BANK OF ENGLAND
PRUDENTIAL REGULATION
AUTHORITY

General Insurance Stress Test 2019

Scenario Specification, Guidelines and Instructions

FINAL

18 June 2019

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 are 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.

PLEASE DO NOT AMEND THE SPREADSHEET. This includes moving information around, inserting or deleting rows or columns. If firms do amend the spreadsheet they will be asked to resubmit information using the original spreadsheet provided.

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 five severe but conceivable scenarios: four natural catastrophe scenarios and a separate claims inflation scenario.
2. Section C is exploratory in nature, and designed to capture information relating to how different firms are managing difficult to assess risks. It comprises of (i) a new climate change exploratory exercise; (ii) repeat of 2017 data request for exposures that will allow the PRA to better understand the impact of potential losses by various sectors of the economy, and (iii) an exploratory cyber underwriting loss scenario.

Section A: Deterioration in the economic environment

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); and a fall in other asset values (including equities down 30%, commercial property down 40% and residential property down 30%).

Section B: Liability shock scenarios

The four natural catastrophe 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 ~ 8.1 with its epicentre close to Tokyo followed by a tsunami, generating some $37 billion of total industry insured loss.

Scenario 5: Scenario 1 and a large UK windstorm and a large UK flood leading to some £20 billion of losses in aggregate to the UK insurance sector.

The final liability shock scenario is not coupled with the deterioration in the economic scenario:

Scenario 6: 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.

Section C: Climate change, liability exposure management, cyber underwriting scenario

This Section is exploratory in nature, and designed to capture information to help understand how different firms are managing difficult-to-assess risks – in this case (i) climate change related risks; (ii) liability exposure management; and (iii) a cyber underwriting loss scenario. We expect that market feedback will enhance developments in this area, increase Board awareness, and will supplement supervisors' 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 liabilities and asset valuations. These scenarios are expressed by their climatic and financial impacts. The set of assumptions underlying each scenario is developed based on our interpretation of available literature and is provided to ensure that firms

complete the return on the same basis. Therefore, the set of assumptions presented should 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 they may 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.

Cyber underwriting loss scenario: this section asks firms to consider a specific 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. The scenario specification is intentionally high-level, such that firms will need to make additional assumptions in order to assess the potential claims. We recognise that this considerably reduces the ability to compare financial loss impacts across firms, but should provide additional understanding of the industry's sophistication and the different approaches taken in estimating the potential sources of loss given a cyber event. This information will be used to improve and develop future stress tests in this area.

Section C is on a best endeavours basis.

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

COORDINATION WITH THE BERMUDA MONETARY AUTHORITY

We are 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.
Interconnectedness	Enhance our understanding of the interconnectedness between our jurisdictions, especially arising 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.

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 losses 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 common issues are identified.

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.

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

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

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 tab. 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 tab 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 Own Funds – Base Case and SCR scenario

Firms are required to project the movement in their Own Funds for the year ending 31/12/2019. This should be in line with the firm's business plan and is referred to as the 'base case'.

A separate projection representing the movement in Own Funds according to the SCR scenario should be completed alongside the 'base case' on the 2019 Projection tab.

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 tab, and the components of the SCR projection should be consistent with the risk charges in the SCR. Firms should explain on the Free Form Comments tab how the SCR projection has been derived, and any difference between the total projected movement and the amount of the 2018 SCR.

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.

Projecting Own Funds –following a Stress

For each stress, firms are required to quantify the impact on Own Funds and their estimated SCR as at 31/12/2019. As in the previous stress test, firms are required to provide a breakdown of the impact on Own Funds between the direct stress, market adjustments and any management actions. For all projections, 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 tab, in Scenario A to B4 and Section C3 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.

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 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 such that the loss before allowance for any reinsurance is less than 5% of total gross written premium. Firms can ignore the impact of the asset shock when assessing materiality for those scenarios in Section B.

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

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 Sections A and B of the Excel template is required by **17:00 on Monday 30 September 2019**.

Submission of Section C of the Excel template is required by **17:00 on Thursday 31 October 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, senior management 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.

Please include a covering email on submission to confirm that "senior management are satisfied with the submission and that the information provides a reasonable estimate of own funds and the SCR after each stress scenario".

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 the first quarter of 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

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. General insurers should assume that this stress occurs instantaneously towards the end of 2019, allowing for changes in the business (eg premiums, claims, investments) per the business plan until the point of the stress. This is intentionally different from the life stress (where the stress is assumed to occur at the beginning of the year), reflecting the importance of new business in assessing solvency and capital requirements for general insurers.

1.1 EVENT DEFINITION

This section sets out the movements in key macroeconomic variables or market indices. Note that the stresses apply to all economies.

<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, Government Guaranteed Bonds and Supranationals</u></td><td>Firms should assume that there is no spread stress to sovereign assets. For the avoidance of doubt, firms should apply the interest rate stresses above to sovereign assets.</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 ‘sovereign’ and does not vary by duration or sector.</td></tr>
</table>

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 and moneyness 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. Firms should assume that CDS derivatives change in value in a way that is consistent with changes to the reference underlying assets. The approach taken for significant CDS positions should be set out and validated by firms. In doing so firms should consider the anticipated credit quality of the swap counterparty following the stress if the derivative is not centrally cleared.
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 ADDITIONAL ASSUMPTIONS

1.2.1 Pension scheme discount rate

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 and what management actions they anticipate taking.

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, based on a range of vendor model event IDs. Firms are to assume that the hurricanes are sufficiently separated in time to be considered as three separate events for the purposes of reinsurance recoveries.

This stress is superimposed on the insurance asset shock scenario. Firms should assume that the asset shock specified in Section A precedes the natural catastrophe event.

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. Firms should assume that the time between events maximises the potential for post loss amplification. For Scenario B1 the estimate of post loss amplification should include any specific estimate of the impact from the Assignment of Benefits.

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 and between the 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 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) included in 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 their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected. 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.

This stress is superimposed on the insurance asset shock scenario. Firms should assume that the asset shock specified in Section A precedes the natural catastrophe event.

3.2 ASSUMPTIONS

In estimating the gross loss, firms are asked to allow for post loss amplification (demand surge), using their natural catastrophe modelling capabilities. Firms should assume that the time between events maximises the potential for post loss amplification.

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 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.

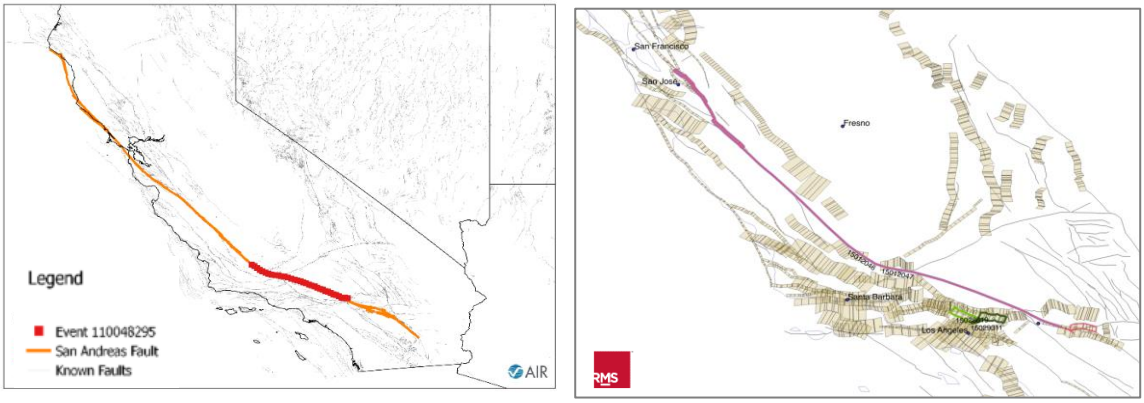
Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers 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 only (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 ie on the Raymond Fault.



California earthquake fault as modelled by AIR (left) and RMS (right). Please note the difference in maps scales.

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 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 liquefaction), 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) included in 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, liquefaction and tsunami).

Firms should provide details of their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected. 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 Trough 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 section 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 rupture 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$24 billion using the RMS HD model (US$19 billion according to RMS RiskLink 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 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.

This stress is superimposed on the insurance asset shock scenario. Firms should assume that the asset shock specified in Section A precedes the natural catastrophe event.

4.2 ASSUMPTIONS

In estimating the gross loss, firms are asked to allow for post loss amplification (demand surge), using their natural catastrophe modelling capabilities. Firms should assume that the time between events maximises the potential for post loss amplification.

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 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.

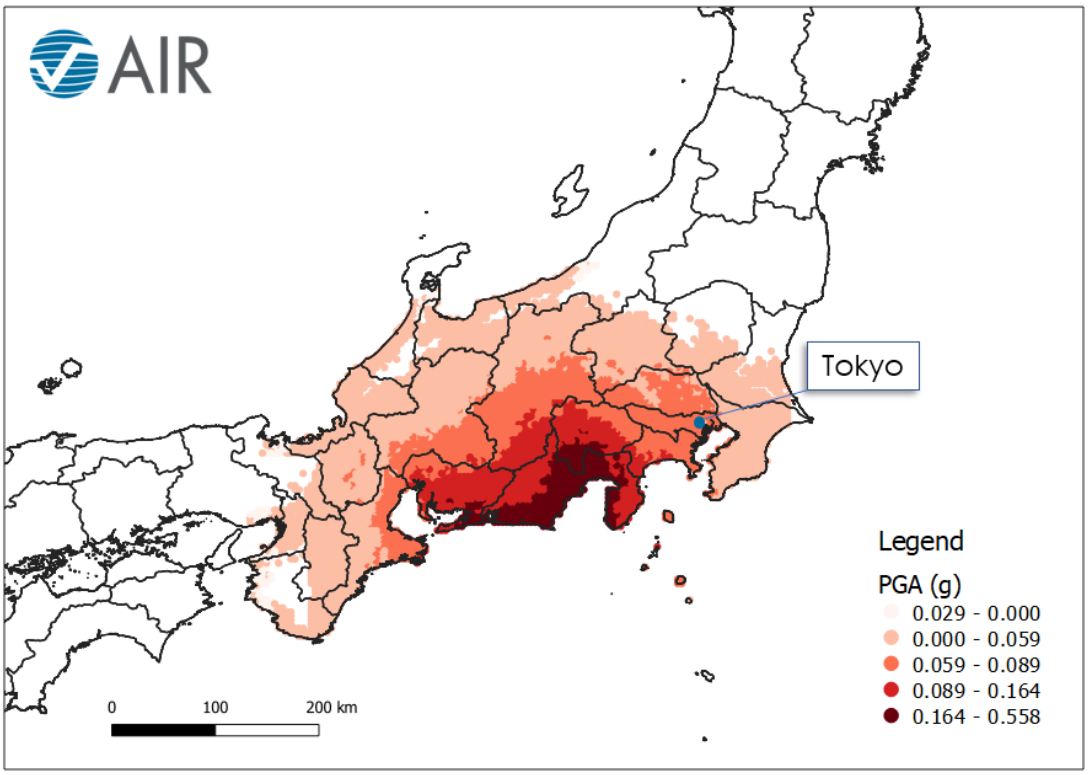
Firms should assume the event fall under the reinsurance treaties in-force as at the beginning of the year and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases 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 RiskLink	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

* For RMS the figures represent the centroid.

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 liquefaction), 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 their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected. 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.

This stress is superimposed on the insurance asset shock scenario. Firms should assume that the asset shock specified in Section A precedes the natural catastrophe event.

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.

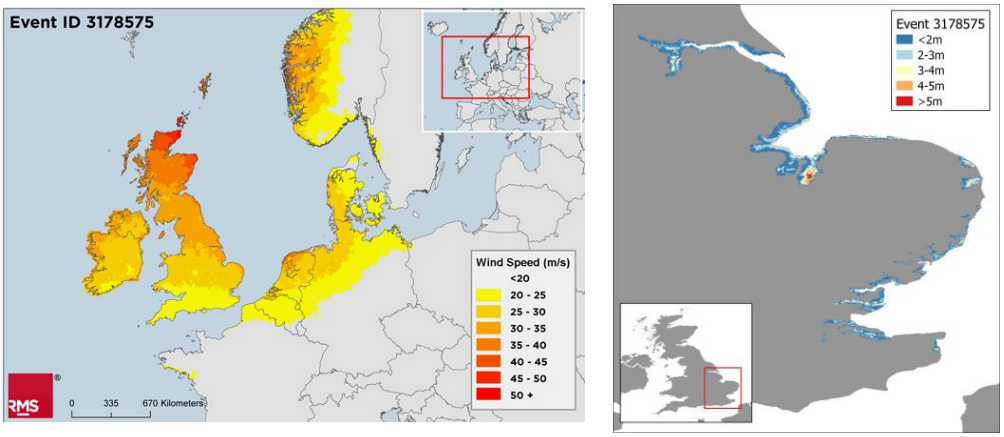
For this scenario we invite firms to list the following information relating to loss adjusters which PRA aims to gather to inform operational stresses to the industry:

- 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 for reserving purposes.

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).

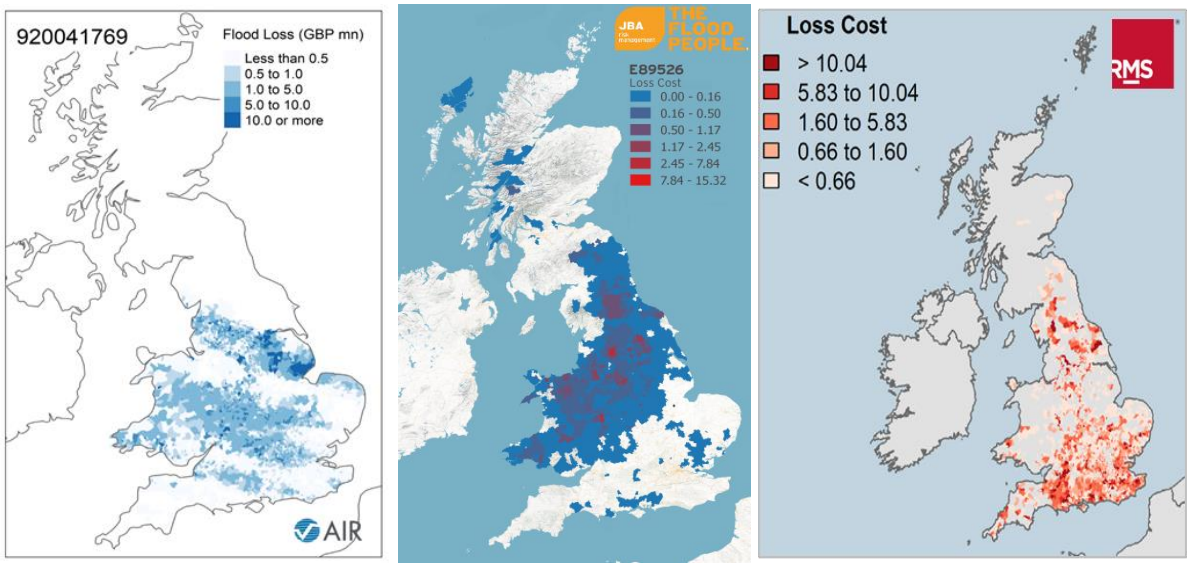


UK Windstorm (left) and Storm Surge (right) footprints, as modelled by RMS. Refer to Annex I for figures from other model provider(s).

The RMS Event ID is 3178575 (Version 18) causing approximately £10 billion of industry losses 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 and Wales)

For the second event, firms are to assume extensive pluvial and fluvial flooding across England and Wales from a sequence of rainfall events throughout the season. This event causes a gross loss in the order of £10-12 billion, with the event lasting more than 140 hours across England and 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 HD (right).

The closest matching JBA Event ID is 89526 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. Firms should assume that the time between events maximises the potential for post loss amplification.

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, inland flood).

Firms should provide details of their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected. 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 assumes that the claims environment changes and firms respond by allowing for an additional 2% claims inflation over the next 10 years.

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.

Note unlike the natural catastrophe scenarios, this stress does not follow the asset scenario in Section A and the stress is assumed to occur at the beginning of the year rather than the end. This difference in approach (relative to the other scenarios in Section B) has been adopted to reduce the burden on firms - specifically firms will not be required to project their TPs at a granular level to end 2019 before applying the stress.

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 until the liabilities are extinguished or 10 years whichever is sooner.

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 base case claims TPs by line of business.

Section C1

7. CLIMATE CHANGE SCENARIOS

The potential financial impacts of climate change are well-documented. Furthermore, the PRA's recent 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 exploratory 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 those firms that have already made sufficient progress in developing climate change scenarios, we ask firms to outline the assumptions behind those 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. 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.

7.1 PART 1: POTENTIAL QUANTITATIVE IMPACTS UNDER SPECIFIC SOCIO-ECONOMIC AND CLIMATIC CONDITIONS

7.1.1 Background

Firms are requested to consider the expected impact under three different climatic states on their assets, liabilities and business models, assuming that their current insurance exposures and their investment profile remain constant. In essence, we ask firms to undertake an instantaneous sensitivity analysis on today's balance sheet under three differing climate scenarios.

[1] PRA expectations set out in SS3/19 'Enhancing banks' and insurers' approaches to managing the financial risks from climate change' available at: https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/supervisory-statement/2019/ss319.

As a background to interpreting these three hypothetical scenarios, we refer to the Paris Agreement that has set out climate targets for the forthcoming decades. Meeting these targets will require significant structural changes in the economy over the coming years and decades. Our first two scenarios assume that the Paris Agreement targets are broadly achieved, although through different means. In the third scenario, it is assumed that the targets are not met, resulting in a significant impact on the global climate.

To understand how each scenario could impact financial risks we consider two primary channels: physical and transition. Physical risks for this exercise are defined as the first-order risks that arise from weather-related events such as storms, floods, subsidence and freeze. Transition risks are those that arise from the adjustment towards a carbon-neutral economy – the severity of the impact will depend on whether the transition is orderly or disorderly[1]. The PRA recognises that the sequence and timing of physical and transition risks under an emissions scenario can be interdependent, a complexity that is purposely excluded from this exploratory exercise.

7.1.2 Exploratory climate scenarios

Scenario A: A sudden transition (a Minsky moment[2]), ensuing from rapid global action and policies, and materialising over the medium-term business planning horizon that results in achieving a temperature increase being kept below 2°C (relative to pre-industrial levels) but only following a **disorderly transition**. In this scenario, transition risk is maximised. The scenario is based on the type of disorderly transitions highlighted the IPCC Fifth Assessment Report (2014)[3]. [*Shock parameters illustrative of potential impact in 2022*]

Scenario B: A long-term **orderly** transition scenario that is broadly in line with the Paris Agreement. This involves a maximum temperature increase being kept well below 2°C (relative to pre-industrial levels) with the economy transitioning in the next three decades to achieve carbon neutrality by 2050 and greenhouse-gas neutrality in the decades thereafter. The underlying assumptions for this Scenario are based on the scenarios assessed in the IPCC Special Report on Global Warming of 1.5°C (2018)[4]. [*Shock parameters illustrative of potential impact in 2050*]

Scenario C: A scenario with failed future improvements in climate policy, reaching a temperature increase in excess of 4°C (relative to pre-industrial levels) by 2100 assuming no transition and a continuation of current policy trends. Physical climate change is high under this scenario, with climate impacts for these emissions reflecting the riskier (high) end of current estimates[5]. [*Shock parameters illustrative of potential impact in 2100*]

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[1] Prudential Regulation Authority (2015), The impact of climate change on the UK insurance sector. Prudential Regulation Authority (2018), Transition in thinking: The impact of climate change on the UK banking sector. CRO Forum (2019); The heat is on: insurability and resilience in a changing climate. Emerging Risk initiative – Position Paper.

[2] UN PRI (2018); The inevitable policy response: act now. Forcing the climate transition. UNEP Finance Initiative. United Nations Global Compact. https://www.unpri.org/climate-change/the-inevitable-policy-response-to-climate-change/3578.article

[3] 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., Figure SPM.12. 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.

[4] Scenario B is based on the „1.5°C-low-OS" scenario category which keeps the maximum temperature increase below 2°C with greater than 80% probability and which results in median temperature increase projections of 1.5–1.6°C relative to pre-industrial levels). From: Rogelj et al (2018). Mitigation pathways compatible with 1.5°C in the context of sustainable development. Global Warming of 1.5 °C: an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [G. Flato, et al (eds)] Geneva, Switzerland, IPCC/WMO**:** 93-174. This scenario's physical climate change is consistent with an SSP1 or SSP2 RCP1.9 scenario: Rogelj et al (2018). "Scenarios towards limiting global mean temperature increase below 1.5 °C." Nature Clim. Ch. 8(4): 325-332.

[5] Emissions in this scenario would be consistent with a continuation of current weak climate policies as included in the current Nationally Determined Contributions (NDCs) as assessed in the Intergovernmental Panel on Climate Change's (IPCC) Special Report on Global Warming of 1.5°C (2018), and assume a physical climate

7.1.3 Translating climate scenarios into possible business model impacts

All three scenarios are referencing temperature targets that reflect different underlying greenhouse gas emission transition pathways, and which are assumed to impact firms at different points in time (2022, 2050 and 2100). However, to ensure cross-firm consistency in assessing the possible impact, firms are requested to assume that each scenario is considered as an instantaneous shock on the investments and liabilities as at 31 December 2018. (Note this scenario is not being used to assess capital resilience). The PRA recognises that when considering second and third order effects of climate change impacts there may be a dependency between impacts on investments and liabilities, something that is not addressed in this exploratory exercise.

In addition, firms are requested to assess and report separately on the impacts from transition and physical risks on their investments and liabilities. Figure 1 summarises the extent to which transition and physical risk is captured within each of the scenarios.

Figure 1: Outline of Climate Change scenario coverage against the different segments of participating insurers' balance sheets

Scenario coverage	**Life insurers**		**General insurers**	
	Investments	*Liabilities*	*Investments*	*Liabilities*
Physical risk	Scenario A Scenario B Scenario C		Scenario A Scenario B Scenario C	Scenario A Scenario B Scenario C
Transition risk	Scenario A Scenario B		Scenario A Scenario B	

7.1.4 Deriving the assumptions and financial impacts for each scenario

The set of assumptions on climatic and financial impacts under the three scenarios are purposely non-exhaustive as the goal of this 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 made based on our interpretation of readily available literature. Where firms have effected their own assessments of climate-related impacts under different scenarios, they are encouraged to provide those, together with their rationale as part of Part 2 (see Section 7.2). We also encourage firms to consider the resources listed in Annex II as a guide to 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 translate into a meaningful financial impact as a result of climate change. Following the PRA's request for technical input, the following metrics were selected for this exercise:

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response that tracks the high-end of the temperature range assessed by the IPCC Fifth Assessment Report (2014).

See *Cross-Chapter Box 11* in: de Coninck et al (2018). Strengthening and Implementing the Global Response. Global Warming of 1.5 °C: an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. [Abdulla et al (eds)]. Geneva, Switzerland, World Meteorological Organisation; and 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.

- Impact to assumed liabilities: Annual Average Loss (AAL) and 1-in-100 Aggregate Exceedance Probability (AEP).
- Impact to investments: 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.

7.1.5 Assumptions to assess the impact on an insurer's liabilities

The assumptions provided below have been developed for the purpose of this exploratory exercise only and should not be considered as the PRA's forecast or view of how climate change may impact other aspects of the economy.

Table 1 below provides factors to assess the potential impact on the Annual Average Loss and potential changes to the 1-in-100 Aggregate Exceedance Probability for all insurance contracts that could give rise to a claim from natural catastrophes in the UK and the US. For avoidance of doubt, this scenario should not include the potential for insurance liabilities to arise from other policies due to other impacts from climate change.

The following points should be considered when assessing the financial impact and interpreting these assumptions:

- The PRA acknowledges that life insurers' liabilities may also be exposed to physical risk from climate change; nevertheless, to reduce complexity for this exploratory exercise, only the physical risk impact on general insurers' liabilities is considered[1].
- To reduce burden on firms, Table 1 only considers the potential for changes in physical damage in relation to the following natural catastrophic events: US hurricane, UK flood, UK freeze and UK subsidence.
- The PRA is interested in understanding the ability of insurers to interpret the outcomes from background research and turn them into stress test parameters within their own models to assess the financial impacts.
- Firms should assume that all factors (other than those specified in the table) remain constant; such as portfolio evolution, flood defences, artificial drainage, land use change, or absence of management actions.
- Contextually, climate change shocks are developed using a baseline, often set in the literature as the pre-industrial greenhouse emission levels. For the purpose of this exercise, shocks to liabilities have been expressed using the long-term historic average up to 2010 as the base line period that broadly aligns with the period against which that catastrophe models are calibrated. This explains why Scenario A, whose shocks are conceptualised to take place in the near term (2022), features a relatively small shock parameter rather than having none. For the avoidance of doubt, the PRA recognises that whilst the financial impact from physical climate risk will become more evident in the next few decades, there is an element of physical risk that has already materialised[2].
- Against each sector, we have provided an indicative list of references, which is a subset of the bibliography that the PRA used as a basis to interpret research and to derive the shock parameters. The list of references provided is purposely not exhaustive and only indicative to help firms commence their background research.

[1] With reference to the Prudential Regulation Authority (2019) report - "A framework for assessing financial impacts of physical climate change: A practitioner's aide for the general insurance sector", the contents of Table 1 represent the outputs of Stage 3 'Background Research' and we are inviting firms to undertake Stages 4 and 5, providing us with a recount of the key assumptions they made.

[2] Prudential Regulation Authority (2019); A framework for assessing financial impacts of physical climate change: A practitioner's aide for the general insurance sector.

Table 1: Impacts to liabilities from physical risk for General Insurers (refer to text above for a description of each Scenario)

		Transition Risks			Physical Risks		
Sector	Assumptions	Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
US Hurricane exposed LoBs - Hurricanes[1]	% increase in frequency of major hurricanes				5%	20%	60%
	Uniform increase in wind speed of major hurricanes				3%	7%	15%
	% increase in surface run-off resulting from increased tropical cyclone-induced precipitation (cumecs)				5%	10%	40%
	Increase in cm in average storm tide sea-levels for US mainland coastline between Texas and North Carolina. Figures exclude wave set-up and run-up.				10cm	40cm	80cm

[1] Bhatia, KG, Vecchi, G., Murakami, H, Underwood, S., and Kossin, J. (2018); Projected Response to Tropical Cyclone Intensity and Intensification in a Global Climate Model. American Meteorological Society, https://doi.org/10.1175/JCLI-D-17-0898.1.
Kopp, R.E, Horton, R.M., Little, C.M, Mitrovica, J.X, Oppenheimer, M., Rasmussen, D.J., Straus, B.H., Tebaldi, C. (2014); Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. Earth's Future, Vol 2(8).
Emanuel K.E., 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.
Ting, M, Kossin, J.P, Camargo, S.J, Li, C. (2019); Past and future hurricane intensity change along the US East Coast, Nature, Vol 9, 7795
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.
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.
Kossin JP, Olander TL, Knapp KR. Trend analysis with a new global record of tropical cyclone intensity. J Clim 2013, 26:9960–9976.
Rhodium Group, LLC., American Climate Prospectus: Economic Risks in the United States (New York: October 2014).
Prudential Regulation Authority (2019); A Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector: A Practitioner's Aide.

			Transition Risks			Physical Risks		
Sector	Assumptions		Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
UK weather exposed LoBs- flood[1], freeze and subsidence[1]	% increase in surface run-off resulting from increased precipitation (cumecs)					5%	10%	40%
	Uniform increase in cm in average storm tide sea-levels for UK mainland coastline.					2cm	10cm	50cm
	Increase in frequency of subsidence-related property claims using as a benchmark the worst year on record					3%	7%	15%
	Increase in frequency of freeze-related property claims using as a benchmark the worst year on record					5%	20%	40%

Notes:

- For impact to General Insurers' assumed liabilities, firms are advised to consider using available tools[2].
- 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] UK Climate Change Risk Assessment 2017. Corti T, Wuest M, Bresch D and
Seneviratne S I 2011 Drought-induced building damages from simulations at a regional scale Nat. Hazards Earth Syst. Sci. 11 3335–3342.
Harrison A M, Plim J F M, Harrison M, Jones L D and Culshaw M G 2012 The relationship between shrink–swell occurrence and climate in south-east England Proc. Geol. Assoc. 123 556–575.
Pritchard O G, Hallett S H and Farewell T S 2015 Probabilistic soil moisture projections to assess Great Britain's future clay-related subsidence hazard Clim. Change 133 635–650.

[2] Prudential Regulation Authority (2019); A Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector: A Practitioner's Aide.

7.1.6 Assumptions to assess the impact on an insurer's investments

The assumptions provided below have been developed for the purpose of this exploratory exercise only and should not be considered as the PRA's forecast or view of how climate change may impact other aspects of the economy.

Table 2 below provides factors to assess the potential impact on the market valuations and changes to the 1-in-100 Value-At-Risk measure for equities and bonds under the three climatic scenarios.

The following points should be considered when assessing the financial impact and interpreting these assumptions:

- 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 available tools, data and systems.
- The table below provides assumptions affecting equities. We ask insurers to use the starting valuations as at the date on which the test is conducted (31 December 2018) – the shock parameters provided are already discounted to today's values.
- The PRA recognises that the impact of climate change to corporate bonds is more complex than the impact it may have on equities, and that there are different views on how those impacts interplay. For the purposes of this exploratory exercise, we invite firms to consider the impact on corporate bonds by applying a flat multiplier of 15% compared to the impact on equities (so that the impact on corporate bonds equals 0.15 times the impact on equities). For the avoidance of doubt, the shock parameters in the tables below are to be applied to the current asset price – in other words, shocks are applied at the respective time points in the future but assessed in terms of the NPV on balance sheets today assuming the discounting is already accounted for when deriving the shock parameters. We are not expecting firms to roll forward the value of the asset price in the future.
- Please note that the main differences between Scenarios A and B are: (i) the underlying assumption between disorderly and orderly transition; and (ii) the point in time at which the shocks occur. Hence the impact is instantaneous on the insurers' balance sheets but the shocks occur at different times in the future for each scenario.
- The table below provides factors to assess the potential impact on the market value of investments from transition and physical risks in each of the climate scenarios. The PRA recognises that the timing and sequence of financial impacts from climate change will in practice be complex, as changes in behaviour could mean that either physical risk could precede transition risk or vice versa. For simplicity, where the scenario contains both of these risks, they should be applied as consecutive shocks, so firms should assume that the physical risk factor is applied second, after allowing for the impacts of the transition risk. For the avoidance of doubt, for "fuel extraction" and "power generation", the impacts from transition risks are applied to specific segments whilst for the physical risks impacts are applied across the overall sector. The excel template requires firms to record both of these impacts separately.
- Against each sector, we have provided with an indicative list of references, which is a subset of the bibliography that the PRA used as a basis to interpret research and to derive the shock parameters. The list of references provided is purposely not exhaustive and only indicative to help firms commence their background research.

Table 2: Impacts on investments from both physical and transition risk for Life and General Insurers (refer to text above for a description of each Scenario)

			Transition Risks			Physical Risks		
Sector	% of investment portfolio in following sectors	Assumptions	Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
Fuel extraction[1]	Gas/Coal/Oil (inc. crude)	Change in equity value for sections of the investment portfolio comprising material exposure to the energy sector as per below:						
		Coal Oil Gas	- 45% - 42% -25%	-40% -38% -15%			-5%	-20%
Power generation[1]	Power transmission and delivery of natural gas and, renewables (production and transmission)	Coal Oil Gas Renewables (inc. nuclear)	-65% -35% -20% +10%	-55% -30% -15% +20%			-5%	-20%

[1] Transition risk impacts based on interpretation of the SDS, NPS and CPS scenarios of the World Energy Outlook (IEA, 2019); and
De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands; and
UNEP FI (2019); Changing Course: a comprehensive investor guide to scenario-based methods for climate risk assessment, in response to the TCFD.
Physical risk impact on investments based on OECD (2015), The Economic Consequences of Climate Change; and
2Degrees Investing Initiative (2019); Storm Ahead: a proposal for a climate stress-test scenario; and http://www.427mt.com/scenario-analysis.

			Transition Risks			Physical Risks		
Sector	% of investment portfolio in following sectors	Assumptions	Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
Transport[2]	Manufacturers, warehousing freight and passenger industries: Automotive (Electric Vehicles and non-Electric Vehicles), Aviation, Marine and other inland transport assets (ports, airports and related assets)	Change in equity value for sections of the investment portfolio comprising material exposure to the transport sector as per below: Automotive non EV Automotive EV Marine (inc. assets like ports) Aviation (inc. assets like airports)	 - 30% + 15% - 15% - 21%	 - 10% + 50% - 10% - 18%			-5%	-10%
Energy intensive industries (materials/metals)[2]	Manufacture and first-order processing of coke, chemicals, cement, iron and related alloys	Proportion of the manufacturing portfolio relying on transporting/extracting/processing fossil fuels or heavily reliant on fossil-fuel energy (eg cement, steel)	-35%	-25%		-5%	-10%	-20%
		Other manufacturing	-15%	-10%				
Agriculture and Food Security[1]	Agriculture, forestry, fishing, dairy cattle, food logistics and retail	Change in equity value for sections of the investment portfolio comprising material exposure to agriculture and food security sector	-65%	-50%		-5%	-10%	-20%
		Proportion of the portfolio with income heavily reliant on transporting/trading/supplying products based on food (eg super-market chains.)	-15%	-10%			-5%	-10%

[1] UNEP FI (2019); Changing Course: a comprehensive investor guide to scenario-based methods for climate risk assessment, in response to the TCFD. ; and Meijl, H. Van, Havlik, P., Bodirsky, B., Dijk, M. Van, Doelman, J., Fellmann, T., Valin, H. (2017). Challenges of Global Agriculture in a Climate Change Context by 2050. JRC Science for Policy Report. https://doi.org/10.2760/772445.

[2] Refer to footnote #1 in previous page

			Transition Risks			Physical Risks		
Sector	% of investment portfolio in following sectors	Assumptions	Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
Real Estate Assets (inc. CRE, rental and leasing, construction, infrastructure) [1]	Change in property value for assets materially affected by physical climate change risk[2]. Apply the price drop impact on mortgage valuations where relevant[3].	Global Average (inc. other regions) North America Europe Asia and Pacific	-10% -10% -5% - 20%				-15% -15% - 8% - 30%	- 30% - 30% -15% - 60%
Sovereign and Municipal bonds[4]	Sovereign bond credit ratings downgraded as countries stress their balance sheets in their need to mitigate impacts from physical climate change. Rating downgrade as a function of a country vulnerability to climate change (refer to Annex II)					- 20 to 0 basis points[1]	- 30 to - 5 basis points	- 70 to - 20 basis points
	US municipal bond yield increase as cities stress their balance sheets in their need to mitigate impacts from physical climate change. Rating downgrade applied to relevant US municipalities most affected.[5]					+ 0.5%	+ 5%	+ 20%
Other shares	Water utilities					-5%	-10%	-20%
	Other Sectors (excluding the sectors above)						-2%	-5%

[1] Shock parameters based on FourTwentySeven publication: http://427mt.com/2018/10/11/climate-risk-real-estate-investment-trusts/.
[2] The change in value of the underlying asset (the property) which has directly been affected by physical climate change, will lead to changes in the valuation of any mortgages associated to that asset (property). Firms should separately assess the value of the investment/mortgage given the change in asset value. Firms should assume no matching adjustment offset for purpose of this exercise.
[3] As part of your return, please explain how you assessed which part of your real estate assets is affected by climate change risk and detail related assumptions.
[4] 2Degrees Investing Initiative (2019); Storm Ahead: a proposal for a climate stress-test scenario; and https://rhg.com/research/physical-risks-climate-blackrock/.
[5] Yield increases are based on our interpretation of historic yield increases following events like Hurricane Katrina (New Orleans) and Hurricane Maria (Puerto Rico). Example of US Municipal Bond climate change risk assessment can be found here: https://www.blackrock.com/us/individual/insights/blackrock-investment-institute/physical-climate-risks.

Notes on the guidance on applying the shock parameters outlined above:

1. The financial shocks are calculated either at business activity or sector level, as a function of the data availability and the granularity of the scenarios. Where shocks should be applied at sector level, insurance companies can resort to sector classification codes. To help firms classify the asset portfolio across the categories outlined in the table above, we have provided in Annex II a crosswalk across different sector classification codes (ie indicative NACE and GICS codes). Firms can use tools such as Thomson Reuters and Bloomberg Terminal to help them map their investment portfolio against sector classification codes. As part of this exercise, insurers are invited to identify the portion of their overall portfolio that they have been unable to map (typically this may include investment funds, partial subsidiaries, unit link funds or non-listed assets).
2. Where the shocks are applied at business activity level, insurance companies will be required to classify the assets in their portfolio according to sub-sectoral business activities (eg split between oil vs. gas). This can be done using alternatively in-house classification approaches or open-source and freely available tools, including but not limited to tools like S&P Trucost, Bloomberg, MSCI or PACTA tool (www.transitionmonitor.org). As part of this exercise, insurers are invited to comment on the extent to which they have been able to undertake the higher granularity split of their investment portfolio.
3. Where assets operate across multiple business activities, the asset value should be split as a function of the estimated revenue or physical asset split underlying the asset. The associated breakdown can be accessed using tools like the ones listed above. Example: A GBP 100 exposure to a utility with an asset base split evenly between coal and renewables should be considered as a GBP 50 exposure to coal and a GBP 50 exposure to renewables. The associated financial shocks should then be applied to the individual exposures respectively.
4. In the final step, the shocks should be applied on the disaggregated portfolio. When applying the shocks involving a delayed (Scenario B) or no (Scenario C) transition, insurance companies should assume a constant portfolio composition over the time horizon of the stress-test, independent of the maturity profile of the portfolio' assets.

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 as a list of resources that may be useful to consult as a starting point of this investigatory exercise.

- TCFD Knowledge Hub: for resources on how to get started on climate-related scenario analysis.
- PACTA tool[1]: 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: probabilistic climate projections and evidence-based economic impact estimates at a granular level around the world.
- Notre Dame Global Adaptation Initiative's country vulnerability ranking or Moody's Investors Service's Climate Change & Sovereign Credit Risk**.** They provide relative country ranking on sovereign susceptibility to climate risks.

[1] The PACTA tool on the transitionmonitor.org website will be customised to allow users to directly apply the IST 2019 climate stress-test. The modified tool is expected to be available to users by mid July 2019, allowing users to apply the granular shocks designed in this stress-test. For this website 2° Investing Initiative uses a stand-alone server, ie no other website or information is stored on the server. The server is set up in compliance with the security standards of the German Federal Data Protection Act (BDSG, "Bundesdatenschutzgesetz"), Tele Media Act (TMG, "Telemediengesetz"), and is built on infrastructure that is DIN ISO/IEC 27001 certified. All uploaded data will be deleted after performing the analysis. All analytical results will only be shared (downloadable) exclusively with the respective user of the tool.

7.2 PART 2: SCENARIO ASSUMPTIONS

The purpose of the information gathering exercise in Part 2 is to support the PRA's development of climate scenarios for future stress tests. As such, we are inviting firms to provide their assumptions and parameters relating to existing work in assessing the financial impacts from climate change.

Of particular interest to the PRA is the work insurers may have done to develop Climate Scenarios either on their own or with the help of third parties. The information that we are trying to collate should ideally include how climate change scenarios represent physical and transition risks in the context of firms' key business decisions. We are aiming to obtain information that details aspects of material assumptions such as:

Climatic scenario assumptions

1. Greenhouse gas projection levels and extent of the global temperature rises assumed to occur;
2. Time frame and pathway over which any 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), or consumer sentiment. 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 material class – equities, corporate bonds, sovereigns, property, infrastructure, utilities, oil and gas, automotive, and so on, where it is found to bematerial), 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. 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 insurers (eg impact on mortality rates of more extreme summers or winters).
    b. Transition risk: transition risks from climate change are those financial risks that result from the process of adjustment towards a carbon-neutral economy and associated impact/cost of reducing emissions. For example, the transition to a carbon-neutral economy and wider adoption of electric vehicles could affect levels of air pollutants.
2. Impact on the valuation of liabilities, also split between physical and transition risks:

Where firms have assumed management actions to mitigate potential climate risk impacts in their analysis, we ask firms to list those management actions and to explain how much credit they have taken in their analysis for those actions.

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

7.3 REPORTING

For Part 1 please use the feedback template provided in the Excel workbook under the tab 'C1 Climate Change'. This contains information that will enable us to understand the business model and possible financial impacts in a relatively standardised way. Nevertheless, given the complexity and the relative infancy of analysis in this area, we recognise that the standard template may oversimplify some of the issues and implications. Where you believe this to be material, we encourage you to provide additional commentary and/or materials. For clarity, firms are invited to report against each of

the metrics requested for each shock separately and in aggregate (for instance for liability shocks, report AAL and 200 year AEP for each of the eight sub-perils against each of the three scenarios).

For Part 2 there is no prescribed format, so firms can provide the documentation in whichever way they choose. Firms can chose whether to fill in this Part as Solo or Group. However, we encourage firms to provide sufficient sign-posting to enable easy navigation of the main assumptions to help understand how both transitional and physical transition have been considered across liabilities and investments.

Section C2

8. EXPOSURE GATHERING FOR COMMERCIAL RISKS BY SECTOR

This section is to provide the PRA with industry direct commercial exposures for the largest regulated general insurers. The information collected will assist in mapping and monitoring of sectoral accumulations and support the PRA's preparedness in case of a significant industry event resulting in a material loss.

Firms are requested to provide details of UK, US and aggregate (ie across all geographies) direct commercial risk exposures in-force on 1 January 2019.

In addition, firms will be required to segment these exposures to industry sectors using two methods:

1) Allocation to high-level sector classifications based on the Standard Industry Classifications (SIC): this common classification will enable aggregation across all participating firms; and

2) Allocation to sector classification using the firm's own classification (top 10 sectors only): this will help inform improvements in how sector/industry is defined for future exercises, and will help to understand individual firm exposures/coding in more detail.

8.1 CONTEXT AND LIMITATIONS

The PRA acknowledges that there are a number of limitations arising, such as the partial coverage of exposures, capturing only one year's worth of exposures, inaccuracies in mapping to industry sectors, and differences in policy coverage and wording, among other considerations.

Nonetheless the PRA believes analysing historical events is also limited as a guide to evaluating future potential liability catastrophes and that analysis of exposure information and accumulations could supplement decision making at both firm (micro) and sector (macro) level. This is especially the case for insurers that have material exposures and/or 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.

8.2 RISKS WITHIN SCOPE AND ALLOCATION TO GEOGRAPHY

Firms are required to report exposure information covering all direct (as opposed to reinsurance) commercial business for policies in-force on 1 January 2019. Personal lines and treaty reinsurance business are specifically excluded.

Firms are also required to provide a separate breakdown of UK and US exposures in addition to the aggregated total exposures of their portfolio ie across all geographical territories.

In allocating exposures to geographical territory, firms should follow the Solvency II rules:

1) For workers' compensation/employers' liability, property and trade credit information shall be reported by country where the risk is situated.
2) For all other lines of business information shall be reported by country where the contract was entered into;

For the purposes of this template "country where the contract was entered into" means:

a. The country where the insurance undertaking is established (home country) when the contract was not sold through a branch or freedom to provide services;

b. The country where the branch is located (host country) when the contract was sold through a branch;

c. The country where the freedom to provide services was notified (host country) when the contract was sold through freedom to provide services;

d. If an intermediary is used or in any other situation, it is a), b) or c) depending on who sold the contract.

8.3 EXPOSURE INFORMATION REQUESTED

Firms are requested to provide details of the (i) number of policies; (ii) gross written premiums and; (iii) total exposed sum insured / limit of liability allocated to commercial product[1] and split down into each "industry/sector" using two different methods of classification:

1) Allocation to high-level sector classifications based on the SIC codes:

   Sector classification is the traditional SIC grouping, but at a 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.

   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.[2]

2) Allocation to sector classification using the firm's own internal classification (top 10 sectors for the whole world only):

   In addition to the high level SIC codes firms are also required to split exposures into their 10 top sectors of the economy according to their own sector classification and granularity – this may not be the same as SIC. This will enable the PRA to better understand the firm's classification system used and the exposures for each sector.

8.4 ADDITIONAL GUIDANCE ON CALCULATING TOTAL EXPOSED SUM INSURED AND POLICIES NUMBERS

The completion of the Sectoral Exposure template requires mapping and allocation of premium, number of policies and limits to territory, industry/sector and lines of business. This should be carried out on best endeavours basis. The usefulness of the collected data depends on the consistency between submissions. Below we provide guidance to assist with allocation for consistency purposes..

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 a firm 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

1 Property; Motor; Employers' Liability; General Liability or Public Liability; Errors & Omissions or Professional Indemnity; Directors & Officers; Trade Credit; and all other classes

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

these contracts to the relevant industry codes. Firms may do this on the basis of known bordereaux or expiring risks adjusted for the estimated premium income for 2019.

Premiums should be allocated to industry/sector and line of business in a way that reflects the underlying or majority of the risk in the sector that it is assigned.

By 'total exposed sum insured' we intend this to be the exposed limit taking into account the share of the firm's participation, and not necessarily the total 100% limit. In particular, for property risks firms are requested to provide the share of limit exposed to risk and not the "from ground up" total sum insured. For commercial motor where liability is unlimited, total limits exposed are not requested.

Limits and number of policies should be allocated in full to each of the lines of business and industry/sector that they are exposed to. Individual class of business limits should reflect the total limit to a given class (reflecting any sub-limits), and should not be an allocation of the aggregate limit. This will involve some double counting. Where there are sub-limits for certain classes of business, the sub-limits should be reported for these classes of business. If it is not possible to split the sub-limits, then the aggregate limit should be shown with a supporting explanation for us PRA to note.

The aggregate (for all lines of business) total exposed limit of liability and number of policies should be shown in the "All Classes" columns of the template. This information will be used to assess and identify aggregate industry exposures to different sectors of the economy to understand aggregations at the product level, as well as validation against the loss estimates under each stress test. We note that this approach will mean that the sum of the individual product limits is unlikely to match the aggregate limit as set out in "All Classes".

8.5 REPORTING

A standardised template is provided in the GIST2019 Template.xls workbook capturing the number of policies, gross written premiums and limits (as defined above) 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.

8.6 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.

Section C3

9. 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.

9.1 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.

9.2 ASSUMPTIONS

The scenario specification is intentionally high-level, such that firms will need to make additional assumptions in order to assess the potential claims. We recognise that this considerably reduces the ability to compare financial loss impacts across firms, but should provide additional understanding of the industry's sophistication and the different approaches taken in estimating the potential sources of loss given a cyber event. This information will be used to improve and develop future stress tests in this area.

Firms should assess the possible claims arising on their portfolio based on the following assumptions. Firms should also provide details of additional assumptions needed in estimating the insurance losses:

- 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 IT systems of organisations in different sectors with varying degree of downtime. The table below summarises the percentages of policyholders with the largest policy limits impacted from the event in each sector and the associated downtime of IT systems:

Sector	% of policyholders	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

Example: The attack impacts the IT systems of the top 10% of the firm's insured banks by policy limit with an associated downtime of 2 days.

- The ransomware attack includes a destructive payload leading to physical damage of 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 consider claims arising from all lines of business in addition to stand-alone cyber products. Where firms rely on significant exclusions, they should clearly indicate this and discuss the completeness of these exclusions.
- 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.

9.3 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.

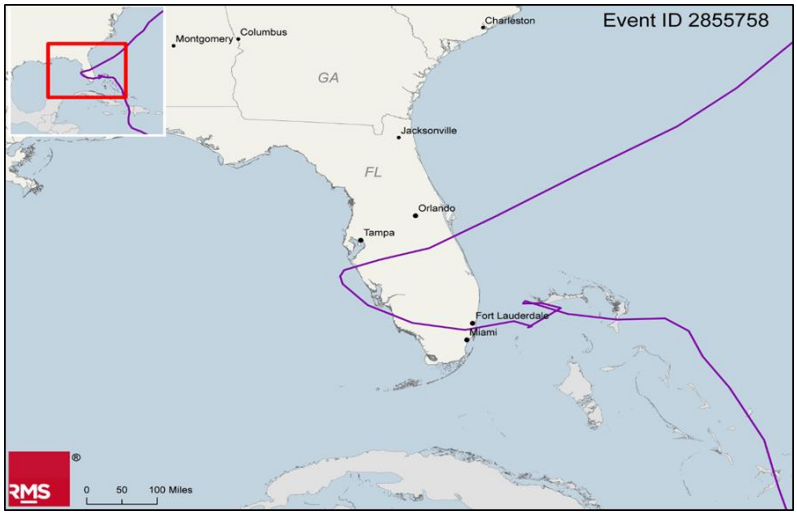
For stand-alone cyber policies, firms should provide a breakdown of losses split between privacy breaches, remediation costs, business interruption and contingent business interruption and other.

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

ANNEX I: NATURAL CATASTROPHE SCENARIOS – ADDITIONAL INFORMATION

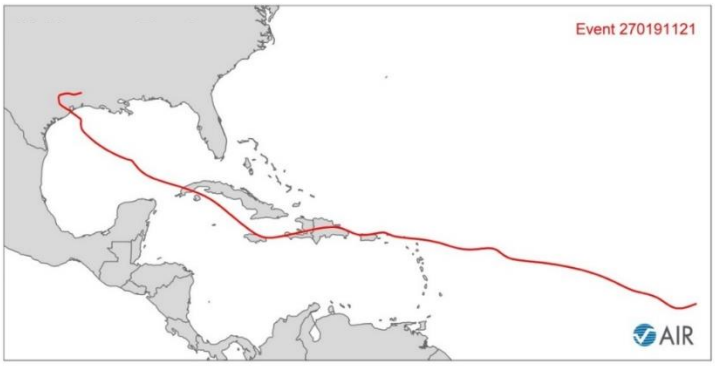
US Hurricane set of events

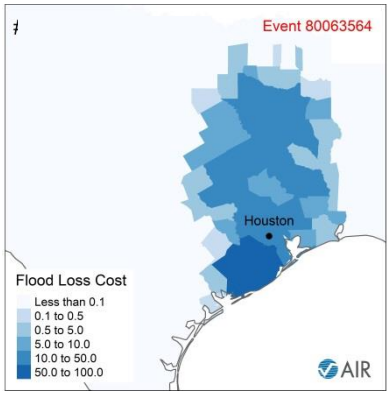
Irma-like hurricane hitting Florida

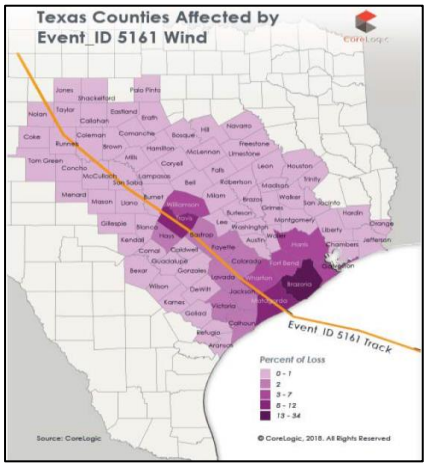


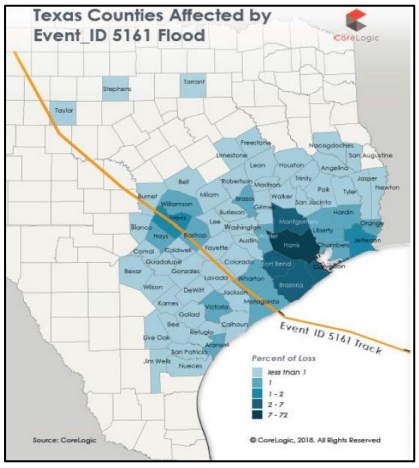
Modelled hurricane track as modelled by RMS.

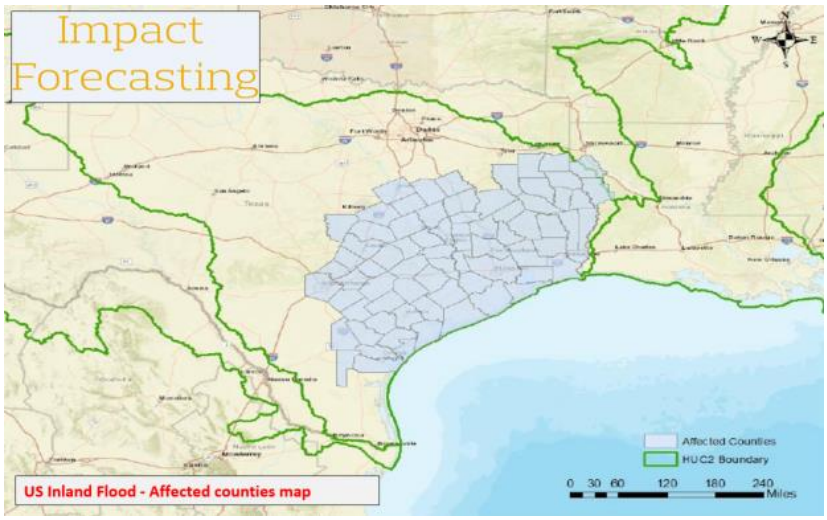
Second hurricane hitting Houston

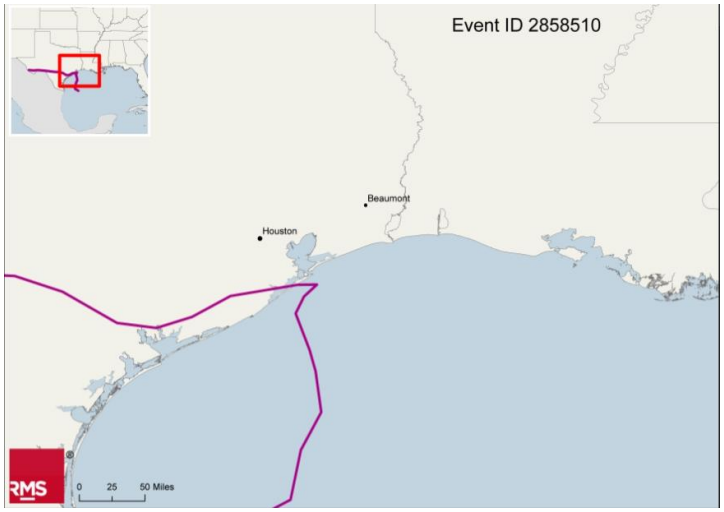






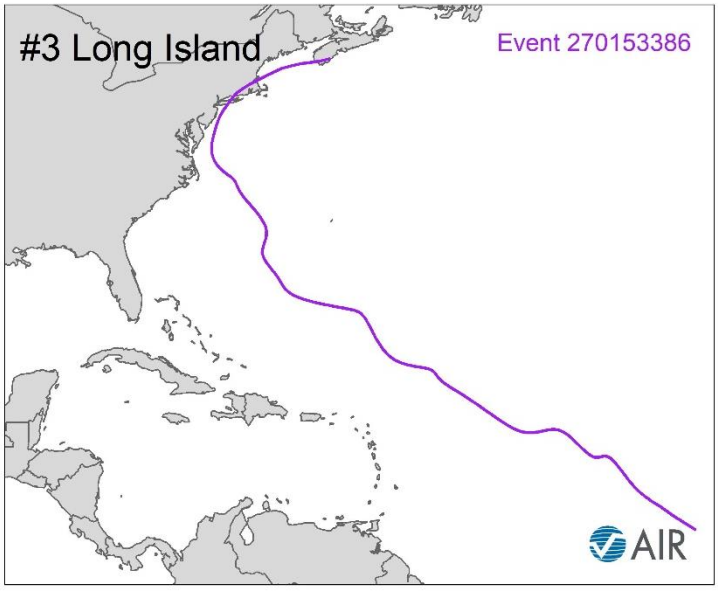






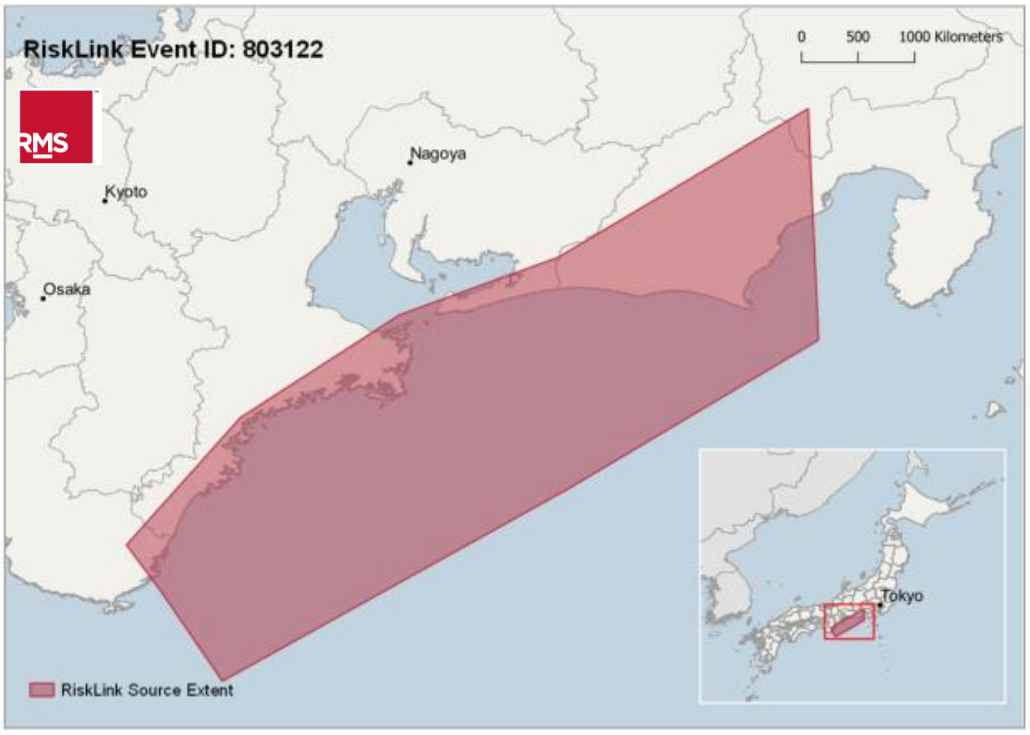
Modelled hurricane tracks and corresponding flood footprint (where provided) as modelled by AIR, Corelogic, Impact Forecasting and RMS.

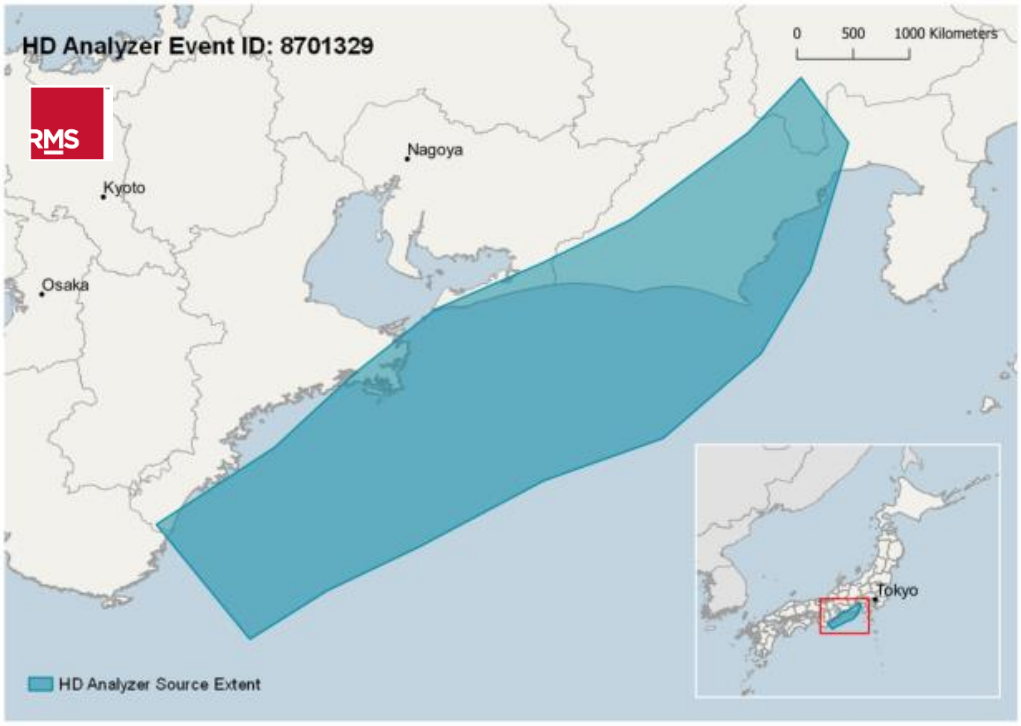
Third hurricane affecting the north east coast



Modelled hurricane track as modelled by AIR.

Japanese Earthquake and Tsunami

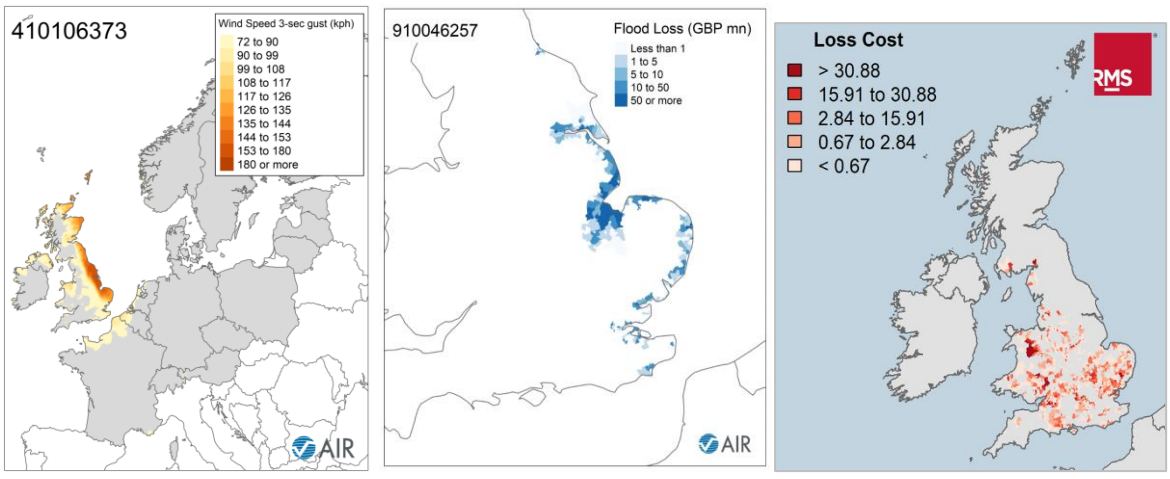




Tokyo earthquake fault as modelled RMS Risk Link (top) and RMS HD (bottom).

UK windstorm

UK windstorm and storm surge



UK Windstorm (left) and Storm Surge (centre) footprints, as modelled by AIR. RMS RiskLink UK Flood footprint (right)

ANNEX II: CLIMATE CHANGE SCENARIOS – ADDITIONAL INFORMATION

The background information provided in this Annex is aimed to aid participating firms understand the basis upon which expert judgement assumptions were developed in creating the climate change scenario analysis shock 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 to demonstrate in full transparency some of the 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 are not representing the latest research and understanding that would normally 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.

Impact to liabilities

- The development of hypothetical values affecting US Hurricane are based on the PRA-led working group[1] and particularly literature review analysed and discuss with catastrophe model development firms including AIR, KatRisk, Rhodium Group, Imperial College and RMS, supplemented by discussions with experts in the market and academics[2]. The hypothetical values

[1] Prudential Regulation Authority (2019); A Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector: A Practitioner's Aide.

[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

Ting, M, Kossin, J.P, Camargo, S.J, Li, C. (2019); Past and future hurricane intensity change along the US East Coast, Nature, Vol 9, 7795

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.

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 (see footnote 1 in previous page) and literature review analysed and presented by Imperial College, JBA Risk Management and Ambiental . The hypothetical values put forward in this exploratory exercise do not represent the opinions of the above-mentioned sources.

Impact to investments

- For clarity, Scenario A that describes a disorderly transition scenario is assumed to have its impacts coupled with a decreased sectorial demand. Positive shocks are more muted to respond to demand adjustment.
- The values related to the set of assumptions behind the Fuel Extraction and Power Generation sectors 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.
- The development of hypothetical values affecting investments are based on the interpretation of available literature by the PRA and discussions with specialists in the field including 2° Investing Initiative, Aviva, Carbon-Delta, DWS, FourTwentySeven, Oliver Wyman, PwC, Rhodium Group. The hypothetical values put forward in this exploratory exercise do not represent the opinions of the above-mentioned sources.
- To support the investment portfolio segmentation, indicative NACE and GICS codes are provided as examples of the sectors discussed. The Table below is provide indicatively and firms can chose to differentiate the way they classify their portfolio against the different Sectors. In such cases, firms are requested to (i) provide evidence of their cross-walk assumptions where different to the one provided in the Appendix; and (ii) why they made this decision.

Table 3: Indicative cross-walk table linking Sectors to investment portfolio codes. Firms are encouraged to develop their own portfolio cross-walk considering the below as a starting point.

Sectors	Example NACE sector codes to consider when mapping your investment portfolio
Fuel extraction	5 Mining of coal and 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 C19 Manufacture of coke and refined petroleum products D35.2 Manufacture of gas; distribution of gaseous fuels through mains H49.5 Transport via pipeline
Transport	C29 Manufacture of motor vehicles, trailers and semi-trailers C29.1 Manufacture of motor vehicles (supplemented by percentage of EV) H49.1 Passenger rail transport, interurban H49.2 Freight rail transport H49.3 Other passenger land transport H49.4 Freight transport by road and removal services H50.1 Sea and coastal passenger transport H50.2 Sea and coastal freight water transport H51.1 Passenger air transport H51.2 Freight air transport

	C29 Manufacture of motor vehicles, trailers and semi-trailers C29.1 Manufacture of motor vehicles (supplemented by percentage of EV) H49.1 Passenger rail transport, interurban
Power generation	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)
Agriculture & food Security	A Agriculture, forestry, and fishing
Energy-intensive industries (materials/metals)	B7 Mining of metal ores C20 Manufacture of chemicals and chemical products C23.51 Manufacture of cement C24.1 Manufacture of basic iron and steel and of ferro-alloys

- 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 B will suffer 5 basis points downgrade whilst Albania would suffer 30.
- Transition Risk assumptions were developed based on discussions with experts in the field and material[1] reviewed for purposes of this exploratory exercise.
- Municipal bonds yield assumptions where based on historic yields of US municipal bonds following natural catastrophes. For instance, following hurricane Maria in 2017 the Puerto Rico 5year bond yield experienced an increase of more than 20%. PRA recognises that there is a range of views on the degree of susceptibility of US municipal bond market to natural disasters and climate change, however, for purposes of this exercise, it has presented with a view based on a historic perspective.

[1] Sources: 2º 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
De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands;
ESRB (2018); Adverse macro-financial scenario for the 2018 EU-wide banking sector stress test; and
FED Reserve (2018); Dodd-Frank Act Stress Test 2018: Supervisory Stress Test Methodology and Results; and
GIZ; UNEP FI; NCFA (2017) Drought Stress Testing – Making Financial Institutions More Resilient to Environmental Risks; and
IRENA (2019); Renewable Energy Prospects for the European Union; and
OECD (2015) The Economic Consequences of Climate Change; and
Ralite, S., and Thoma, J for the 2O investing initiative (2019); Storm Ahead: A proposal for a climate stress-test scenario. Discussion Paper; and
Standard & Poors (2017); How Environmental and Climate Risks And Opportunities Factor into Global Corporate Ratings – an update; and
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: ACKNOWLEDGEMENTS

The PRA is grateful for the following organisations for valuable discussions held in the design and parameterisation stage of this exercise:

2°Investing Initiative

AIR Worldwide

Ambiental

Aviva

Beazley

Carbon Delta

Cybercube

DWS

FourTwentySeven

Impact Forecasting

Imperial College

JBA Risk Management

KatRisk

LSE

Oliver Wyman

PwC

Rhodium Group

RMS

RSA

Scor

Tremblor

University College London

ANNEX V: CONTENTS OF TEMPLATE

TAB	CONTENTS
Firm Info	Firm Information, Sign Off details, Exchange Rates used
Summary	Eligible Own Funds, SCR and Coverage Ratio from each Scenario
2018 balance sheet	Solvency II base balance sheet S.02.01.01 and Own Funds from S.23.01.01 or S.23.01.04
2019 Projection	Projected movement in Own Funds
Capital	Solvency II Capital Requirement as at 31/12/2018 and 31/12/2019
Scenario A	Projected Movement in Net Assets after Stress Scenario specific data items
Scenario B1	Projected Movement in Net Assets after Stress Scenario specific data items
Scenarios B2, B3 and B4 have exact copies of the above	
Scenario B5	Scenario specific data items
C1 Climate Change	Climate change exercise Parts 1 and 2
C2 Sectoral Exposures	Sectoral exposures split by geography and main lines of insurance business
C3 Cyber Underwriting	Projected Movement in Net Assets after Stress Scenario specific data items
Reinsurers	Please list here all reinsurers used by the firm, from whom you may make recoveries under the scenarios discussed in this request.
Free Form Comments	Please record any comments you have on the way you have completed the spreadsheet