BANK OF ENGLAND
PRUDENTIAL REGULATION
AUTHORITY

General Insurance Stress Test 2019

Scenario Specification, Guidelines and Instructions

To be finalised in June 2019

DRAFT FOR FEEDBACK FROM PARTICIPATING FIRMS

April 2019

Note: The Bank may decide to delay or not to run the exercise depending on market conditions.

Prudential Regulation Authority | 20 Moorgate | London EC2R 6DA

CONTENTS

INTRODUCTION

This document provides instructions for completing the general insurance stress tests, as well as details of additional data designed to assist the PRA in monitoring sector risks. The stress tests and the additional data collection are collectively referred to as the PRA's General Insurance Stress Test (GIST 2019).

The previous exercise was conducted in 2017. This year there are two notable additions. First we will be running this exercise concurrently with a life stress test exercise. Second, for the economic and natural catastrophe scenarios we will be coordinating this exercise with the Bermuda Monetary Authority (the BMA). Further details are provided in subsequent sections.

Firms are requested to complete the Excel workbook 'GIST 2019 Template.xls' (GIST Template) to record the numerical results for each stress test and provide the additional qualitative information requested.

OBJECTIVES

The PRA's objectives in conducting this exercise are to inform our view of sector risks and assist in the supervision of individual firms. For clarity, this is not a pass/fail exercise and is not designed to set capital buffers.

OBJECTIVES: INSURANCE STRESS TESTING		
Sectoral	**Sector resilience**	Assess losses gross and net of reinsurance across the UK insurance industry to severe but conceivable scenarios to inform PRA's view of sector resilience.
	Systemic risks/ Sectoral behaviours	Assist in understanding the extent to which individual firms make business decisions that are appropriate for the firm but, taken across the entire sector, may not result in the best outcomes (eg all switching into one asset class).
	Counterparty dependencies	Identify the extent to which the sector relies on a concentration of reinsurers and/or jurisdictions following an extreme scenario.
	Exploratory risks/ horizon scanning	Assist in exploring and raising industry debate around emerging risks to understand how firms are responding eg in relation to climate change, liability or cyber risks.
Firm supervisory	**Effectiveness of risk management**	Provide an alternative view of balance sheet volatility to specified scenarios that inform our view of how firms are managing their exposures and whether this is in line with their risk appetite.
	View on capital	The PRA stress testing exercise is not used for setting capital. It provides a complementary view on a firm's capital assessment with potential for identifying assumptions or approaches that are optimistic. *Note: The severity of some scenarios may be beyond a firm's one year change in Own Funds at the 1 in 200 level*.
	Assessment of modelling approaches	Assist in understanding how different firms address technical challenges in their assessment of extreme loss events eg impacts of tsunami following an earthquake.

SCOPE OF EXERCISE

Only Category 1 and 2 general insurers, the largest Lloyd's syndicates and the Society of Lloyd's are being requested to participate in the 2019 stress test.

Where firms have not received a request to participate, they do not need to submit a response. Should firms wish to be included in the exercise, they should contact their supervisor at the PRA, copying in IST2019@bankofengland.co.uk.

STRUCTURE OF THE GENERAL INSURANCE STRESS TEST

This exercise consists of two parts:

1. Sections A and B contain the core stress tests: a downturn in the economic environment and a set of six severe but conceivable scenarios: four natural catastrophe scenarios, a separate claims inflation scenario as well as a new cyber underwriting loss scenario.
2. Section C is not a stress test; instead it is designed to capture information relating to how different firms are managing difficult to assess risks. It comprises a new climate change exploratory exercise and repeats a 2017 data request for exposures that will allow the PRA to better understand the impact of potential losses by various sectors of the economy.

Section A: Deterioration in the economic environment

General insurers are requested to assess their Balance Sheet against the following scenarios:

Scenario 1: A parallel downward shift in risk free interest rates of 100 bps; a widening in corporate bond spreads dependent on their current credit rating (eg 150 bps for AAA rated assets); a simultaneous mass downgrade of credit assets; and a fall in other asset values (including equities down 30%, commercial property down 40% and residential property down 30%).

At this stage in the exercise, the PRA asks firms to provide feedback regarding the pros and cons of the two options outlined for the credit downgrade event included in Scenario 1. These options are outlined in the Event Definition on page 11. Firms should plan for either of the two options being selected.

Section B: Liability shock coupled with deterioration in the economic environment

The following scenarios are assumed to occur against the backdrop of a deteriorating economic scenario as defined under Scenario 1 (eg Scenario 2 should consider the impact of three US hurricanes and a parallel shift to risk free rates of 100 bps):

Scenario 2: Scenario 1 and a cluster of three US hurricanes making landfall in continental US ($181 billion of loss in aggregate). This scenario is more severe than our 2017 US hurricane scenario, which was an industry loss of around $125 billion.

Scenario 3: Scenario 1 and a severe earthquake of Magnitude ~8.0 along the San Andreas fault, followed by an aftershock of Magnitude ~7.0, leading to significant property losses and disruption to supply chains.

Scenario 4: Scenario 1 and an extremely severe earthquake of Magnitude ~ 8.0 with its epicentre close to Tokyo followed by a tsunami, generating some $60 billion of total industry insured loss.

Scenario 5: Scenario 1 and a large UK windstorm and a large UK flood leading to some £22 billion of losses in aggregate to the UK insurance sector.

Scenario 6: Scenario 1 and a deterioration in Technical Provisions due to claims inflation (over and above consumer price inflation) being 2.0% p.a. higher than allowed for in the reserving basis.

Scenario 7: A cyber underwriting loss scenario based on a gang of hackers exploiting a systemic weak point in operating systems or chip architecture to carry out a ransomware attack leading to a mass outage of a few days across multiple sectors of the economy.

Section C: Climate change, liability exposure management

This section is not a stress test. Instead it is designed to capture information to help understand how different firms are managing difficult-to-assess risks – in this case climate change related risks and liability exposure management. We expect that market feedback will enhance developments in this area, increase Board awareness, and will supplement supervisor's knowledge of the firms' overall governance and culture. These findings will also support the climate related activity of the Bank's Climate Hub in assisting the Network for Greening the Financial System (NGFS).

Climate Change: firms are requested to consider the impact of three hypothetical greenhouse emission scenarios on selected metrics of their business models and asset valuations. These scenarios are expressed by their climatic and financial impacts. The set of assumptions underlying each scenario is developed for illustrative purposes only, to ensure that firms complete the return on the same basis and should therefore not be taken as a precedent for future domestic or international exercises. **The assumptions in Section C do not represent a PRA forecast neither do they represent scenarios that have been built bottom-up by the PRA based on a view of future carbon price.**

We also ask firms to provide qualitative and quantitative information on any climate scenarios that the firms have already developed.

Liability exposure management: this section is a repeat of the industry level commercial exposure data requested in our 2017 exercise. However, we have reduced the level of granularity of the data request (ie fewer industry codes) and expanded the scope to include all worldwide exposures, not just the UK.

Section C is on a best endeavours basis.

***Note: these stress tests, including all parameters and calibrations, have been designed for the purpose of this stress testing exercise only. Firms should not interpret them as indicators of a PRA position on risk calibrations or interactions*.**

COORDINATION WITH THE BERMUDA MONETARY AUTHORITY

We will be conducting a joint exercise with the Bermuda Monetary Authority (the BMA) for the natural catastrophe and economic scenarios.

Many London market insurers are exposed to similar risks to those based in Bermuda; furthermore (as illustrated in our previous stress test exercise)[1] UK based insurers cede a significant proportion of risks to Bermuda based reinsurers. Consequently, we believe coordination will strengthen both the PRA's and the BMA's understanding of the assessment and interconnectedness of these risks.

Coordination Objectives

COORDINATION OBJECTIVES	
Groups resilience	Test the resilience of insurance firms operating across UK and Bermuda jurisdictions including at least the UK and Bermuda.
Reassurance	Provide reassurance to industry, and the wider market, of the resilience of our regulated entities.
Interconnectedness	Enhance our understanding of the interconnectedness between our different jurisdictions, especially from the reinsurance premium and claims flows, in the event of our stress scenarios.
Supervision	Inform and prioritise our supervision of some of the largest firms we supervise.

Regulatory exchange of information

Formal exchange of information between the BMA and the PRA will be in line with our Memorandum of Understanding (MOU).

Where participating firms have operations in both the UK and Bermuda, information will be shared in line with that provided under the existing supervisory college arrangements.

Where firms do not have any operations in Bermuda, we will only share aggregate information, ensuring that individual firms are not identifiable.

In support of the objectives outlined above we expect to share aggregated information such as gross and reinsurance recoverables following each stress, the aggregated impact of investment losses from the economic scenario and additional learnings or observations on firm feedback to the extent that these were common issues.

Use

This stress test exercise is not being used to set additional capital on firms by either the PRA or the BMA. Instead, the results from the exercise will inform and advance the supervisory work of the PRA and the BMA. Were we to identify any prudential issues of concern for a firm, this would be followed up as part of our business as usual supervision. Where the issue could be common across both jurisdictions, the PRA and the BMA could carry out joint investigations, subject to the agreement with the firm. To the extent the exercise contributes to more focussed regulatory investigations, this would ultimately be less burdensome on our regulated firms.

1 December 2017 available at https://www.bankofengland.co.uk/prudential-regulation/letter/2017/general-insurance-stress-test-2017-feedback.

Market Communication

The PRA and the BMA will also be coordinating the publications of our key findings from the exercise. Only aggregate results and findings will be published drawing attention to sectoral findings or learnings of interest at a market level. No firm specific information will be published. The PRA and the BMA are likely to communicate key findings in the form of a Dear CEO letter during the first quarter of 2020.

ACCOUNTING AND REPORTING

Accounting Basis

Firms are requested to provide a separate submission, on a Solvency II basis, for each material UK solo or group legal entity, and if applicable, for each of their syndicates at Lloyd's. Where firms are uncertain as to the scope of their submission, they should consult with and obtain the agreement of their PRA supervisor.

Opening Balance Sheet

Firms are required to provide their Balance Sheet as at year-end 2018 on the 2018 Balance Sheet worksheet. Basic Own Funds are derived from net assets, and eligible own funds should be disclosed on this worksheet. The worksheet provides the necessary Solvency II QRT references.

Where firms expect or have carried out significant change of their portfolio (for example through a transfer of business) this should be set out in the expected year-end 2019 projection – see subsequent section.

Solvency Capital Requirement

On the capital worksheet please disclose details of the SCR as at year-end 2018, and as at year-end 2019 according to the current estimate. Where the estimate differs from that provided in the most recent Regular Supervisory Report, please explain the difference in the Free Form Comments tab.

Projecting the Balance Sheet – Base Case and following a Stress

Firms are required to project their Own Funds and their estimated SCR as at 31/12/2019. These projections should be in line with the firm's business plan and is referred to as the 'base case'. Where material, firms should provide an estimate of the change in Own Funds and the projected SCR which is attributable to any transfers of business taking place during 2019.

Similarly for each stress, firms are also required to quantify the impact on Own Funds and their estimated SCR to 31/12/2019. As in the previous stress test, firms are required to provide a breakdown of the impact on the Balance Sheet between the direct stress, market adjustments and any management actions. For all projected balance sheets and SCRs, firms should calculate any tax effects using their Solvency II basis, and use the free form comments tab to explain any material differences which would result if loss relief assumptions for IFRS purposes were used.

Where there is likely to be a material change to the SCR post stress, firms are asked to provide an estimate of the SCR if different to the Base Case. Firms should make reasonable assumptions eg scaling is acceptable where it would not lead to materially different results to a more detailed calculation. Furthermore, changes in risk margin can be approximated.

The "Projected Movement in Net Assets" included in the 2019 Projection worksheet and in Scenarios 1 to 6 is intended to capture all items of income and expenditure, capital transactions and adjustments which affect basic own funds under headings based on those traditionally used for financial accounting. Calculation of the SCR according to Article 101 of the Directive should result in the projected movement in Basic Own Funds under the SCR scenario being equal to the 2018 SCR disclosed on the Capital worksheet. Please explain any difference on the Free Form Comments tab.

Management actions

Firms should disclose what management actions they anticipate taking in the various scenarios and how this would impact their Own Funds and their projected SCR.

For example, these could include changes to their reinsurance programme and likely cost allowing for reinsurance rate increases where relevant, expected changes to their underwriting strategy, changes to premium rates they would charge and changes to their asset allocation. While some of these management actions will impact the year-end 2019 Balance Sheet and Own Funds, the full impact may not be captured. Firms are asked to provide additional qualitative information in the Free Form Boxes provided.

Where firms anticipate re-capitalisation plans, firms should provide this information, but should not assume new capital will be in place before year-end 2019 unless existing contractual arrangements allow for this. Details of any such contractual arrangements should be included in the submission.

Materiality

Firms should complete all scenarios unless they can demonstrate that, given their specific risk coverage, the impact is immaterial. In this case immateriality is defined as less than 5% of total gross written premium.

Firms should include a details of exposure to each reinsurer where expected recoveries are more than 2% of the total recoverable.

PROCESS AND FEEDBACK

Submission template

For each stress scenario, firms are required to submit a number of outputs that are standard across scenarios within the Excel template provided – the GIST Template.

In certain scenarios we ask for additional information that will allow the PRA to assess the calculation and impact of each stress in greater detail.

Deadline for submission

Submission of the completed Excel template is required by **17:00 on Monday 30 September 2019**.

The Excel workbook should be saved ensuring that **Firm Name** and **FRN number** in the file name and the subject of the email. Submissions should be sent to **IST2019@bankofengland.co.uk.**

Governance requirements

On submission, the Board of directors is required to confirm they are satisfied with the submission and that the information provides a reasonable estimate of own funds and their SCR after each stress scenario. The results do not need to be audited.

Presentation of the Stress Test results to the PRA

The PRA encourages firms to present their stress test results shortly after the formal submission date to help our understanding of the impact of the stresses and any issues that arose in completing this exercise. This need not contain any additional information, but reflects the value of a two-way dialogue to help understand the thought process and the underlying issues in greater depth. Following our previous stress test exercise some firms shared their Board presentations – these were very constructive in supporting our understanding of their stress test results.

Resubmissions

Individual firm supervisors will be using the stress test submission as part of their ongoing supervisory reviews and the stress test results will inform the firm's supervisory risk score.

Firms should ensure that the quantitative and qualitative information provided is clear and sufficient. Where this is not the case, the PRA will ask for a resubmission to enable it to make an adequate assessment. Firms will need to provide a resubmission within 2 weeks of request.

PUBLIC DISCLOSURE

The PRA will not publish any firm specific information as part of this exercise. Where there is a need to take firm specific supervisory action, the PRA will do so as part of our normal supervisory engagement with the firm.

The PRA intends to publish a Dear CEO letter containing our findings at an aggregate level during Q1 2020, drawing attention to sectoral findings or learnings of interest at a market level.

QUERIES

All queries should be submitted to **IST2019@bankofengland.co.uk**, copying in the firm's PRA supervisor. Please ensure that the Firm Name and FRN number is included in the subject of the email.

ENCLOSURES

a) **GIST 2019 Template.xls** to record results

Section A

1. INSURANCE ASSET SHOCK (IAS)

This asset shock has been designed to stress both life insurance and general insurance companies, with a fall in interest rates and risk free yield curves, a widening of corporate bond spreads, and falls in equity markets and real estate. This stress should be applied as an instantaneous stress on the starting balance sheet as at the beginning of the year 2019.

1.1 EVENT DEFINITION

This sections sets out the movements in key macroeconomic variables or market indices.

<table>
<tr><td><u>Interest rates</u></td><td>All interest rate spot curves experience a 100bps absolute fall at all tenors (including the Ultimate Forward Rate).

This stress is likely to lead to negative rates at shorter durations. Where this is the case, and firms have the capability to model negative rates they should do so. For firms without the capability to model negative rates, these should be floored at zero, but this should be made clear in the response and firms should attempt to quantify on a best efforts basis the impact were negative rates modelled explicitly.

The interest rate stresses should also apply to all assets whose valuation is interest rate sensitive in addition to the stresses outlined below (eg derivatives, corporate bonds, illiquid assets).</td></tr>
<tr><td><u>Gilt-swap spread</u></td><td>Firms should assume that there is no stress to gilt-swap spreads.</td></tr>
<tr><td><u>Sovereign and Central Bank Bonds</u></td><td>Firms should assume that there is no stress to sovereign assets.</td></tr>
<tr><td><u>Credit Downgrades</u></td><td>For Central Government and Central Bank bonds, firms should assume that the Credit Quality Step (CQS) remains unchanged post stress.

Option 1: For all other assets, firms should assume that there is a 2 notch downgrade.

Option 2: For all other assets, firms should assume that 75% of each asset experiences a 1 CQS downgrade and the remaining 25% of each asset experiences no movement in credit rating. For avoidance of doubt, all assets should be notionally split into 75%/25% parts.</td></tr>
<tr><td><u>Credit Spreads</u></td><td>For fixed income assets, firms should apply the following stresses to credit spreads. For avoidance of doubt, the credit rating and Credit Quality Step (CQS) referred to in the table below is the pre-stress rating/CQS.

<table>
<tr><th>Credit Rating (non-MA fund)</th><th>Credit Quality Step (MA fund)</th><th>Credit Spread increase</th></tr>
<tr><td>AAA</td><td>0</td><td>150bps</td></tr>
<tr><td>AA</td><td>1</td><td>170bps</td></tr>
<tr><td>A</td><td>2</td><td>200bps</td></tr>
<tr><td>BBB</td><td>3</td><td>300bps</td></tr>
<tr><td>BB and lower and unrated</td><td>4+</td><td>400bps</td></tr>
</table>

The credit spread increase will apply to all types of bonds that do not qualify as</td></tr>
</table>

	'sovereign' and does not vary by duration or sector.
Equities	All equities experience a **30% decrease in value**. This applies to public and private equity, hedge funds and CIS investments.
Property	Firms should assume a **40% fall in commercial property** and **30% fall in residential property**.
Cash and Money Market Instruments	Firms should assume **no stress** to the value of cash or money market instruments with duration less than one year. For instruments with duration more than one year these should be treated as described under '*All other assets*' below. Firms should not assume any management actions post-stress including entering into new money market transactions.
Derivatives	Option values should move in line with an increase in implied volatility at all tenors of **700bps**. This includes, but is not limited to, equity and swaption implied volatility. Swap values should move in line with a decrease in the floating yield curve of 100bps at all tenors (ie the interest rate stress). Where relevant, firms should assume that reference swap assets also fall in value in line with the relevant stress outlined in the asset shock scenario. *Longevity-linked instrument values should move as if floating longevity expectations matched the extent to which longevity is stressed (this is applicable only in scenarios 3 and 4).*
Inflation	Firms should assume that there is **no stress** to inflation rates.
Foreign exchange	Firms should assume that there is **no stress** to foreign exchange rates.
All other assets	Any investment asset not specifically referenced should be stressed as if it were a corporate bond (ie apply the **credit spread** and **interest rate** stresses above) where it is sensible to do so (ie the assets have a contractual cash flow profile and are either mapped to a CQS or have a credit rating). Where this is not possible, all other assets should experience a **30% value fall** as for equities. This is to ensure that all assets held by firms (other than cash) experience some form of stress. This should include investments in subsidiaries where the firm does not intend to 'look through'.
Fundamental Spread	Firms should use the relevant EIOPA Fundamental Spread (FS) based on the Financial/Non-Financial sector and revised Credit Quality Step of the asset post-stress. Firms should assume there is no change to the EIOPA FS tables at the stress date. Firms should assume the Long Term Average Spread (LTAS) floor component of FS is unchanged following the stress event.

1.2 ASSUMPTIONS

For the valuation of pension scheme liabilities, firms should assume that the discount rate would change by the level of any change in the risk-free rate plus 50% of the change in spread on AA rated corporate bonds. Under the proposed stress the risk-free rate decreases by 100bps and 50% of the spread on AA rated corporate bonds is an increase of 85bps. Therefore, both elements combined result in a **15bps fall** at all tenors to the discount rate.

Where firms have an approved Internal Model, they should use the same methodology used in the Internal Model for the pension scheme.

1.3 REPORTING

Firms should assess the impact on both the asset and liability side of their projected Solvency II Balance Sheet as at year-end 2019.

Firms should disclose any changes they plan to make to their asset allocation.

Firms should separate out the impact on their Defined Benefit Pension Schemes.

Section B1

2. US HURRICANE SET OF EVENTS

The US set of hurricanes scenario is a counterfactual to the 2017 Harvey, Irma and Maria (HIM) cluster of losses, with an Irma-like hurricane making two landfalls in Florida, a Harvey-like hurricane hitting Houston, and a third hurricane (unrelated to Maria) making landfall on the East coast of the US. The PRA is specifically interested in how firms model the precipitation induced flooding associated with slow moving hurricanes while recognising that the insured loss would be less due to significant portion of these losses not being insured or being retained in national pools. **This stress is superimposed on the insurance asset shock scenario.**

2.1 EVENT DEFINITION

This stress scenario is for a Harvey, Irma and Maria (HIM) type of scenario where a cluster of three major US hurricanes occur in the same year. At today's values, the three hurricanes are specified to cause a total industry loss in excess of US$180 billion, with a range of vendor model event IDs supplied.

Firms are to assume that the events are sufficiently separated in time to be considered three separate events for the purposes of reinsurance recoveries.

Firms should assume that the asset shock specified in Scenario 1 occurs.

2.2 ASSUMPTIONS

Firms are expected to form their own views in estimating the impact of the losses. In estimating the gross loss, firms should allow for storm surge, precipitation-induced flooding, policy leakage (across different Lines of Business) and demand surge or post loss amplification.

Where firms are using external vendor models, firms should adjust the model output reflecting any model limitations including non-modelled claims, past model performance in recent events and the firm's own views.

Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should consider what management actions they may take following the series of events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2019, with adequate descriptions in the Free Form Comments box.

2.2.1 First hurricane: Irma-like hurricane hitting Florida

The figure below illustrate the track of the first hurricane of Category 4 on the Saffir-Simpson scale at landfall from one model provider (refer to Annex I for figures illustrating tracks from other model providers). The hurricane is assumed to cause losses across the Caribbean before making two landfalls in Florida, the first one being a Category 4 hurricane. The table below provides details of the hurricane's first US landfall.

Hurricane – Wind and Surge only	AIR	RMS
eventID	270025393	2855758
Gross Market Loss ($billion) US & Carribbean	122.2	141
Saffir-Simpson Category	4	4
Central Pressure (mbar)	941.4	941
Maximum Windspeed (mph)	154.8	149
Speed (mph)	21.7	11
Longitude (degrees)	-80.773	-80.11
Latitude (degrees)	25.246	25.96
State	FL	FL
County	Monroe	Miami-Dade

Modelled hurricane track as modelled by AIR. Refer to Annex I for figures from other model provider(s).

Indicatively, the resulting industry loss is assumed to be approximately US$122 billion according to AIR and US$141 billion according to RMS (approximately 4% of the RMS loss comes from the Caribbean), with the closest matching AIR Event ID being 27025393 and the closest matching RMS Event ID being 2855758. Loss estimates include demand surge/post-loss amplification. The PRA is aware that the event footprint, associated parameters and industry loss differ between vendor models.

2.2.2 Second hurricane hitting Houston

The map below illustrates the modelled track from a vendor model for the second, slow-moving hurricane making landfall in Galveston and Houston (refer to Annex I for figures from other model providers). The hurricane is assumed to have a wide footprint leading to significant precipitation-induced flood losses exceeding 120hrs in duration but less than 504 hours. The hurricane is assumed to cause losses across the Gulf of Mexico before making a US mainland landfall. The hurricane is also assumed to lead to surge and wind losses. The tables below provide details of the hurricane's US landfall.

Hurricane Variable – Wind and Surge only	AIR	Corelogic	Impact Forecasting	KatRisk	RMS RiskLink
EventID	270191121	5161	82	411741	2858510
Gross market loss ($billion) (inc. Caribbean)	7.1	7.0	7.3	5.1	6.8
Saffir-Simpson Category	2.0	3	3	3	1
Central Pressure (mbar)	943	947	948	944.6	978
Maximum Windspeed (mph)	100	130	154[1]	116	86
Longitude (degrees)	-94.89	-95.87	-97.11	-95.0	-94.94
Latitude (degrees)	29.23	28.68	27.77	29.01	29.21
State	TX	TX	TX	TX	TX
County	Galveston	Matagorda	Nueces	Galveston	Galveston

[1] This is the 3-sec gust speed

Hurricane Variable – Inland Flood	AIR	Corelogic	Impact Forecasting	KatRisk	RMS (HD)
EventID	80063564	5161	60940	411741	9615711
Gross market loss ($billion)	31	30	34.4	33.2	19.4
States affected	TX, MN, UT, SD, LA	TX, LA	TX	TX, LA	IL, LA, TX
Event Duration (hrs)	143	n/a	n/a	n/a	144
Basins affected	n/a	Central Texas Coastal, Sabine, Lower Brazon, Galveston Bay-San Jacinto, Neches, Trinity, Lower Colorado-San Bernard Coastal	Texas and Gulf region (HUC12)	n/a	Great Lakes, Mississippi, Rio Grande, Texas

Modelled hurricane track and corresponding flood footprint as modelled by KatRisk. Refer to Annex I for figures from other model provider(s).

Indicatively, the resulting industry loss is assumed to be in excess of US$30 billion including demand surge/post-loss amplification, split between ~25% of wind and storm surge damage and ~75% of precipitation-induced damage.

The closest matching vendor model event IDs are provided in the tables above. Please note that some vendor models have the same event ID across both wind and flood losses whilst other have provided the closest flood event ID for a given hurricane footprint.

The PRA is aware that the event footprint, associated parameters and industry loss between vendor models will differ. Where firms do not licence or use an inland flood model, firms may use alternative methods such as realistic disaster scenarios or pro-rate the wind and storm surge damage proportionally, providing brief outline of the methodology adopted.

2.2.3 Third hurricane affecting the north east coast of United States

The map below illustrates the RMS track for the third Category 2 hurricane making landfall on the East Coast and NY state in particular, causing significant losses in Nassau, Suffolk, Kings and

Queens in particular. Please refer to Annex I for figures illustrating other model provider's track. Details of the hurricane's landfall are provided in the table below.

Hurricane Variable	AIR	RMS
EventID	270153386	2857297
Gross market loss ($billion)	28.9	31
Saffir-Simpson Category	2	2
Central Pressure (mbar)	948.9	950
Maximum Windspeed (mph)	104.3	101
Forward Speed (mph)	33.8	25
Longitude (degrees)	-73.12	-73.78
Latitude (degrees)	40.68	40.58
State	NY	NY
County	Suffolk	Queens

Modelled hurricane track as modelled by RMS. Refer to Annex I for figures from other model provider(s).

Indicatively, the resulting industry loss is assumed to be approximately US$28.9 billion according to AIR (event ID 270153386) and US$31 billion according to RMS (event ID 2857297). The losses are expected to be driven by a combination of storm surge and wind. The PRA is aware that the event footprint, associated parameters and industry loss differ between vendor models.

2.3 REPORTING

Data assumptions and adjustments made to the vendor model estimates to reflect firms' own view of risk should be disclosed, including for example:

- the allowance made for uncaptured exposures or data limitations (eg locations not geocoded); and
- the allowance made for non-modelled secondary perils (eg storm-surge), non-modelled coverages (eg contingent business interruption) and non-modelled lines of business (eg on-shore energy or aviation).

Firms are also asked to disclose their estimates of post loss amplification, their estimates of the secondary uncertainty (if any) around their loss estimates, the vendor model and version used, as well as any other assumptions made in the loss estimation.

The gross loss estimate should break down the loss between lines of business and coverage (eg residential property damage, commercial property damage, business interruption, contingent business interruption, motor, marine and energy, liability).

The gross loss estimate should also break down the loss between types of peril (eg wind, storm-surge, inland flood).

Firms should provide details of the exposures that have been modelled (modelled number of risks and modelled sums insured), their exposures impacted by the different hurricanes (impacted number of risks and impacted sums insured), and give details of the firm's expected number of claims and average cost per claim. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

Section B2

3. CALIFORNIA EARTHQUAKE AND AFTERSHOCK

This stress is similar but not identical to the California earthquake scenario included in GIST2017. It tests firms' resilience to a severe earthquake and a subsequent aftershock. It takes into consideration the latest UCERF3 version of the US hazard model for California that considers the possibility of a multi-fault rupture that have the potential for Mw7.5+ involving San Andreas and Hayward faults followed by a second event in the region of Los Angeles. The stress test is analogous to what has been observed during past earthquake sequences (eg the 2010-2011 New Zealand series of events; the late 20th century sequence in Turkey; the 1811-1812 New Madrid sequence in the United States of America). **This stress is superimposed on the insurance asset shock scenario.**

3.1 EVENT DEFINITION

This stress test is for a severe earthquake in central and southern California, followed by a severe second event. The scenario has been based on a plausible Magnitude ~8 main shock along sections of the San Andreas fault and potentially the Hayward fault, and a subsequent magnitude ~7 event in the region of Los Angeles. At today's values, the two earthquakes are estimated to cause a total industry loss of US$ 70 billion approximately according to AIR and US$80 billion according to RMS.

A major earthquake (Magnitude ~8) rupturing sections of the central and southern sections of the San Andreas fault that potentially triggers also the Hayward fault would be a rare but plausible event. As far as the San Andreas fault trigger alone is considered, the last major event of similar characteristics occurred in 1857 near Fort Tejon (magnitude 7.9). Therefore, in PRA's view, the stress-test event cannot be ruled out for consideration, especially when time-dependency effects are considered given that the Hayward fault is at the end of its cycle.

The inclusion of the second event in a plausible multi-event scenario follows the lessons learned regarding stress transfer mechanisms across different faults (eg New Zealand 2010 and 2011 events). Firms are to assume that the events are sufficiently separated in time to be considered two separate events for the purposes of reinsurance recoveries.

Firms should assume that the asset shock specified in Scenario 1 occurs.

3.2 ASSUMPTIONS

In estimating the gross loss, firms are asked to allow for demand surge (post loss amplification), using their natural catastrophe modelling capabilities.

Firms should estimate both the aggregate losses and the breakdown between the two earthquakes taking into consideration ground-shaking, fire-following, liability losses triggered by earthquake and tsunami losses. Breakdown between physical damage and contingent business interruption is also requested. Liability losses examples could include litigation for structural failure or hazardous biochemical release. Should the firm not have access to suitable modelling capabilities, they are requested to estimate the non-modelled components (eg liability or contingent business interruption) using an alternative approach of their choice. The approach should be clearly disclosed, along with assumptions and expert judgements made, to estimate the non-modelled components.

Where firms are using external vendor models, firms should adjust the model output reflecting any model limitations including non-modelled claims, past model performance in recent events and the firm's own views.

Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the

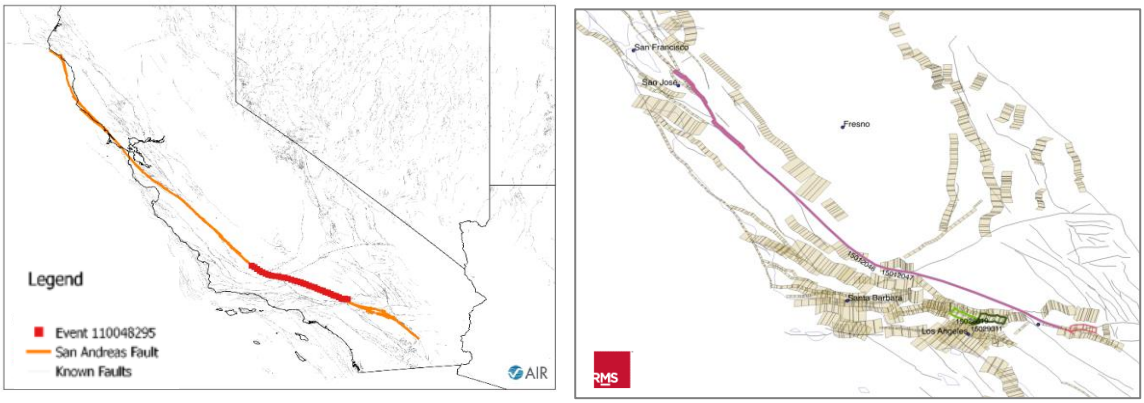
impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should consider what management actions they may take following the series of events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2019, with adequate descriptions in the free form box.

3.2.1 Earthquake sources

The map below illustrates the AIR rupture extents for the first event, which is assumed to match the characteristics of a multi-fault Magnitude ~7.5+ event rupturing sections of the San Andreas fault (N.B. RMS event connects with the Hayward fault). For firms not using any vendor model, the fault rupture characteristics can be found in the table below. The epicentre is located in the region from Fremont through to Soledad to the region of San Bernardino. The epicentre should be located at 34.66 latitude and -118.41 longitude for the first event. Firms are requested to simulate the second event (magnitude ~7.0) with an epicentre located at 34.15 latitude and -118.04 longitude i.e. on the Raymond Fault.



California earthquake fault as modelled by AIR (left) and RMS (right).

For the first event, the closest matching AIR Event ID would be 110048295 (time-dependent catalogue) causing approximately US$32 billion of industry losses at today's values, according to AIR. This loss corresponds to an approximate 100 year return period on AIR's California exceedance probability curve computed using AIR's industry exposure database. The closest matching RMS Event ID would be 15012046 leading to some US$56 billion of industry losses. This loss corresponds to an approximate 150 year return period on the RMS USEQ IED.

For the second event, the closest matching AIR Event ID would be 110020504 (time-dependent catalogue) causing some US$35 billion of industry losses. The closest matching RMS Event ID (denoted in green in the RMS figure above) would be 15022404 estimated to cause approximately US$25 billion industry losses.

The PRA is aware that event footprints, associated parameters and industry losses differ between vendor models.

Parameters for firms not relying on vendor models	First earthquake: San Andreas/Hayward		Second earthquake: Santa Monica / Raymond / Hollywood/San Gabriel	
Model provider	AIR	RMS	AIR	RMS
Earthquake magnitude (Mw)	7.8	8.0	7.1	7.0
Depth (km)	8.1	8.1	9.7	9.7
Rupture length (km)	240	590	62	46
Epicentre latitude (°)	34.66	34.58	34.15	34.15
Epicentre longitude (°)	-118.41	-118.12	-118.27	-118.04

3.3 REPORTING

Data assumptions and adjustments made to the vendor model estimates to reflect firms' own view of risk should be disclosed, including for example:

- the allowance made for uncaptured exposures or data limitations (eg locations not geocoded); and
- the allowance made for non-modelled secondary perils (eg fire following), non-modelled coverages (eg contingent business interruption) and non-modelled lines of business (eg energy).

Firms are also asked to disclose their estimates of post loss amplification, their estimates of the secondary uncertainty (if any) around their loss estimates, the vendor model and version used, as well as any other assumptions made in the loss estimation.

The gross loss estimate should break down the loss between lines of business and coverage (eg residential property damage, commercial property damage, business interruption, contingent business interruption, motor, marine and energy, liability).

The gross loss estimate should also break down the loss between types of peril (eg ground-shaking, fire following, tsunami).

Firms should provide details of the exposures that have been modelled (modelled number of risks and modelled sums insured), their exposures impacted by the earthquake and the aftershock (impacted number of risks and impacted sums insured), and give details of the firm's expected number of claims and average cost per claim. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

Section B3

4. JAPANESE EARTHQUAKE AND TSUNAMI

This scenario is for a tsunami-generating event in the order of magnitude 8.1 Nankai earthquake on the Tokai and Tonankai Segments, affecting the high exposure regions between Tokyo and Nagoya. For Japan, tsunami-generating events tend to be offshore and at larger distances from the coastline. This scenario attempts to maximise the impact of loss since it is sufficiently off-shore to generate tsunami and sufficiently close to the coastline to impact on-shore structures. This event is not too dissimilar to the 1944 Tonankai event, which ruptured the Tonankai and Nankai sections of the Nankai Trough. **This stress is superimposed on the insurance asset shock scenario.**

4.1 EVENT DEFINITION

This stress test is for a severe earthquake in the order of Magnitude 8.1 with its off-shore epicentre affecting the high exposure regions between Nagoya and Tokyo. The scenario has been based on a plausible event of approximate Magnitude 8.1 rupturing one or more sections of the Nankai Trough, in the interface between the Philippine sea and the Amurian plates (the latter is part of the Eurasian plate). At today's values, the earthquake and resulting tsunami (including the effects of fire-following) are estimated to cause a total industry loss of approximately US$37 billion according to AIR and US$19 billion according to RMS RiskLink model (US$24 billion using the RMS HD model).

The event has similarities to the 1944 Tonankai event, which occurred in the same tectonic region, albeit in a different section of the Nankai Trough (Tokai-Tonankai segments for this stress event, as opposed to Nankai and Tonankai in the case of the 1944 earthquake). Although different from a tectonic perspective, the tsunamic component of this events has similarities to the Fukushima event in 2011 that increased the insurance market's awareness of tsunami risk (albeit the expected loss for this event might be different than that of 2011). In the PRA's view, this type of event could plausibly occur in our lifetime, especially when time-dependency effects are considered.

Firms should assume that the asset shock specified in Scenario 1 occurs.

4.2 ASSUMPTIONS

In estimating the gross loss, firms are asked to allow for demand surge (post loss amplification), using their natural catastrophe modelling capabilities.

Firms should estimate the losses taking into consideration ground-shaking, tsunami wave, fire-following, liability losses triggered by earthquake and tsunami losses. Breakdown between physical damage and contingent business interruption is also requested. Liability losses examples could include litigation for structural failure or hazardous biochemical release. Should the firms not have access to suitable modelling capabilities, they are requested to estimate the non-modelled components (eg liability or contingent business interruption) using an alternative approach of their choice. The approach should be clearly disclosed, along with assumptions and expert judgements made, to estimate the non-modelled components.

Where firms are using external vendor models, firms should adjust the model output reflecting any model limitations including non-modelled claims, past model performance in recent events and the firm's own views.

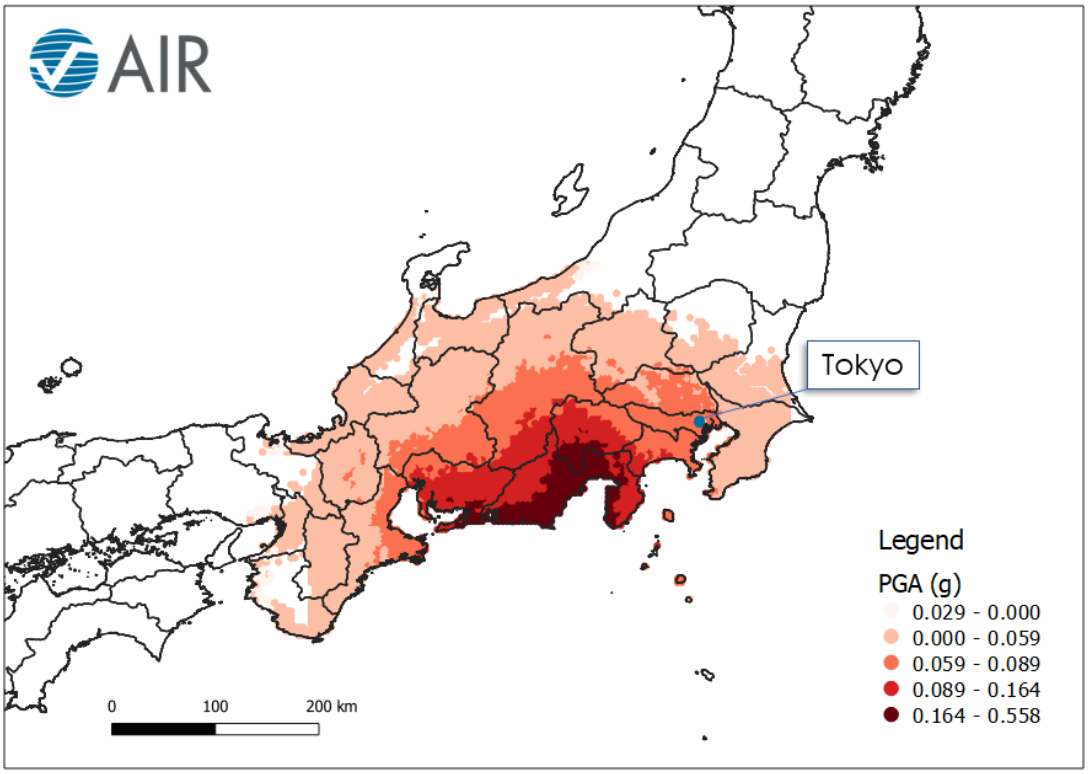
Firms should assume the event fall under the reinsurance treaties in-force as at the beginning of the year and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should consider what management actions they may take following the series of events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2019, with adequate descriptions in the free form box.

4.2.1 Earthquake sources

The map below illustrates footprints of the tsunami-generating Magnitude ~8.0 event, as estimated by AIR (refer to Annex I for figures from other model providers). Note that for RMS, only the HD model explicitly covers tsunami and hence RiskLink results will require loading applied by the user to reflect the tsunami losses. For firms not using any vendor model, candidate earthquake rupture characteristics are provided in the table below. Tsunami waves are estimated to reach a maximum wave height of 6 meters along the coastline according to AIR.



Event footprint resulting from a ~Mw8 earthquake on the Tokai segment of the Nankai Trough as modelled by AIR. Refer to Annex I for event footprint figures from other model provider(s).

For this event, the closest matching AIR Event ID would be 520014687 (Time-dependent catalogue) causing approximately US$37 billion of industry losses at today's values, according to AIR. The closest matching RMS RiskLink Event ID would be 803122 leading to some US$18.5 billion of industry losses which excludes tsunami losses. The closest RMS HD Event ID would be 8701329 leading to some US$24.3 billion of industry losses, according to RMS.

The PRA is aware that event footprints, associated parameters and industry losses differ between vendor models.

Parameters for firms not relying on vendor models	AIR	RMS Link	RMS HD
Source	Subduction-fault	Tokai - Tonankai	ANN70 Nankai Trough (XE) TSU
Earthquake magnitude (Mw)	8.16	8.1	8.1
Depth (km)	14.9	10-30 km	10-24 km
Epicentre latitude (°)	34.44	34.27	34.37
Epicentre longitude (°)	138.05	137.16	137.29
Maximum tsunami-induced surge at coastline (m)	5.7	n/a	Varies along coastline

4.3 REPORTING

Data assumptions and adjustments made to the vendor model estimates to reflect firms' own view of risk should be disclosed, including for example:

- the allowance made for uncaptured exposures or data limitations (eg locations not geocoded); and
- the allowance made for non-modelled secondary perils (eg fire following), non-modelled coverages (eg contingent business interruption) and non-modelled lines of business (eg energy).

Firms are also asked to disclose their estimates of post loss amplification, their estimates of the secondary uncertainty (if any) around their loss estimates, the vendor model and version used, as well as any other assumptions made in the loss estimation.

The gross loss estimate should break down the loss between lines of business and coverage (eg, residential property damage, commercial property damage, business interruption, contingent business interruption, motor, marine and energy, liability).

The gross loss estimate should also break down the loss between types of peril (eg ground-shaking, fire following, tsunami).

Firms should provide details of the exposures that have been modelled (modelled number of risks and modelled sums insured), their exposures impacted by the earthquake and the aftershock (impacted number of risks and impacted sums insured), and give details of the firm's expected number of claims and average cost per claim. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

Section B4

5. UK Windstorm AND UK Flood

This scenario is for a set of two events, a large UK windstorm and a large UK flood generating some £20 billion of gross insured loss. The first event is a UK windstorm causing significant storm surge losses along the East coast of England generating approximate half of the overall losses. The second event is for extensive flooding across England and Wales generating the remainder of the overall losses. Firms are encouraged to develop their own view of risk. This should include adjustments for the firm's view of any limitations of the vendor models used. **This stress is superimposed on the insurance asset shock scenario.**

5.1 EVENT DEFINITION

This stress test is for a set of two large UK events generating some £20 billion of losses in aggregate in the United Kingdom. Firms may ignore losses in other parts of Europe.

Firms are to assume that the events are sufficiently separated in time to be considered two separate events for the purposes of reinsurance recoveries

The return period for aggregate wind, surge and flood losses of this size to the UK is estimated to be approximately 200 to 250 years according to RMS and AIR, if the events are assumed to be independent. Firms should note that, if there is some correlation between wind and flood losses, the return period will differ. Should firms assume correlation in their estimation across perils, they are expected to outline the basis of their assumptions.

Firms should assume that the asset shock specified in Scenario 1 occurs.

5.2 ASSUMPTIONS

Firms are asked to estimate the size of the loss per event and in aggregate using their natural catastrophe modelling capabilities. In estimating the gross loss, firms should provide their own view and allow explicitly for all material non-modelled risks.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should consider what management actions they may take following the series of events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2019, with adequate descriptions in the free form box.

For this scenario we invite firms to list the following information relating to loss adjusters which PRA aims to gather to inform operational stresses to the industry:

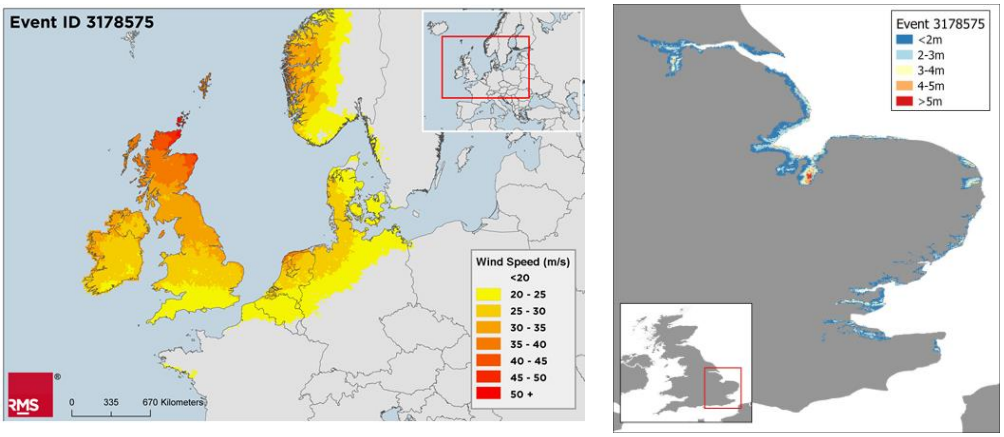
- the number of claims split between commercial and retail with an estimation of what percentage of each would have external adjusting applied;

- top three adjusters (by volume of claims adjusted rather than size of claim) and the percentage of total claims they would settle under commercial and retail;
- an estimation of the maximum period by which time 80% of all claims (both outsourced and handled in-house) are expected to be assessed.

5.2.1 First event: UK windstorm and storm surge

A severe extra tropical cyclone is assumed to cross North of Scotland, causing strong onshore winds throughout Scotland and Northern England. The strongest winds associated with this event, located offshore, act to drive water south into the North Sea causing a severe storm surge along the East coast of England between the Humber and Thames estuaries. This event causes a gross loss of around £10 billion, of which £9 billion is caused by storm surge. For purposes of this stress tests, losses outside the UK are assumed to generate negligible losses for this event.

The maps below illustrate footprints for the closest matching RMS events. Refer to Annex I for figures from other model provider(s).

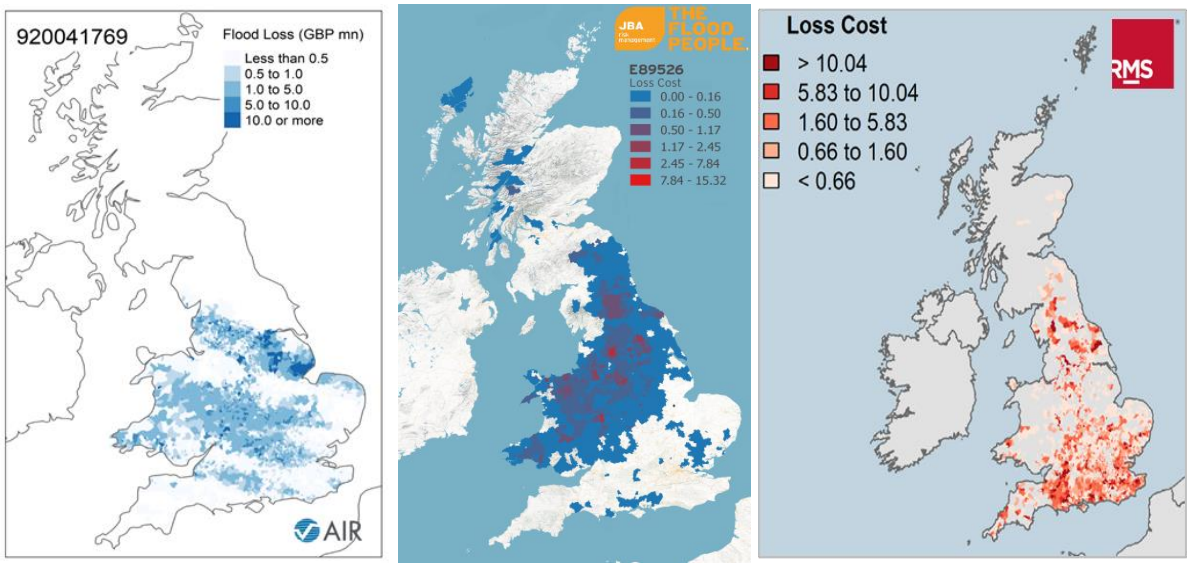


UK Windstorm (left) and Storm Surge (right) footprints, as modelled by RMS. Refer to Annex I for figures from other model provider(s).

The RMS Event ID is 3178575 (Version 18) causing approximately £10 billion of industry losses at of which £9 billion is attributed from coastal flooding. The closest matching event IDs from AIR is 410106373 (for Extra Tropical Cyclone, version 20 onwards) generating some £1 billion of industry losses in the UK and Event ID 910046257 (for Coastal Flood, version 20) generating some £9 billion of industry losses. The PRA is aware that event footprints, associated parameters and industry loss estimates vary between vendor models.

5.2.2 Second event: UK inland flood (England & Wales)

For the second event, firms are to assume extensive pluvial and fluvial flooding across England & Wales from a sequence of rainfall events throughout the season. This event causes a gross loss of in the order of £10-12 billion, with the event lasting more than 140 hours across England & Wales. The map below illustrates the area impacted by flooding for one model vendor. Refer to Annex I for figures from other model provider(s).



Second event area impacted by flooding as modelled by AIR (left), JBA (middle) and RMS (right).

The closest matching JBA Event ID is 1943403 generating a market loss in the order of £9 billion (estimated based on a residential market loss estimate of £5 billion). For AIR, the closest matching Event ID would be 920041769 causing approximately £11billion of industry losses at today's values, according to AIR. The closest matching RMS RiskLink Event ID is 1943403 whilst the closest RMS HD Event ID is 3749426. Both events suggested by RMS cause some £11.5-12 billion industry losses, according to RMS. The PRA is aware that event footprints, associated parameters and industry loss estimates vary between vendor models.

5.3 REPORTING

Data assumptions and adjustments made to the vendor model estimates to reflect firms' own view of risk should be disclosed, including for example:

- the allowance made for uncaptured exposures or data limitations (eg locations not geocoded); and
- the allowance made for non-modelled secondary perils (eg storm-surge), non-modelled coverages (eg contingent business interruption) and non-modelled lines of business (eg energy).

Firms are also asked to disclose their estimates of post loss amplification (and their expected reliance on external claims adjusters), their estimates of the secondary uncertainty (if any) around their loss estimates, the vendor model and version used, as well as any other assumptions made in the loss estimation.

The gross loss estimate should break down the loss between lines of business and coverage (eg residential property damage, commercial property damage, business interruption, contingent business interruption, motor, marine and energy, and liability).

The gross loss estimate should also break down the loss between types of peril (eg wind, storm-surge, river flood).

Firms should provide details of the exposures that have been modelled (modelled number of risks and modelled sums insured), their impacted exposures under the storm track or flood footprint (impacted number of risks and impacted sums insured) and give details of the firm's expected number of claims and average cost per claim. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

Section B5

6. RESERVE DETERIORATION

The reserve deterioration scenario is designed to stress Technical Provisions (TPs) as at Year-end 2018 by applying an increase in claims inflation to TPs. It has been chosen for simplicity to apply to all TPs across all geographical regions and product lines. **This stress is superimposed on the insurance asset shock scenario.**

6.1 EVENT DEFINITION

In this scenario, there is an unexpected increase in claims inflation. The increase is in excess of what is currently assumed in firms' reserving or business planning assumptions whether implicitly or explicitly. It is additional to consumer price inflation.

This calculation has been chosen in the interests of simplicity, to minimise the calculation burden on firms and to be consistently applied across firms.

Firms should assume that the asset shock specified in Scenario 1 also occurs.

6.2 ASSUMPTIONS

For this reserving shock, firms are asked to estimate the impact on technical provisions held on their balance sheet as at year-end 2018 from an increase in claims inflation of 2% per annum (pa).

This increase of 2% p.a. in claims inflation applies to ultimate until the liabilities are extinguished.

Both claims TPs and premium TPs are being stressed.

This should be applied to all classes of business and geographic regions.

Firms should not assume a matching increase in investment yields.

6.3 REPORTING

Firms should provide details of the impact in aggregate and by class of business, separately for claims TPs and premium TPs.

Firms should also provide the discounted mean term of the claims and premium TPs by class of business.

Section B6

7. CYBER UNDERWRITING LOSS SCENARIO

The 2019 cyber underwriting loss scenario is based on a group of hackers exploiting a systemic weak point to carry out a ransomware attack leading to a mass systems outage. The hackers ransom a number of large corporates disrupting their systems for a number of days leading to significant business interruption, contingent business interruption and other losses across multiple sectors of the economy. **This stress is superimposed on the insurance asset shock scenario.**

7.1 EVENT DEFINITION

This stress scenario is for a systemic cyber event impacting the computer systems of a number of firms. Hackers exploit a systemic weak point in operating software or chip architecture to hold firms ransom, keeping the impacted firms' IT systems down for a number of days. This leads to a mass system outage of both internal systems and external client facing systems across multiple sectors of the economy. The scenario has similar elements to the WannaCry and NotPetya attack in 2017 but, unlike WannaCry, the spread of the attack is not halted by a kill switch.

While their systems are down, customers of impacted banks are not able to withdraw money from the ATM network, life insurance companies cannot pay pensioners and other annuity clients, clients of the asset managers cannot sell their assets or withdraw funds, hotels and airlines cannot take bookings and the online websites of impacted retail consumer firms are not operational. Other sectors of the economy are also impacted and the cyber event has ripple effects from suppliers not being able to meet their commitments to the insured firms.

Firms are asked to estimate the impact of such a cyber-event that creates losses across geographies and multiple industries.

7.2 ASSUMPTIONS

To allow a meaningful and consistent comparison of responses across firms, insurers are asked to assume the following:

- The attack has a global impact.
- Such an attack impacts multiple sectors including the financial sector, the hospitality sector, the retail customer sector and the healthcare sector among others.
- For this exercise, firms should assume that the attack impacts the systems of at least their largest percentage of policyholders in each sector (by Limit of indemnity) with their IT system down for the set number of days:

	% of sector	No of days
○ Banks	10%	2
○ Hospitality	20%	3
○ Airlines	10%	2
○ Healthcare	20%	5
○ Consumer Retail	10%	2
○ Manufacturing	10%	5
○ Pharmaceuticals	20%	5
○ Other sectors	10%	3

- The ransomware attack includes a destructive payload leading to physical damage of vulnerable assets.
- Firms may assume that policyholders impacted have adopted reasonable network security processes, including anti-virus software and patching.

- The perpetrator of the attack is not definitively identified and the attack is not considered an act of war.
- Firms should also consider the impact on non-standalone cyber policies. Where firms rely on significant exclusions, they should explain the key uncertainties and allow for some probability that these exclusions do not hold perfectly, where appropriate.
- In modelling the net of reinsurance impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

7.3 REPORTING

Additional assumptions made or adjustments to the above assumptions provided should be disclosed.

The gross loss estimate should break down the loss between the stand alone cyber classes and other lines of business. Firms should also provide an estimate as to their own operational loss.

For stand-alone cyber policies, firms should provide a breakdown of losses split between privacy breaches, remediation, business interruption and contingent business interruption and other.

For other classes of business, firms should split the gross loss between D&O, E&O, Crime including Kidnap & Ransom and Other Classes.

Significant exclusions should be detailed with the key uncertainties highlighted and assumptions made on their probability of holding disclosed.

Section C1

8. CLIMATE CHANGE SCENARIOS

The potential financial impacts of climate change are well-documented. Furthermore, the PRA's recent draft Supervisory Statement[1] set out the importance of firms using scenario analysis to assess the impact of the financial risks from climate change on their business strategy. However, last year's Task Force on Climate-related Financial Disclosures (TCFD) report (published in September 2018) showed that while firms were starting to consider impacts to their strategic resilience resulting from climate change, few were systematically using scenario analysis.

This investigatory exercise is designed to provide additional market impetus in this area. It will also provide additional data that informs the Bank's development of a consistent and effective approach to climate-focused scenario analysis, both domestically and through international groups like the Network for Greening the Financial System. Whilst this exercise will inform future Bank work, it should be viewed as investigatory in nature. **The assumptions and methodology have been designed on this basis and should therefore not be taken as a precedent for future domestic or international exercises.**

This section comprises of two parts:

Part 1 consists of three data-driven sets of hypothetical narratives that are designed to help companies think through how different plausible futures could impact their business models in the medium to longer term. And while we have provided a set of assumptions that are designed to quantify the impacts using simple metrics for illustrative purposes, this is designed to promote discussion on how business models and balance sheets may need to adapt, not about assessing current financial resilience.

Wherever possible we have obtained the underlying assumptions for each narrative based on publically available research. However, given the limited availability of research on how climate scenarios translate into financial impacts, high-level assumptions have been made to simplify the exercise and make results across firms comparable. These assumptions are set out below.

Part 2 asks firms to provide qualitative and quantitative information on any climate scenarios that the firms have already developed.

Firms are asked to complete this section on a best endeavours basis. Where firms are not able to answer a specific question they should provide a reason – for example, whether this is due to the firm's level of maturity in this area or whether their approach to managing climate-related risks means the question is not relevant.

8.1 STRUCTURE OF THE SCENARIO ANALYSIS

The scenario analysis is split in two parts: a quantitative data-driven scenario analysis and a qualitative information gathering section.

Part 1: Asks firms to conduct a scenario analysis where we provide a set of hypothetical greenhouse gas emission scenarios expressed by their resulting climatic and financial impacts. ***These do not represent a PRA forecast neither do they represent scenarios that have been built bottom-up by the PRA based on a view of potential future climate policies (such as a carbon price).*** That is work for the future. Consequently, the scenarios presented as part of this exercise should not be interpreted as a prelude to a reference scenario for the Bank of England. Rather, they are a set of

1 Draft PRA expectations set out in CP23/18 'Enhancing banks' and insurers' approaches to managing the financial risks from climate change' available at: https://www.bankofengland.co.uk/prudential-regulation/publication/2018/enhancing-banks-and-insurers-approaches-to-managing-the-financial-risks-from-climate-change

extreme yet plausible hypothetical assumptions, based on publically available information, that are put together using expert judgement to test a firm's ability to respond to a given assumed climatic state. We subsequently request firms to attempt and quantify the financial impacts against the assumed climatic and financial impacts stemming from three plausible future greenhouse gas emission scenarios.

Part 1 of the scenario analysis has two objectives: (1) gather quantitative information regarding financial impacts under a given set of climate change-related assumptions; and (2) allow the PRA to assess the value of the systems, tools and data currently available to insurers for assessing financial impacts from physical climate change risk. Should the firms have already undertaken quantification of the financial impact from a climatic state under a different set of assumptions than those put forward by the PRA, they are requested to present those results in Part 2 below.

Part 2: For those firms that have already made sufficient progress in developing climate scenarios, we ask firms to outline qualitatively the set of assumptions they have contemplated under their assumed climate change scenarios. The aim of this qualitative information-gathering exercise is for the PRA to understand the range of assumptions and parameters currently considered by insurers when assessing financial impacts from climate change risks. This part of the scenario analysis focusses on understanding the main assumptions (and challenges) that firms use to translate broad climatic scenarios into tangible impacts to their firms. If firms consider multiple stress test scenarios they only need report a maximum of two in detail. If firms have not developed yet their own set of assumptions, they are requested to complete this section of the scenario analysis by expressing (1) any interim assumptions they may have contemplated; and (2) state any barriers that is prohibiting them from developing these scenarios.

8.2 PART 1: POTENTIAL QUANTITATIVE IMPACTS UNDER SPECIFIC SOCIO-ECONOMIC & CLIMATIC CONDITIONS

We ask firms to consider the expected impact on their assets, liabilities and business models, assuming that their in-force insurance exposures and their current investment profile remain constant. In essence, we ask firms to undertake a sensitivity analysis under three different climatic states.

As a background to interpreting these three hypothetical scenarios: the Paris Agreement has set out climate targets for the year 2100. Meeting these targets will require significant structural changes in the economy over the coming years and decades. In order to consider how these risks could materialise as financial impacts to firms over short and long durations, we have set out three scenarios:

- The first scenario is designed to assess firm's resilience to a Minsky moment – a wholesale reassessment of prospects in financial markets which materialises over the medium-term business planning horizon.
- The second and third scenarios are designed at directing firms' focus on the long-term financial impact from climate-related risks in different future outcomes.

In order to be consistent with the Paris agreement, we have defined the projected temperature rise targets relevant to 2100, but we are asking firms to report these impacts at shorter time frames where the temperature rises achieved will be different from the long-term target specified. This exercise is not aiming to ask firms to develop the physical, macro- and micro-economic financial impacts stemming from the expected climatic state; instead, this scenario analysis provides explicit, hypothetical risk assumptions to ensure firms are analysing financial impacts on the same basis and hence minimise the burden of undertaking this exercise. As such, the three scenarios outlined below are provided for illustrative purposes to aid firms understand the basis upon which the PRA's hypothetical physical and transition risk assumptions have been provided.

Scenario A: A sudden transition scenario materialising over the medium-term business planning horizon that results in achieving a maximum temperature increase of 2°C (relative to pre-industrial levels) by 2100 but only following a **disorderly transition**. In this scenario, transition risk is maximised. Firms are invited to undertake scenario analysis assuming the Minsky moment has occurred by 2022. The scenario is based on the type of disorderly transitions highlighted in Furman (2015)[1].

Scenario B: A long-term **orderly** transition scenario that is broadly in line with the Paris Agreement. This involves a maximum temperature increase of 2°C by 2100 (relative to pre-industrial levels) with the economy transitioning to be greenhouse gas-neutral in the next three decades by 2050. The underlying assumptions for this Scenario are based on the range of 2° scenarios cited in the IPCC AR5 report (2014)[1].

Scenario C: A 'hot house' scenario reaching a maximum temperature increase of 5°C (relative to pre-industrial levels) by 2100 assuming **no transition** where physical climate change is maximised following an emissions pattern similar to an IPCC RCP 8.5[2]. We have asked firms to consider their physical risks as at 2100.

Firms are requested to consider the impact of climate change on selected metrics of their business models and asset valuations, split between:

- Physical risk: for purpose of this investigatory exercise, physical risk is only applicable for general insurers. This is reflected as the risk arising from hydro-meteorological events, such as droughts, floods, storms and sea-level rises. To minimise the burden of the scenario analysis exercise, the components considered are only a subset of perils that could be impacted by physical climate change risk. For this exercise US hurricane and UK flood, freeze and subsidence perils have been selected to test firms' abilities to respond to such an exercise.
- Transition risk: financial risk that can result from the process of the financial system adjusting towards a lower-carbon economy, including policy, consumer behaviour or technological shifts.

The set of assumptions on climatic and financial impacts under the three scenarios are purposely non-exhaustive as the goal of the scenario analysis is investigatory in nature. The PRA recognises that for different portfolios, the materiality of natural catastrophe perils and asset classes affected will differ. We have provided reference values as part of the set of assumptions. Where firms are inclined to provide their own assessments of climate-related impacts under different scenarios; they are encouraged to do so together with their rationale. The resources listed in Annex II may be useful in interpreting the scenario analysis values below.

The PRA recognises that metric(s) chosen to measure the financial impact from climate change are dependent on the focus of any given climate change study. This scenario analysis exercise does not intend to capture the full range of relevant metrics that could reflect a meaningful financial impact as a result of climate change. From the consultation undertaken to date, the following metrics were selected for this exercise:

- Impact to assumed liabilities: Annual Average Loss (AAL) and 1-in-100 Aggregate Exceedance Probability (AEP).
- Impact to assets: change in portfolio market valuation. Expressed as a monetary value amount and as a 1-in-100 Value at Risk (VAR), separately for equities and bonds.

1 Furman, J, Shadbegian, R., Stock, J. (2015): 'The cost of delaying action to stem climate change: a meta-analysis', available at https://voxeu.org/article/cost-delaying-action-stem-climate-change-meta-analysis.
2 IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

PHYSICAL RISKS – impact to liabilities

The set of assumptions detailed below are put together for exploratory purposes to ensure that firms complete the return on the same basis. **This set of assumptions are developed for illustrative purposes only.**

The physical risk assumptions provided below have been developed to permit firms to assess the financial impacts of climate change contained on their existing assumed liabilities. The PRA acknowledges that life insurer's liabilities and both life and non-life assets are equally exposed to physical climate change risk, however, for this exercise, we have limited the complexity of the analysis to reflect the current level of maturity of available tools, data and systems.

Peril	Assumptions	Scenario A: 2022	Scenario B: 2050	Scenario C: 2100
US Property - Hurricanes[1,2,3,4]	% increase in frequency of major hurricanes		10%	20%
	Uniform increase in wind speed of major hurricanes			5%
	% increase in surface runoff resulting from increased tropical cyclone-induced precipitation		5%	10%
	Increase in cm in average sea-levels for US mainland coastline between Texas and North Carolina		5cm	10cm
UK Property - Flood[5], ,freeze and subsidence	% increase in surface runoff resulting from increased precipitation		6%	10%
	Uniform increase in cm in average sea-level		4cm	10cm
	Increase in subsidence-related property claims using as a benchmark the worst year on record since 1990		10%	25%
	Increase in freeze-related property claims using as a benchmark the worst year on record since 1990		10%	25%

Notes:

- For impact to General Insurers' assumed liabilities, firms are advised to consider using available tools[6].
- For impact to assets, firms are not expected to complete a return. However, if a firm has developed the tools that permit them to do so, we ask to provide this return with the underlying assumptions in Part 2.
- Refer to Annex II for further background on the material used to develop the assumptions above, which should be interpreted as exploratory only.

[1] Risky Business (2014), National Report: The economic risks of climate change in the United States ;

[2] Emanuel K, Sobel A 2013. Response of tropical sea surface temperature, precipitation, and tropical cyclone-related variables to changes in global and local forcing. J Adv Model Earth Syst, 5:447–458.

[3] Emanuel, K. E., 2017: Assessing the present and future probability of Hurricane Harvey's rainfall. Proc. Natl. Acad. Sci. USA, 114, 12 681–12 684, doi:10.1073/pnas.1716222114.

[4] Klotzbach, P.J.; Bowen, S.G.; Pielke, R., Jr.; Bell, M. 2018 Continental United States hurricane landfall frequency and associated damage: Observations and future risks. Bull. Am. Meteorol. Soc.

[5] Source: UK Climate Change Risk Assessment 2017.

[6] PRA (in press); A Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector: A Practitioner's Aide

TRANSITION RISKS – impact to assets

The set of assumptions detailed below are put together for exploratory purposes to ensure that firms complete the return on the same basis. **This set of assumptions are developed for illustrative purposes only.**

The transition risk assumptions provided below have been developed to permit firms to assess the financial impacts on their assets. The PRA recognises that feedback loops between climatic impact and the wider economy need to be fully incorporated when assessing the financial impacts from climate change on a firm, however, for this exercise, we have limited the complexity of the analysis to reflect the current level of maturity of tools, data and systems available.

The table below provides assumptions affecting equities. For impacts on corporate bonds apply a flat multiplier of 15% to these changes in equities values (i.e. impact on corporate bonds = 0.15 x impact on equities).

Sector	% of investment portfolio in following sectors[1]	Assumptions	Scenario A: 2022	Scenario B: 2050	Scenario C: 2100
Energy[2]	Electricity producers/Gas/Coil/Crude/other oil/renewables	Change in equity value for sections of the investment portfolio comprising material exposure to the energy sector as per below:			
		Coal Oil Gas Renewables	- 40% - 28% +13% +20%	-15% -10% +7% +10%	
Transport[3]	Automotive (Electric Vehicles and non-Electric Vehicles), Aviation (freight and passenger), Marine (freight and passenger), manufacture of other transport equipment	Change in equity value for sections of the investment portfolio comprising material exposure to the transport sector as per below:	-30%	-10%	
		Automotive non EV Automotive EV Non-Automotive (eg marine, aviation)	- 30% + 5% - 20%	- 10% - -5%	
Materials/ Metals/ Mining[4]	Manufacture and first-order processing of coke and refined petroleum products, chemicals, cement, iron and related alloys processing	Change in equity value for sections of the investment portfolio comprising material exposure to meterials/metals/mining sector as per below:			

[1] Refer to Annex II for indicative suggested NACE and GICS sector codes to help guide your portfolio segmentation

[2] Source: World Energy Outlook (IEA, 2018). Scenario A based on SDS, Scenario B based on NPS and Scenario C on CPS.

[3] Source: World Energy Outlook (IEA, 2018). and De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands

[4] Source: De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands

		Proportion of the portfolio relying on transporting/extracting/processing fossil fuels or heavily reliant on fossil-fuel energy	-25%	-10%	
Water, Agriculture & Food Security[1]	Agriculture, forestry, fishing, dairy cattle, water utilities, food logistics and retail	Change in equity value for sections of the investment portfolio comprising material exposure to water (inc. utilities), agriculture & food security sector as per below:			
		Proportion of the portfolio with income heavily reliant on transporting/trading/supplying products based on water/food/agriculture (eg super-market chains, utilities, etc.)	-15%	-10%	
Real Estate Assets (inc. CRE & infrastructure)[2]	Real estate activities	Change in property value for assets materially affected by physical climate change risk. Apply the price drop impact on mortgage valuations where relevant.	-30%	-10%	
		Change in property value for assets not affected by physical climate change risk. Apply the price drop impact on mortgage valuations where relevant.	+10%	+7%	
Investment / Interest Rates[3]		Sovereign bond credit ratings downgraded as countries stress their balance sheets in their need to fund adaptation strategies (downgrade as a function of a country vulnerability to climate change – refer to Annex II)	-30 to -5 basis points	- 50 to -10 basis points	

Notes:

- The asset categories outlined below have been purposely limited to first-order impacts as the purpose of the scenario analysis is primarily investigatory in nature. To help firms classify the asset portfolio across the categories outlined in the table below we have provided in the Annex II suggested indicative NACE and GICS codes that could be used alongside tools such as Thomson Reuters and Bloomberg Terminal.
- Other resources: A non-exhaustive list of tools and data providers that may assist firms in undertaking this scenario analysis is provided below. This set of resources should not be considered as an endorsement of the following products or services, or the data underlying them, but rather a list of resources that may be useful to consult as a starting point of this investigatory exercise.

[1] Source: OECD (2015), The Economic Consequences of Climate Change

[2] De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands.
UNEP FI - Acclimatise (2018); Navigating a New Climate
Dubbelboer, J., Nikolic, I., Jenkins, K., and Hall, J. (2017) An Agent-Based Model of Flood Risk and Insurance, Journal of Artifical Societies and Social Simulation 20(1) 6, Doi: 10.18564/jasss.3135;
Risky Business (2014) National Report: The economic risks of climate change in the United States.

[3] GEF (2014) The price of doing too little too late: the impact of the carbon bubble ion the EU financial system

- TCFD Knowledge Hub: for resources on how to get started on climate-related scenario analysis.
- PACTA tool: for help in assigning listed debt and equity to specific sector categories such as energy, transport and materials.
- Transition Pathway Initiative: Assessing companies' strategic resilience to transition-related risks for a subset of large global firms.
- Climate Impact Lab: Maps of physical impacts on a granular level, up to end of century.
- Notre Dame Global Adaptation Initiative country vulnerability ranking or Moody's Investors Service' Climate Change & Sovereign Credit Risk**:** provides relative country ranking on sovereign susceptibility to climate risks.

8.3 PART 2: SCENARIO ASSUMPTIONS

Part 2 supports the development of future climate change scenarios for PRA stress tests. For those firms that have already made sufficient progress in developing climate change scenarios, the scenario analysis requests assumptions and parameters. The focus of this part of the scenario analysis is on understanding how firms are translating broad climate change scenarios into more detailed assumptions to assess financial tangible impacts on their businesses.

Firms are asked to provide details of all the material assumptions for up to two of their main climate change-related scenarios (where available).

The climate change scenarios should indicate how physical and transition risks related to climate change are addressed in the context of their key business decisions.

We expect the material assumptions to include the following:

Climatic scenario assumptions

1. Greenhouse gas levels and extent of the global temperature rise assumed to occur
2. Time frame and pathway over which this rise is assumed to occur
3. Material additional aspects such as the impacts of international initiatives / policy actions, assumptions around technology (for example carbon-capture), consumer sentiment, etc. It would be particularly helpful if firms could explain what assumptions they have made about a future carbon price, and how that was calculated.

Assumptions required translating climatic scenarios to business impacts

1. Impacts on asset valuations (by class – equities, corporate bonds, sovereigns, property, infrastructure, utilities, oil and gas, automotive, etc. - if material), and split between
    a. Physical Risk: Physical risks from climate change are those which arise from climate and weather-related events, such as droughts, floods and storms, and sea-level rise; and
    b. Transition Risk: Transition risk is the financial risk which can result from the process of adjustment towards a lower-carbon economy and associated impact/cost of reducing emissions.
2. Impact on the valuation of liabilities
    a. Physical risk: Physical risks from climate change are those which arise from climate and weather-related events, such as droughts, floods and storms, and sea-level rise. In particular, changes in the frequency and severity of hydro-meteorological natural

catastrophes (to the extent that the firm has exposure to specific perils). Physical risk can impact both general and life insurance (eg impact on mortality rates of more extreme summers or winters).

b. Transition risk: Transition risk is the financial risk that can result from the process of adjustment towards a lower-carbon economy and associated impact/cost of reducing emissions. For example, the transition to a lower carbon economy and wider adoption of electric vehicles could affect levels of air pollutants.

Where firms have other material assumptions, these will also need to be set out in the feedback. Firms should set out where they make assumptions about potential opportunities (eg green revenues) as well as risks in their analysis.

Section C2

9. EXPOSURE GATHERING FOR COMMERCIAL RISKS BY SECTOR

This section is a repeat of GIST2017 and aims at capturing commercial exposures. Unlike 2017, in 2019 the PRA is asking sectoral information for all commercial risks worldwide split into US, UK and rest of the world rather than only for UK risks. However, this is being asked at only a very high level of sectoral breakdown. It aims at providing the PRA with a map of where firms' and industry's exposures lie across both property and liability. This will provide the PRA with an understanding of sectoral accumulations and assist the PRA's preparedness in the event of a significant loss.

9.1 DEFINITION

The intention of this section is to capture the exposures of UK general insurers to various sectors of the economy. It is not a scenario but it will allow the PRA to build a map of exposures for individual firms and across the GI sector with the potential to use this information for assessing the impact of future loss events.

The information collected would enable the PRA to better tailor its supervisory activities post any liability catastrophe scenario by prioritising those firms with the largest exposures to the impacted sectors.

The PRA acknowledges the limitations arising from only partial coverage of exposures, from capturing only one year's worth of exposures, from likely inaccuracies in mapping to industry sectors, and from differences in policy coverage and wording, attachment point, reinstatement provisions and exclusions, among other considerations.

Nonetheless the PRA believes analysing historical events is limited as a guide to evaluating future potential liability catastrophes and that an analysis of exposure information could supplement useful information at both firm (micro) and sector (macro) level. This is especially so at a time of the insurance cycle when many insurers are expanding their liability business.

The PRA acknowledges that some firms are developing their ability to capture liability exposure information. While recognising the good progress made to date by some firms and the information supplied in GIST2017, this request leverages best practice in the industry for the benefit of broader oversight of liability accumulations. As in 2017, the PRA will feed back to the industry our summary of the exposures by high-level sector classification.

9.2 INFORMATION REQUESTED

Firms are requested to provide the number of policies, gross written premiums and total limits exposed through their different products offered by each sector of the economy. The sectors of the economy are delineated by using the traditional Standard Industrial Classification (SIC) grouping but at a much higher level than requested for in GIST2017. Each policy is to be allocated to one SIC code based on the most relevant SIC code for the policyholder.

For 2019 and after taking on board firms 2017 submissions, the PRA is only requesting this information for SIC codes at a lower degree of granularity than before ie at a higher sectoral level.

Many firms will already have a sectoral allocation that can be used or mapped to our requested codes. If need be, a description of the various sectors and codes is provided by the ONS.[1]

1 Available at www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007.

The information requested in this section is to be provided for all in-force policies as at 1 January 2019 and is only being requested for direct commercial business. Personal lines and treaty reinsurance business are specifically excluded. Firms are requested to provide the information split by coverage provided ie: Property; Motor; Employers' Liability; General Liability or Public Liability; Errors & Omissions or Professional Indemnity; Directors & Officers; Trade Credit; and all other classes. For commercial motor where liability is unlimited, total limits exposed are not requested.

Where there are multiple policyholders under a policy, it will suffice to use the holding company or the largest company under the policy. Where there are multiple layers to a policy or policies, the PRA prefers firms to consider these as one policy. Where there are multiple reinstatements or an aggregate limit, the PRA prefers firms to provide the aggregate limit provided. Where the number of reinstatements is unlimited, firms should estimate a reasonable aggregate limit using a sensible or rule of thumb approach, disclosing the assumption made.

For policies which have been written through delegated authorities or schemes or facilities, where firms receive information through bordereaux, firms should allocate individual policies or risks under these contracts to the relevant SIC codes. Firms may do this on the basis of known bordereaux or expiring risks adjusted for the estimated premium income for 2017.

9.3 SCOPE: WORLDWIDE

The PRA is no longer restricting the scope of this section to UK policyholders only. Firms are requested to provide the information for the totality of their commercial book split into three geographical groups, namely the UK, the US and the rest of the world

9.4 REPORTING

A standardised template is provided in the GIST2019 Template.xls workbook capturing the number of policies, gross written premiums and total limits exposed for each SIC code for the various product lines. Exposures underwritten at Lloyd's and non-Lloyd's exposures are to be provided separately.

For the avoidance of doubt, this information will be held by the Bank and will not be disclosed at a firm level to any third parties. However, the PRA may release aggregate sector information where there are a sufficiently large number of risks to avoid individual firm identification.

9.5 FEEDBACK

The PRA will use the information collated to develop our view of the aggregate exposures to various sectors of the economy and the PRA will feed back aggregate results to the industry.

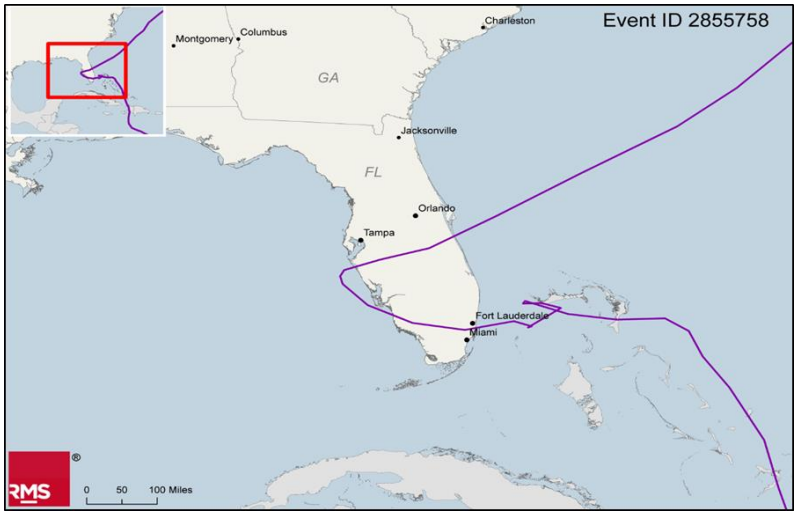
At the request of firms, the PRA will share with the firm our assessment of their exposures relative to the market.

ANNEX I

NATURAL CATASTROPHE SCENARIOS – ADDITIONAL INFORMATION

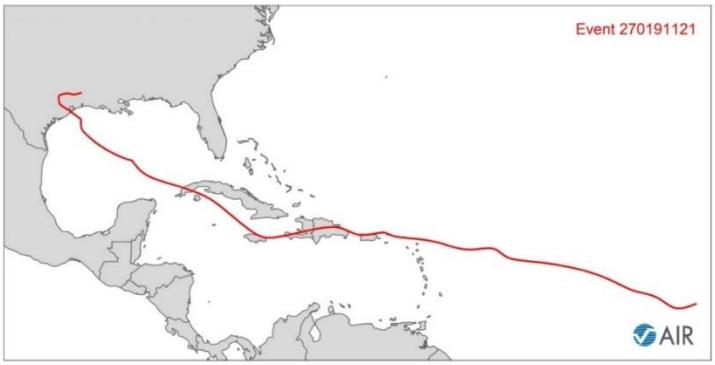
US Hurricane set of events

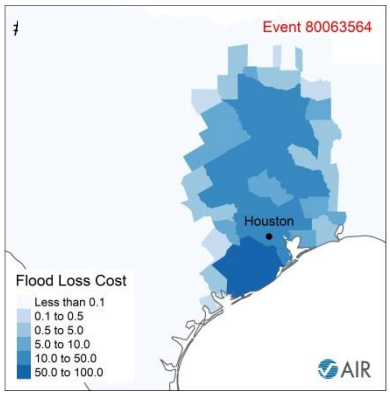
Irma-like hurricane hitting Florida

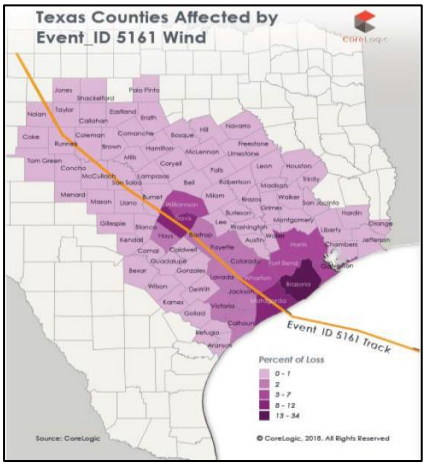


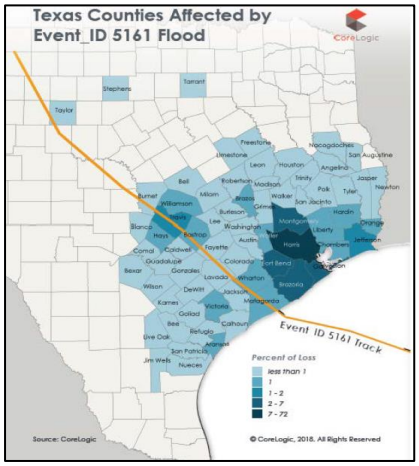
Modelled hurricane track as modelled by RMS.

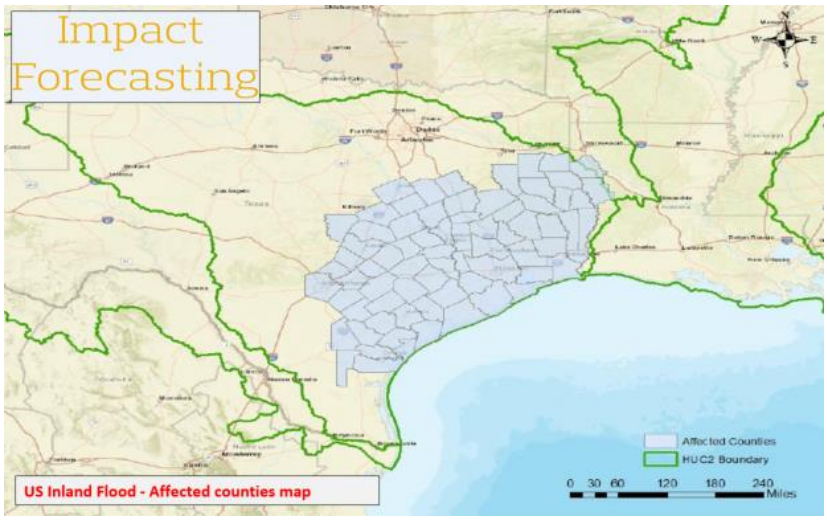
Second hurricane hitting Houston

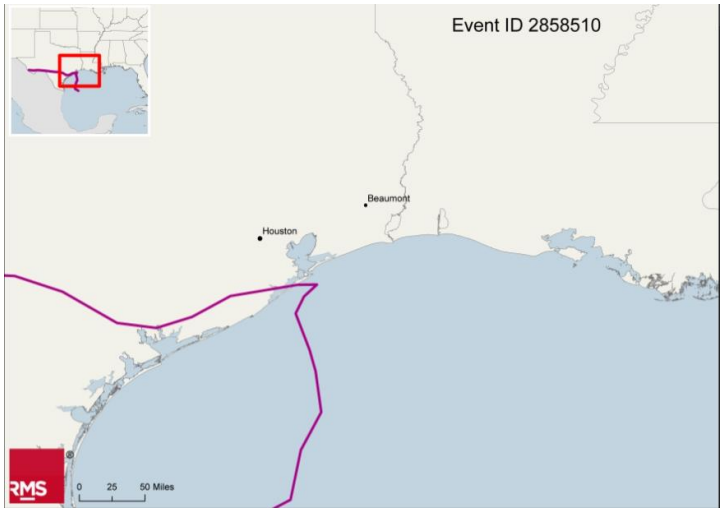






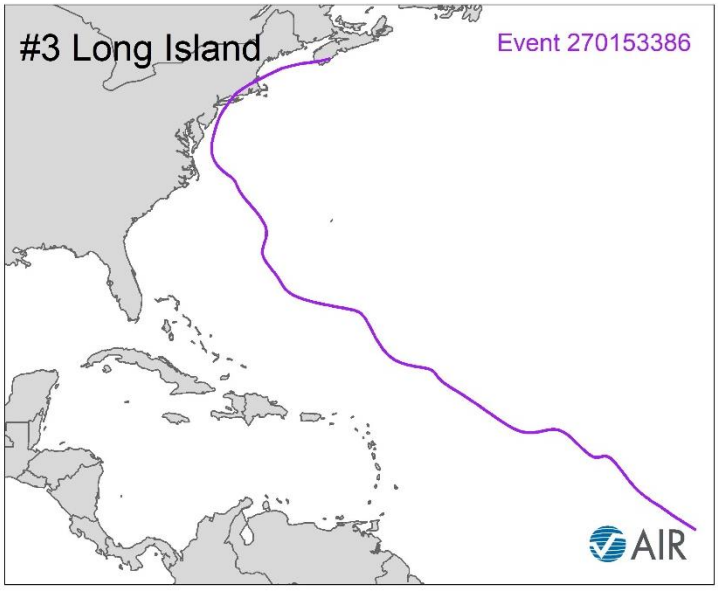






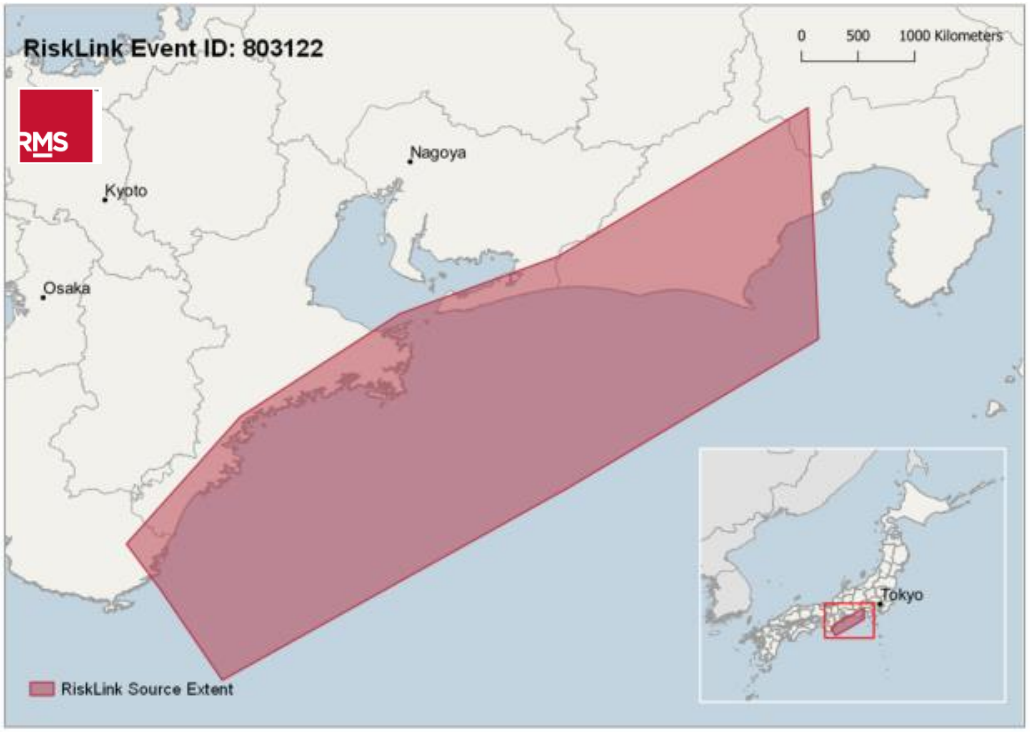
Modelled hurricane tracks and corresponding flood footprint (where provided) as modelled by AIR, Corelogic, Impact Forecasting and RMS.

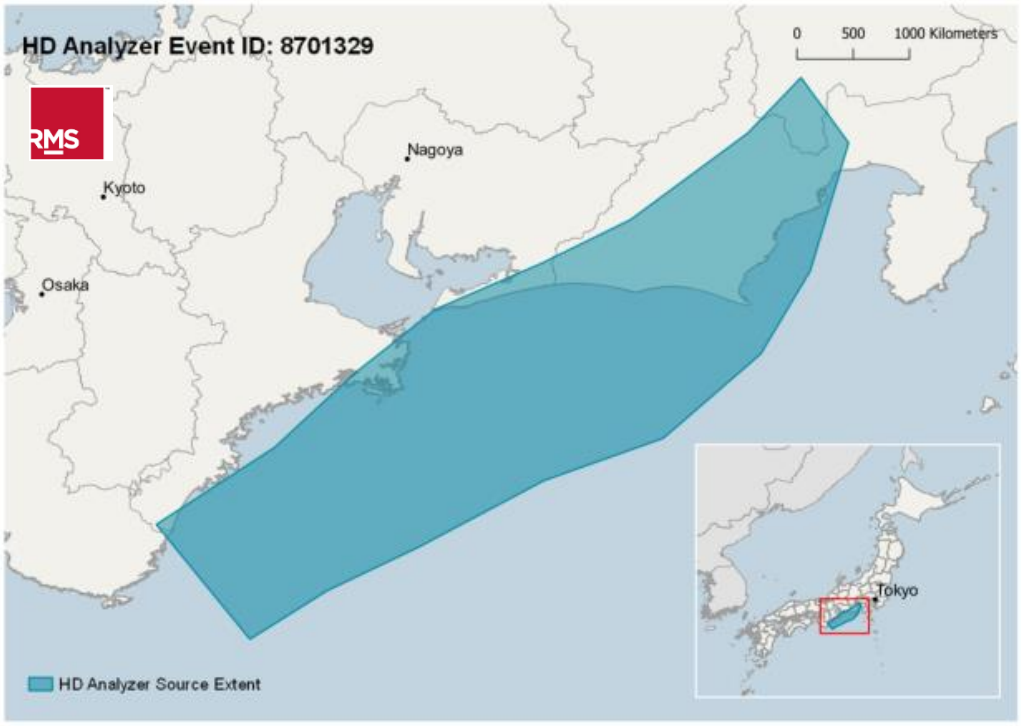
Third hurricane affecting the north east coast



Modelled hurricane track as modelled by AIR.

Japanese Earthquake and Tsunami

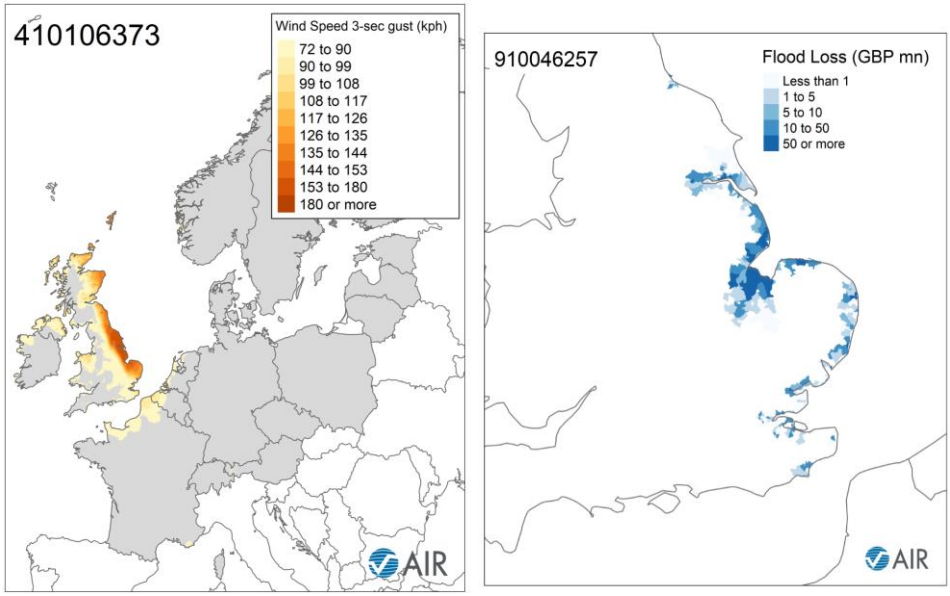




Tokyo earthquake fault as modelled RMS Risk Link (top) and RMS HD (bottom).

UK windstorm

First event: UK windstorm and storm surge



UK Windstorm (left) and Storm Surge (right) footprints, as modelled by AIR.

ANNEX II

CLIMATE CHANGE SCENARIOS – ADDITIONAL INFORMATION

The background information provided in this Annex is to aid the firms understand the basis upon which expert judgement assumptions were developed in creating the climate change scenario analysis parameters. The information provided below is neither an example of a thorough nor exhaustive research effort to develop climate change scenarios. Instead this information is shared in aim of full transparency of underlying assumptions. Since the aim of the scenario analysis as part of the Insurance Stress Test 2019 exercise is principally exploratory, the information upon which the scenarios were based upon are nor representing the latest research and understanding that would permit an insurance firm to build their own climate change scenarios. Future Bank of England initiatives such as the NGFS will provide with further information to support firms build their own climate change scenarios.

Physical Risk

- The development of hypothetical values affecting US Hurricane are based on the PRA-led working group discussions leading to the publication of the Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector[1] and particularly literature review analysed and discuss with catastrophe model development firms including AIR, KatRisk and RMS, supplemented by discussions with experts in the market and academics[2]. The

[1] PRA (2019), in press.

[2] Sources: Bhatia, K., G. Vecchi, H. Murakami, S. Underwood, and J. Kossin, 2018: Projected response of tropical cyclone intensity and intensification in a global climate model. J. Climate, in review; and

Crompton, R. P., R. A. Pielke Jr., and J. K. McAneney, 2011: Emergence time scales for detection of anthropogenic climate change in US tropical cyclone loss data. Environ. Res. Lett., 6, 014003, doi:10.1088/1748-9326/6/1/014003; and

Donnelly JP, Hawkes AD, Lane P, MacDonald D, Shuman BILLION, Toomey MR, van Hengstum P,

Woodruff JD. Climate forcing of unprecedented intense-hurricane activity in the last 2,000 years. Earth Future 2015, 3:49–65. doi:10.1002/2014EF000274; and

Emanuel K, Sobel A. Response of tropical sea surface temperature, precipitation, and tropical cyclone-related variables to changes in global and local forcing. J Adv Model Earth Syst 2013, 5:447–458; and

Emanuel, K. E., 2017: Assessing the present and future probability of Hurricane Harvey's rainfall. Proc. Natl. Acad. Sci. USA, 114, 12 681–12 684, doi:10.1073/pnas.1716222114; and

Klotzbach, P.J.; Bowen, S.G.; Pielke, R., Jr.; Bell, M. Continental United States hurricane landfall frequency and associated damage: Observations and future risks. Bull. Am. Meteorol. Soc. 2018; and

Knutson TR, McBride JL, Chan J, Emanuel K, Holland G, Landsea C, Held I, Kossin JP, Srivastava AK, Sugi M. Tropical cyclones and climate change. Nat Geosci 2010, 3:157–163. doi:10.1038/ngeo0779; and

Knutson TR, Sirutis JJ, Zhao M, Tuleya RE, Bender M, Vecchi GA, Villarini G, Chavas D. Global projections of intense tropical cyclone activity for the late 21st century from dynamical downscaling of CMIP5/RCP4.5 scenarios. J Clim 2015, 28:7203–7224; and

Kossin, J. P., 2018: A global slowdown of tropical cyclone translation speed. Nature, 558, 104-108; and

Levin E., and Murakami, H. Examining the Sensitivity and Impact of Anthropogenic Climate Change on North Atlantic Major Hurricane Landfall Drought and Activity. Presented at AMS 2018 https://ams.confex.com/ams/33HURRICANE/webprogram/Paper339882.html; and

Murakami H, Vecchi GA, Underwood S, Delworth T, Wittenberg AT, Anderson W, Chen J-H, Gudgel R, Harris L, Lin S-J, et al. Simulation and prediction of category 4 and 5 hurricanes in the high-resolution GFDL HiFLOR coupled climate model. J Clim. 2015 and

Peduzzi P, Chatenoux B, Dao H, De Bono A, Herold C, et al. Global trends in tropical cyclone risk. Nat Clim Change 2012, 2:289–294; and

Stott, P. A., Christidis, N. , Otto, F. E., Sun, Y. , Vanderlinden, J. , van Oldenborgh, G. J., Vautard, R. , von Storch, H. , Walton, P. , Yiou, P. and Zwiers, F. W. (2016), Attribution of extreme weather and climate-related events. WIREs Clim Change, 7: 23-41. doi:10.1002/wcc.380; and

Walsh, K. J. E., and Coauthors, 2015: Tropical cyclones and climate change. Wiley Interdiscip. Rev.: Climate Change, 7, 65–89, doi.org/10.1002/wcc.371.

hypothetical values put forward in this exploratory exercise do not represent the opinions of the above-mentioned sources.

- The development of hypothetical values affecting UK Flood are based on the PRA-led working group discussions leading to the publication of the Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector and literature review analysed and presented by JBA Risk Management and Ambiental supplemented by discussions with the Environment Agency and the MetOffice. The hypothetical values put forward in this exploratory exercise does not represent the opinions of the above-mentioned sources.

Transition Risk

- The values related to the set of assumptions behind the Energy section have been developed based on International Energy Agency's World Energy Outlook (2018) assuming projections given an interpretation of the New Policies/Current Policies and Sustainable Development scenario projections.
- To support the investment portfolio segmentation, indicative NACE and GICS codes are provided as examples of the sectors inferred.

Sector	% Exposure to NACE sector	GICS sector
Energy	D35 Production of electricity D35.11 Production of electricity, to be supplemented with additional classification by source: oil, gas, coal, renewable energy (solar, wind, hydro, geothermal, nuclear)	55: Utilities, broken down to industry leve (electric, gas, multi-utilities, water, independent power and Renewable energy producers)
	5.1 Mining of hard coal 5.2 Mining of lignite 6.1 Extraction of crude petroleum 6.2 Extraction of natural gas 8.92 Extraction of peat 9.1 Support activities for petroleum and natural gas extraction	10 Energy: 101020 Oil, gas and consumable fuels
Transport	D34: Manufacture of motor vehicles, trailers and semi-trailers (supplemented by percentage of EV) D35 manufacture of other transport equipment	2030: Transport 2510: Automobiles and components
	H 50.1 Sea and coastal passenger transport H 50.2 Sea and coastal freight water transport H51.1 Passenger air transport H51.2 Freight air transport	
Materials/ Metals/ Mining	C19 Manufacture of coke and refined petroleum products C20 Manufacture of chemicals and chemical products C 23.51 Manufacture of cement C24.1 Manufacture of basic iron and steel and of ferro-alloys C24.52 Casting of steel	15 – Materials 151010 – Chemicals 151040 – Metals and mining
Water, Agriculture & Food Security	A: agriculture, forestry, and fishing A1.41: Raising of dairy cattle	301010 Food & Staples retailing

Real Assets (inc. CRE & infrastructure)	L – Real estate activities	60 – real estate

- To aid the assessment of sovereign credit risk, firms are invited to estimate by linearly interpolating the country rank based on a published source. For instance, using the Notre Dame country vulnerability ranking: Switzerland under Scenario A will suffer 5 basis points downgrade whilst Albania 30.
- Transition Risk assumptions were developed based on discussions with experts in the field and material[1] reviewed for purposes of this exploratory exercise.

[1] Sources: 2 degrees investing initiative (2016); Transition Risk Toolbox; and

CISL (2015); Unhedgeable risk; and

CRO Forum (2019); The heat is on – insurability and resilience in a changing climate; and

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Ralite, S., and Thoma, J for the 2O investing initiative (2019); Storm Ahead: A proposal for a climate stress-test scenario. Discussion Paper; and

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UNEP FI - Acclimatise (2018); Navigating a New Climate.

ANNEX III

ABBREVIATIONS USED

AAL	Annual Average Loss
ACS	Annual Cyclical Scenario
AEP	Aggregate Exceedance Probability
AOF	Ancillary Own Funds
BOF	Basic Own Funds
CC	Climate Change
CQS	Credit Quality Step
PD	Probability of Default
E(.)	Expected Value
EEA	European Economic Area
EIOPA	European Insurance and Occupational Pensions Authority
ERM	Equity Release Mortgages
FS	Fundamental Spread
FRN	Firm Reference Number
£	Great Britain Pound
IAS	Insurance Asset Shock
IM	Internal Model
IMAP	Internal Model Approval Process
IST	Insurance Stress Test
LEI	Legal Entity Identifier
LGD	Loss Given Default
LTAS	Long Term Adjustment Spread
MA	Matching Adjustment
MAP	Matching Adjustment Portfolio
Nat Cat	Natural Catastrophe
OEP	Occurrence Exceedance Probability
OF	Own Funds
PRA	Prudential Regulatory Authority
SCR	Solvency Capital Requirement
SD	Standard Deviation
SII	Solvency II
TMTP	Transitional Measures on Technical Provisions
TP	Technical Provisions
VA	Volatility Adjustment
VAR	Value At Risk
UFR	Ultimate Forward Rate
US$	United States Dollar

ANNEX IV

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