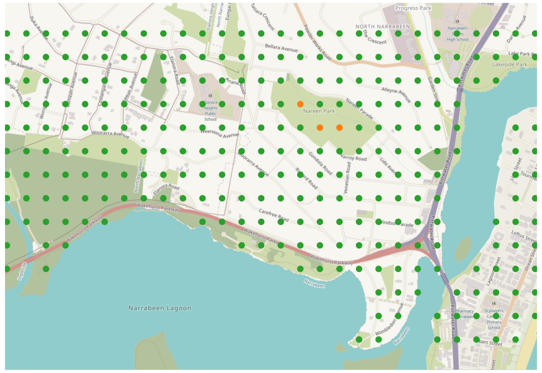
AVERAGE MVAR% FOR SURFACE WATER FLOODING OVER TIME



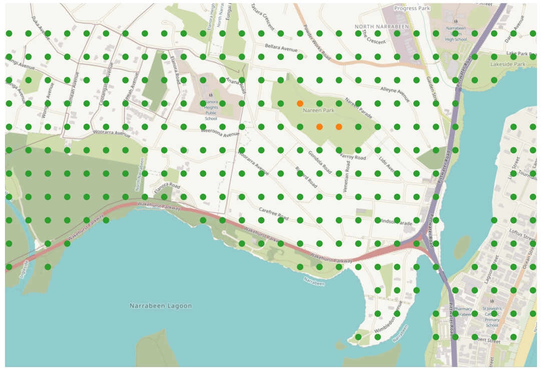
The black line shows the average MVAR% for the site analysed. The orange and red lines show the values used by XDI to determine moderate and high risk (as per the legend below).

C	HIGH RISK = %MVAR > 1.0%
B	MODERATE RISK = 0.2% < MVAR <1.0%
A	LOW RISK = %MVAR , 0.2%

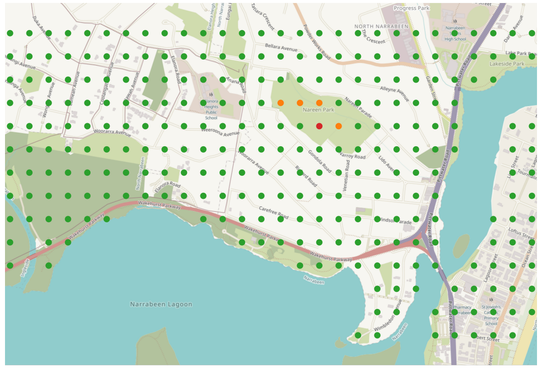
SURFACE WATER FLOODING 2030



SURFACE WATER FLOODING 2050



SURFACE WATER FLOODING 2100



ONSITE RESULTS – MVAR% SOIL SUBSIDENCE

MVAR% SOIL MOVEMENT

Soil Subsidence MVAR% figures are **low** across the site in all years.

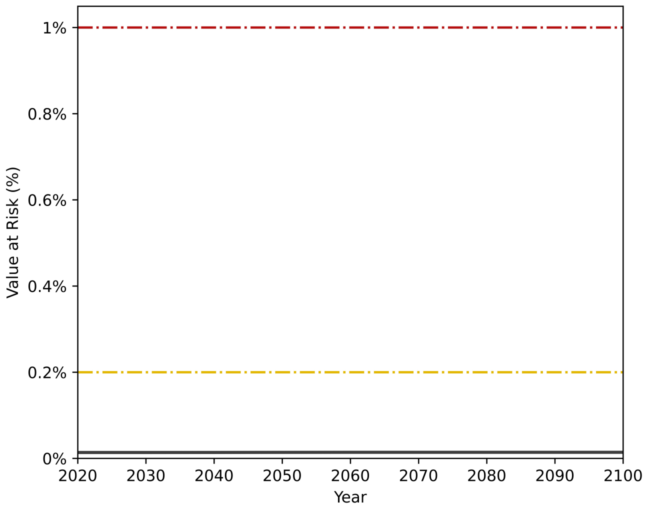
The following figures show the distribution of the MVAR% from Soil Subsidence across node locations at **SAMPLE** for the years 2030, 2050 and 2100.

The figures show the colour coded risk ratings for MVAR% related to Soil Subsidence at **SAMPLE** over three time periods, where XDI has placed a node to test its vulnerability.

For more information on archetypes see slide 12.

MODERATE RISK
HIGH RISK
MVAR%

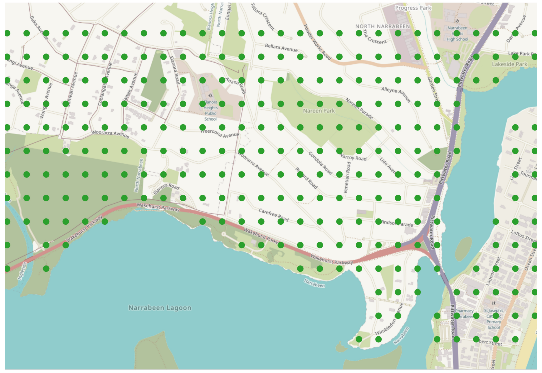
AVERAGE MVAR% FOR SOIL SUBSIDENCE OVER TIME



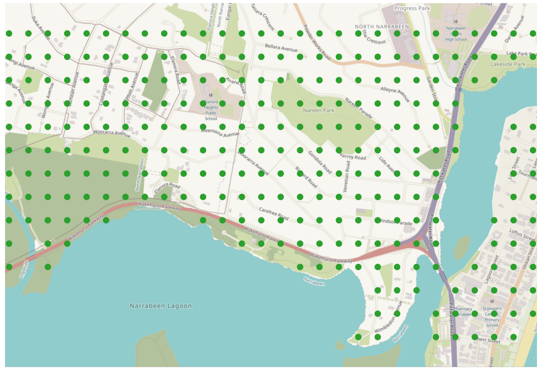
The black line shows the average MVAR% for the site analysed. The orange and red lines show the values used by XDI to determine moderate and high risk (as per the legend below).

C	HIGH RISK = %MVAR > 1.0%
B	MODERATE RISK = 0.2% < MVAR <1.0%
A	LOW RISK = %MVAR , 0.2%

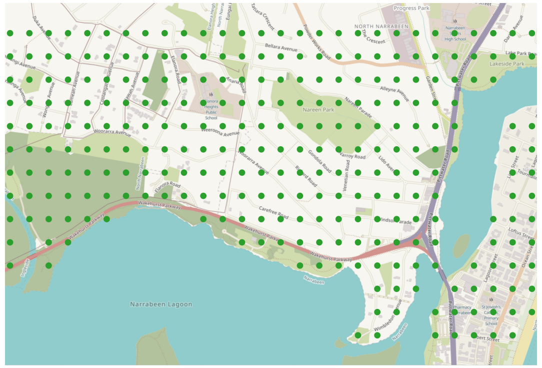
SOIL SUBSIDENCE 2030



SOIL SUBSIDENCE 2050



SOIL SUBSIDENCE 2100



FAILURE PROBABILITY EXTREME HEAT

HFP increases throughout the century, reaching **High** levels by 2100.

The following figures show the distribution of Heat Failure Probability (HFP) across the **SAMPLE** site for the years 2030, 2050 and 2100.

Heat failure probability results are the same across all nodes onsite and offsite, as these results only depend on:

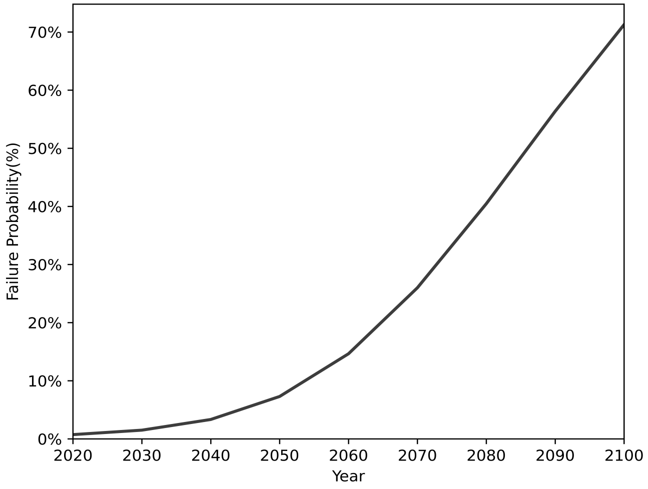
- 50ºC Heat threshold values (as per the XDI archetype default threshold)
- Projected extreme heat event frequencies, which are the same for all assets within the same geographical area

MODERATE RISK

HIGH RISK

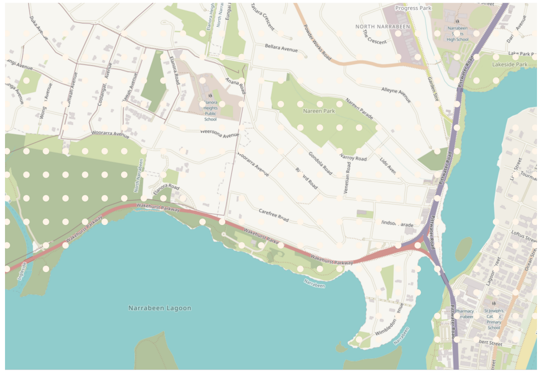
FP%

AVERAGE FP% FOR EXTREME HEAT OVER TIME



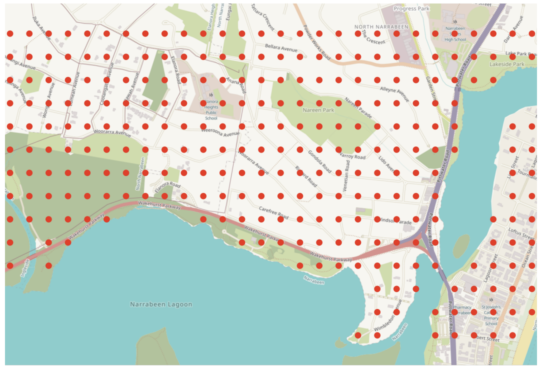
0% FAILURE PROBABILITY (%) 100%

EXTREME HEAT 2030



EXTREME HEAT 2050

EXTREME HEAT 2100



APPENDIX

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 MODELING

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, with a further assessment of how this changes the 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 governments 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).

Risk analysis of any type has inherent uncertainties. These are compounded in climate related risk analysis, as risk calculations combine information from many different sources, 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 presents 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, it is 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.

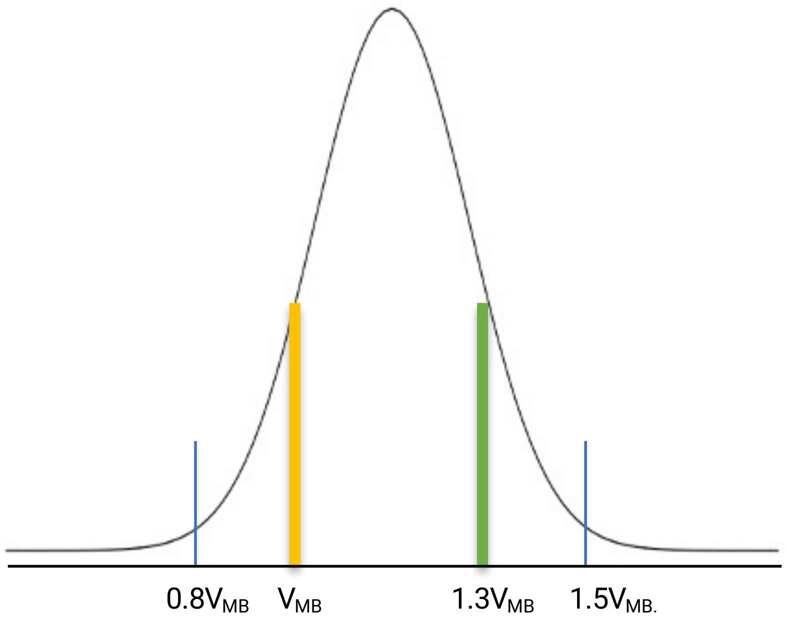
HOW IS THIS RESULT CALCULATED?

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.