Applications of Climate Science for Business Risk

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Cambridge Centre for Risk Studies

#CamClimateRisk
Business Risks From Climate Change

Growing awareness and momentum on climate issues driving a societal response and demand for a low carbon future
Climate-Related Financial Disclosures

- Companies are being asked to make climate-related financial disclosures
  - Within past 2 years, companies with balance sheets totaling $120 Trillion have supported this initiative
- Less than 10% of companies currently do so
  - Tend to be the early adopter companies
- Non-financial sectors (energy, transport, building and agriculture) led the way initially
  - Banking now overtaken them
- There is no single methodology for doing this
  - There are many different approaches to TCFD disclosures being offered by Advisory Service companies.
- Potential for TCFD to become mandatory
  - Oct 2019 speech by Mark Carney, Governor of Bank of England, gave corporations two years to agree rules for reporting, before regulators impose their own
Business Risk from Climate Change

Business Risk consist of three broad areas:

- **Physical Risks** Business disruption and damage to assets from extreme weather events
  - One to five year outlook of unexpected extreme weather events
  - Multi-decadal outlook of changed weather patterns and climatic adaptation

- **Liability Risks** where the business faces costs, penalties, and reputation damage from
  - Activities of the organisation, past and present, that contribute to the causal mechanisms of climate change (for example carbon emissions)
  - Commitments to reduce carbon emissions

- **Transition Risks** where society’s response and adaptation towards a low-carbon economy provides opportunities, but also creates disruption to current processes, economies, and asset valuations
Cambridge Global Risk Index measures multiple threats to the global economy.

- Provides an objective measure of risk of shocks to the global economy.
- Cities in the index represent 43% of the total global economy.
- Developed a standardized metric ‘GDP@Risk’ to measure risk from widely disparate threats.
- 2020 Cambridge Global Risk Index provides the 6th year of insight into changes over time and from different drivers.

We are creating an additional Climate Change Business Risk Index.
Six of our 22 threat types are directly influenced by climate change.

Many other threat types are indirectly influenced by climate change.

The threat types directly influenced by climate change account for 23% of the total GDP@Risk in the Cambridge Global Risk Index.

279 Major Cities of the World Economy
11,708 extreme weather events in past 20 years

Total reported direct costs of $3.9 Trillion
- $195 Billion a year
- Direct costs are property damage and business activity loss from disruption

Economic studies suggest that indirect costs could be an additional multiple of direct costs
- Studies suggest values from 1.5X to over 10X
  - 2X is a reasonable multiple
- Indirect costs are reduced economic growth during recovery, counterparty loss, infrastructure utility loss
- Some recovery programmes may provide economic stimulus to offset some of loss

Observed extreme weather events cause direct and indirect economic loss that averages more than half a Trillion dollars a year

Data Sources: UN; Munich Re; Swiss Re; EM-DAT; Wang (2020)
Extreme Weather as a Trigger for Other Risks to the Global Economy

Threat Linkage Levels

0  No causal linkage, and no significant ability to exacerbate
1  No causal linkage, but would exacerbate consequence of threat B if they coincided
2  Weak potential for threat A to trigger threat B
3  Moderate potential for threat A to trigger threat B
4  Strong potential for threat A to trigger threat B
5  Very strong potential - highly likely that if threat A occurs, it would trigger threat B

Only linkage levels 2 to 5 are shown in diagram
Where Extreme Weather Events are Most Likely

- Heatwave Risk
- Drought Risk
- Hurricane Risk
- Flood Risk
Changing Likelihood of Heatwaves in Chicago

- **L1: Recent Historical Past**
  - Observed weather records
  - 1979-2018

- **L2: Climate Change Modelled View**
  - Multi-Model Mean
  - CMIP5 RCP4.5
  - 2018-2059

Probability of Exceeding

Number of Days with Mean Temperature Above 25°C (72°F) in a Year

- 100%
- 90%
- 50%
- 10%
- 5%
- 1%
Heatwave Impact on Business Activities

- **Reduced Productivity of Employees**
- **Transportation and Infrastructure Failures**
- **Increased Sales in Retail Stores**

**Effect of Heatwaves on Business Activities**

- Increased Air Conditioning Loads in Buildings
- Overheating in Data Centres
- Power Plants Offline

**Effect of Heatwaves on Business Activities**

- Average Temp
- Baseline
- Air Conditioning Load
- Productivity Manual Factory Work
- Outdoor Manual
- Thermal Power Plant Output
- Retail Footfall

*°C Daily Mean Temperature above Seasonal Average*
Agricultural Yield Reduction with Temperature

For each one degree Celsius increase in average temperature during growing season:

- **Wheat** Yield Reduced: 6.0%
- **Rice** Yield Reduced: 3.2%
- **Maize** Yield Reduced: 7.4%
- **Soybean** Yield Reduced: 3.1%

Degree-Celsius increase in Mean Temperature Reduction in Crop Yields

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>6.0%</td>
</tr>
<tr>
<td>Rice</td>
<td>3.2%</td>
</tr>
<tr>
<td>Maize</td>
<td>7.4%</td>
</tr>
<tr>
<td>Soybean</td>
<td>3.1%</td>
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</tbody>
</table>
Cambridge Climate Change Index of Business Risk

Change in Heatwave Risk from Climate Change

1979-2018 compared with 2018-2059
Number of Days a Year with
Mean Daily Temperature Above 25°C
Prob of Exceedance 10%
Observed weather records vs Climate Model View CMIP5 RC4.5

Change in Number of Days a Year
2 Weeks of Additional Days Above 25°C by 2040
10% chance per year
Climate Model View RCP4.5

GDP>$5 Billion
Over 14 days Increase in T>25°C Days per Year

$56 Trillion of GDP in 2019
i.e. 65% of Gross World Product of $87 Trillion 2019

Cambridge Climate Change Index of Business Risk
Areas of High Economic Productivity with Increased Heatwave Risk
Cities with the Greatest Increases in Heatwave-Triggered Economic Losses

- Total Annualized Heatwave Economic Losses from major cities more than doubles (123% increase)
  - From around $3 Bn expected each year to over $6.7 Bn
- Cities may also see localized additional heat loads
  - Heat island effects of urban conurbations
- Business adaptation will need to incorporate this into siting of key facilities with high-cooling needs

<table>
<thead>
<tr>
<th>Rank</th>
<th>City</th>
<th>Country</th>
<th>Increase</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>New York</td>
<td>United States</td>
<td>172%</td>
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<tr>
<td>2</td>
<td>Paris</td>
<td>France</td>
<td>176%</td>
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<tr>
<td>3</td>
<td>London</td>
<td>United Kingdom</td>
<td>218%</td>
</tr>
<tr>
<td>4</td>
<td>Chicago</td>
<td>United States</td>
<td>127%</td>
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<tr>
<td>5</td>
<td>Washington</td>
<td>United States</td>
<td>159%</td>
</tr>
<tr>
<td>6</td>
<td>Tokyo</td>
<td>Japan</td>
<td>110%</td>
</tr>
<tr>
<td>7</td>
<td>Philadelphia</td>
<td>United States</td>
<td>152%</td>
</tr>
<tr>
<td>8</td>
<td>Shanghai</td>
<td>China</td>
<td>87%</td>
</tr>
<tr>
<td>9</td>
<td>Sydney</td>
<td>Australia</td>
<td>152%</td>
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<td>10</td>
<td>Atlanta</td>
<td>United States</td>
<td>114%</td>
</tr>
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<td>11</td>
<td>Baltimore</td>
<td>United States</td>
<td>192%</td>
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<td>Los Angeles</td>
<td>United States</td>
<td>82%</td>
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<tr>
<td>13</td>
<td>Miami</td>
<td>United States</td>
<td>234%</td>
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<tr>
<td>14</td>
<td>Detroit</td>
<td>United States</td>
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<td>15</td>
<td>Boston</td>
<td>United States</td>
<td>178%</td>
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<tr>
<td>16</td>
<td>Vienna</td>
<td>Austria</td>
<td>196%</td>
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<tr>
<td>17</td>
<td>Brussels</td>
<td>Belgium</td>
<td>201%</td>
</tr>
<tr>
<td>18</td>
<td>Moscow</td>
<td>Russian Federation</td>
<td>150%</td>
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<td>19</td>
<td>Dallas</td>
<td>United States</td>
<td>48%</td>
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<tr>
<td>20</td>
<td>Mumbai</td>
<td>India</td>
<td>463%</td>
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2040 Climate Model View RCP4.5
Flood Losses Will Increase Significantly with Climate Change

- Climate change will result in changed patterns of rainfall, increasing the risk of flooding.
- Water vapour increases by 7% for every degree of warming. Volume of precipitation is likely to increase by 1-2% per degree of warming.
- Regions with high annual rainfall are going to get wetter.
- Dry regions of sub-tropics likely to get drier and shift towards poles.
  - Europe can expect wetter winters and drier summers, particularly in central and southern Europe.
- Heavier rainfall will increase – fewer by more intense events – longer dry spells and higher risk of floods.
- Most of the increased risk over next 20 years is driven by riverine and flash flooding from increased precipitation.
  - Coastal flood risk will increase more in the longer term.
  - Sea level rise projections are fairly modest in next 20 years, assuming no catastrophic collapse of ice shelves.
  - Wind speeds and central pressures from storms that cause storm surges could increase risk of coastal flooding.
  - But science is still ambivalent about storm intensification.

### Cities with greatest increase in climate-change flood risk

<table>
<thead>
<tr>
<th>Rank</th>
<th>City</th>
<th>Country</th>
<th>2020</th>
<th>2040</th>
<th>Increase</th>
<th>as%</th>
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<tr>
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<td>New York</td>
<td>United States</td>
<td>2.53</td>
<td>2.91</td>
<td>0.37</td>
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<td>2</td>
<td>Houston</td>
<td>United States</td>
<td>1.50</td>
<td>1.76</td>
<td>0.26</td>
<td>17%</td>
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<tr>
<td>3</td>
<td>Los Angeles</td>
<td>United States</td>
<td>1.55</td>
<td>1.80</td>
<td>0.24</td>
<td>16%</td>
</tr>
<tr>
<td>4</td>
<td>Osaka</td>
<td>Japan</td>
<td>1.59</td>
<td>1.79</td>
<td>0.20</td>
<td>12%</td>
</tr>
<tr>
<td>5</td>
<td>Chicago</td>
<td>United States</td>
<td>1.01</td>
<td>1.19</td>
<td>0.18</td>
<td>18%</td>
</tr>
<tr>
<td>6</td>
<td>Tokyo</td>
<td>Japan</td>
<td>2.56</td>
<td>2.73</td>
<td>0.17</td>
<td>7%</td>
</tr>
<tr>
<td>7</td>
<td>Philadelphia</td>
<td>United States</td>
<td>0.85</td>
<td>1.01</td>
<td>0.16</td>
<td>18%</td>
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<tr>
<td>8</td>
<td>Shanghai</td>
<td>China</td>
<td>0.97</td>
<td>1.11</td>
<td>0.14</td>
<td>14%</td>
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<tr>
<td>9</td>
<td>Paris</td>
<td>France</td>
<td>1.19</td>
<td>1.31</td>
<td>0.12</td>
<td>10%</td>
</tr>
<tr>
<td>10</td>
<td>Atlanta</td>
<td>United States</td>
<td>0.57</td>
<td>0.69</td>
<td>0.12</td>
<td>20%</td>
</tr>
<tr>
<td>11</td>
<td>São Paulo</td>
<td>Brazil</td>
<td>0.61</td>
<td>0.71</td>
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<td>0.84</td>
<td>0.94</td>
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<td>12%</td>
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<tr>
<td>13</td>
<td>Taipei</td>
<td>Taiwan</td>
<td>0.53</td>
<td>0.63</td>
<td>0.10</td>
<td>18%</td>
</tr>
<tr>
<td>14</td>
<td>San Francisco</td>
<td>United States</td>
<td>0.76</td>
<td>0.86</td>
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<td>12%</td>
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<td>Jakarta</td>
<td>Indonesia</td>
<td>0.28</td>
<td>0.37</td>
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<td>33%</td>
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<tr>
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<td>India</td>
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<td>0.27</td>
<td>0.09</td>
<td>51%</td>
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<tr>
<td>17</td>
<td>Miami</td>
<td>United States</td>
<td>0.51</td>
<td>0.60</td>
<td>0.09</td>
<td>17%</td>
</tr>
<tr>
<td>18</td>
<td>Detroit</td>
<td>United States</td>
<td>0.49</td>
<td>0.58</td>
<td>0.09</td>
<td>17%</td>
</tr>
<tr>
<td>19</td>
<td>Seoul</td>
<td>South Korea</td>
<td>0.45</td>
<td>0.53</td>
<td>0.08</td>
<td>17%</td>
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<tr>
<td>20</td>
<td>Nagoya</td>
<td>Japan</td>
<td>0.63</td>
<td>0.70</td>
<td>0.07</td>
<td>11%</td>
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<tr>
<td>21</td>
<td>London</td>
<td>United Kingdom</td>
<td>1.73</td>
<td>1.80</td>
<td>0.07</td>
<td>4%</td>
</tr>
<tr>
<td>22</td>
<td>Mumbai</td>
<td>India</td>
<td>0.25</td>
<td>0.31</td>
<td>0.06</td>
<td>24%</td>
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<tr>
<td>23</td>
<td>Mexico City</td>
<td>Mexico</td>
<td>0.44</td>
<td>0.50</td>
<td>0.06</td>
<td>12%</td>
</tr>
<tr>
<td>24</td>
<td>Beijing</td>
<td>China</td>
<td>0.39</td>
<td>0.45</td>
<td>0.06</td>
<td>13%</td>
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<tr>
<td>25</td>
<td>Guangzhou</td>
<td>China</td>
<td>0.41</td>
<td>0.47</td>
<td>0.06</td>
<td>12%</td>
</tr>
</tbody>
</table>
Hurricanes Will Become Wetter – Maybe More Intense

- We expect storm windspeeds to increase with warmer sea surfaces, but no definitive evidence of this yet.
  - Scientific debate about increased occurrence of stronger storms

- We do expect hurricanes to hold more moisture and produce more intensive rainfall
  - Studies suggest that climate change intensified rainfall in hurricanes Katrina, Irma, and Maria by up to 10%

- Climate simulations of tropical cyclones in Atlantic, Pacific and Indian oceans suggests increased rainfall of 5-10%

- Potential track shifts for Atlantic hurricanes – cyclogenesis could potentially occur further mid-ocean, reducing likelihood of US landfall

- Potential shift north of cyclogenesis in Pacific Ocean could increase landfall frequencies in SE Asia
The annual average rate of loss from these extreme weather processes will increase with climate change.

We estimate that direct economic losses will increase by 20% over the next 20 years.

With indirect losses, this could add an additional cost to the global economy of over $100 Billion a year, at today’s values.

These estimates of course have highly uncertainties around them, but are indicative of the problem we face.

Businesses will need to adapt their processes to accommodate these changes and understand how their business will be affected.

The indices we are developing are intended to inform this process.
Invitation to Business Community

▪ Help shape these scientific research outputs to be most useful to you
▪ Help scientists understand what decisions you are trying to make about managing your climate change risk
▪ Guide and prioritize focus on the things that make a difference to you

Challenge to the Climate Science Community

▪ Focus research on the time horizons and activities of the business community
▪ Help businesses understand their tail risk from extremes
▪ De-mystify the science and improve communication about these complex issues