City Climate Risk

Investor Engagement and Finance Innovation for Urban Resilience
- What climate-related damage is foreseen?
- What is the financial extent of the risk?
- Are investors engaged to improve safety, livelihoods?
- What City finance innovation is anticipated?

Number of loss events 1980–2015

- **Geophysical events:** Earthquakes, tsunamis, volcanic activity
- **Hydrological events:** Flood, mass movement
- **Meteorological events:** Tropical storm, extratropical storm, convective storm, local storm
- **Climatological events:** Extreme temperatures, drought, wildfire
Selected Significant Extreme Weather Events 2014-2015

- WESTERN CANADA: Warmest summer on record. Moderate to extreme drought from unusually hot days and dryness.
- ARCTIC SEA ICE: During its growth season, the Arctic has its smallest annual maximum extent.
- RUSSIA: Warmest March-May since national records began in 1936.
- MOROCCO (08/06): Marrakesh receives over 13 times its monthly average rainfall in one hour.
- CHINA: Heavy rains from May-October cause floods that affect 75 million people.
- INDIAN PACIFIC BASIN: In August, first recorded occurrence of three simultaneous major hurricanes (Kilo, Ignacio, and Jimena) in the basin.
- HURRICANE ODILE (09/10-19): Tied for strongest hurricane to make landfall in Baja California in the historical record.
- MEXICO: Consecutive storms bring heavy precipitation during March, over three times the monthly average.
- CHILE: Driest January in at least five decades.
- SOUTH AMERICA: Warmest year since continental records began in 1910.
- SOUTH AFRICA: Worst drought in eighty years.
- CYCLONE CHAPALA (10/28-11/04): First hurricane-strength storm on record to make landfall in Yemen, delivering over five years of rain in one event.

Some events were influenced by an unusually large El Niño pattern that emerged in the last half of 2015.
2016: Billion Dollar Weather and Climate Disasters

U.S. 2016 Billion-Dollar Weather and Climate Disasters

- Rockies and Northeast Severe Weather July 28–30
- Rockies and Central Tornadoes and Severe Weather May 21–26
- Western and Eastern Drought Entire Year
- Plains Tornadoes and Central Severe Weather May 8–11
- West Virginia Flooding and Ohio Valley Tornadoes June 22–24
- Southeast and Eastern Tornadoes February 22–24
- Western and Southern Wildfires Summer–Fall 2016
- South and Southeast Tornadoes April 26–May 2
- Hurricane Matthew October 7–9
- Louisiana Flooding August 12–15
- Southern Severe Weather March 17–18
- North Texas Hail Storm March 23–24
- North and Central Texas Hail Storm April 10–12
- Houston Flooding April 17–18

This map denotes the approximate location for each of the 15 billion-dollar weather and climate disasters that have impacted the United States during 2016.
Zwillow: In US 1.9M homes at risk

How many homes would be under water if the oceans rose 6 feet?*
Nationally, 1.9 million homes worth $882 billion.

*A new study found oceans could rise 6 feet by 2100.
Annual Expected Loss by Zip Code

Total Asset and Economic Activity Losses

Today
- <$10M (77%)
- $10 to $30M (16%)
- >$30M (5%)

2020s
- <$10M (71%)
- $10 to $30M (19%)
- >$30M (10%)

2050s
- <$10M (53%)
- $10 to $30M (23%)
- >$30M (24%)

Source: A Stronger, More Resilient New York

SwissRe: A More Resilient NYC
Sandy Supplemental Compared with 2012 Agency Outlays

Billions of US Dollars

- Sandy Appropriation
- Executive Office of the President
- General Services Administration
- Small Business Administration
- Legislative Branch
- Judicial Branch
- National Science Foundation
- Corps of Engineers - Civil works
- Department of Commerce
- Environmental Protection Agency
- Department of the Interior
- NASA
- International Assistance Programs
- Department of State
- Department of Justice
- Department of Energy
- Other Independent Agencies
- Department of Homeland Security
- Department of Housing and Urban Development
- Department of Education
- Department of Transportation
- Other Defense Civil Programs
- Office of Personnel Management
- Department of Labor
- Department of Veterans Affairs
- Department of Agriculture
Climate Change Slows Middle Class Emergence

- Climate change threatens to erode progress made on poverty reduction.
- Global incomes could decline 23 percent by 2100 relative to a world without climate change.
Climate Change is Not the Only Driver of Risk

Ocean Drive, FL 1926
2013

Ocean Drive FL
American Infrastructure Grade: D+
- What climate-related damage is foreseen?
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AUM $75T ('15) | Real Estate Asset Risk $35T ('70)

- Economic losses from natural catastrophes
  - $181 bn year
  - Swiss Re 2016

- Real Estate Assets at Risk in 2070
  - $35 tn (total value)
  - UNEP FI 2016

- Investment in Fossil Energy
  - $1.6 tn year
  - IEA 2014

- Total Assets Under Management in 2014
  - $75 tn (total value)
  - Boston Consulting Group 2015

- Infrastructure finance needs 2015-30
  - $6 tn year
  - New Climate Economy 2014

- Costs of Energy Actions in the INDCs
  - $1.1 tn year
  - IEA 2015
Climate Risk & Business Cycle Timelines Misaligned

- Flash floods, tornadoes, heat-waves
- Floods, hurricanes, droughts
- El Niño southern oscillation
- Changes to rainfall affecting water resources
- Global warming

2°C exceeded – significant sea level rise

- Financial reporting
- Compliance cycles
- Business planning
- Contract management
- Investment payback
- Economic cycles
- Infrastructure operation

Years from now: 10, 20, 30
<table>
<thead>
<tr>
<th>Vertical Investments</th>
<th>Sample Sub-Segments</th>
<th>Examples of Identified Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Water efficiency products (low flow, loss reduction), desalination and re-use</td>
<td>Company that treats and recycles water</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Drought resistant seeds, drip irrigation, precision agriculture, resilient food storage &amp; logistics</td>
<td>Company that examines weather data to provide insurance to farmers</td>
</tr>
<tr>
<td>Healthcare</td>
<td>Pharma, vaccines vs. new disease vectors (e.g., blue tongue, dengue), resilient facilities for extreme weather events</td>
<td>Company that provides climate health analytics to hospitals</td>
</tr>
<tr>
<td>Energy</td>
<td>Resilient generation: CHP, distributed, backup; Resilient distribution: micro-grids, storage and disaster recovery</td>
<td>Company that manufactures systems for wind and solar assessment</td>
</tr>
<tr>
<td>Coastal Area</td>
<td>Early warning systems, advanced weather/climate resilient materials, design tech</td>
<td>Company that provides flood maps for coastal regions</td>
</tr>
<tr>
<td>Insurance / Financial</td>
<td>Specific climate related risk insurance, risk assessment, micro-lending and micro-insurance related to adaptation efforts</td>
<td>Company that provides parametric insurance services</td>
</tr>
</tbody>
</table>
- What climate-related damage is foreseen?
- What is the financial extent of the risk?
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Business Risk from Climate Change is Beyond the Fenceline

Risks to:

**BROADER NETWORK**
Public/private electric and water utilities and other infrastructure

**VALUE CHAIN**
Supplies of natural resources and raw materials

**CORE OPERATIONS**
Physical assets, production processes, emergency management, operations and maintenance

Other inputs into production

Workforce and changing lifestyles

Customers’ access to product

Customers and demand for goods and services

Government-supplied services

Businesses see climate change as magnifying existing risks

Climate change can exacerbate threats to a company's core operations, supply and distribution chains, workforce and customers. Seeing existing risks through a climate lens places these risks within a business framework, but some impacts could be overlooked.

: Weathering the Storm, C2ES
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Adaptation Options (FL example)

Example Florida

Averted loss
$ Billions

Calculated in 2008 dollars for the average climate scenario

~40% of total expected loss can be averted cost-effectively

$30 billion Annual expected loss
Potential Sovereign Rating Downgrade due to Climate Risk

<table>
<thead>
<tr>
<th>Country</th>
<th>Potential Downgrade, status-quo climate</th>
<th>Added potential downgrades due to climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>4.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Bahamas</td>
<td>4.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Thailand</td>
<td>1.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Mexico</td>
<td>1.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Colombia</td>
<td>1.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Philippines</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Taiwan</td>
<td>0.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Honduras</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Guatemala</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Bermuda</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Aruba</td>
<td>0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Dom Rep</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Jamaica</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Fiji</td>
<td>0.2</td>
<td>0.0</td>
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</tr>
</tbody>
</table>

Bar: Potential Downgrade, status-quo climate

Filled bar: Added potential downgrades due to climate change

Climate Resilience Consulting

12 Standard & Poors
S&P’s Green Bond Evaluation

**Comprehensive Environmental Impact** (Final score – weighted aggregate)

**Transparency**
- Use of proceeds reporting
- Reporting comprehensiveness

**Governance**
- Management of proceeds
- Impact assessment structure

**Mitigation**
- Buildings, Industrial Efficiencies, Energy Infrastructure, Transport and Water

**Adaptation**
- Increased resilience

**eKPIs**
- Carbon
- Water
- Waste
- Land Use
- Air and Water Pollution

**Net Benefit**
- Local Baseline
- Best in Class
- Hierarchy Overlay

* eKPI – Environmental Key Performance Indicator
European Law: French Art. 173-VI; UK Adaptation Reporting Power

The physical risk produced by climate change has three main types of financial impact on the different asset classes:
- More frequent extreme events, which can lead to damage or higher insurance costs
- Gradual change in weather conditions that can modify economic balances
- Policies set up to adapt to climate change require additional investment
Climate Risk Disclosure

Figure 1: 10-K Climate Disclosure by S&P 500 Companies, 2009-2013
(Note: 10-K disclosure scores range from 0-100)

Average 10-K Disclosure Score

Phase I Report of the Task Force on Climate-Related Financial Disclosures
Presented to the Financial Stability Board
March 31, 2016
Investor Awareness of Climate Risk
Green Bonds $42B ‘15 ($11B ‘13)
Oasis Platform for Catastrophe and Climate Change Risk Assessment

Better risk assessment achieved through the 3 components of the OASIS Platform:

1. **Loss Modeling Framework (LMF)**
   - Assesses standardized data to quantify potential economic and financial consequences from catastrophic events.

2. **E-market**
   - Links supply (of risk assessment models) with demand for these models by end users.

3. **Capacity Building**
   - Training for model-makers and model users to develop and use catastrophe risk models using standardized approach and data.
Global Adaptation and Resilience Investment Work Group

Global Adaptation and Resilience Fund

THE INVESTMENT OPPORTUNITY
$500 million - $1 billion growth equity vehicle that invests in 10 - 20 companies

Climate Risk Maps
- Weather/Climate Analytics
- Flood Risk Models
- Climate Risk Consulting/Engineering

Climate Adaptation Tools
- Water Efficiency Devices
- Drought Resistant Agriculture
- Climate Resilient Healthcare
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Every $1 for Risk Mitigation Saves Society $4

Multihazard Mitigation Council
Bang for the Buck – Infrastructure Spend $1.44

<table>
<thead>
<tr>
<th>Fiscal Stimulus Multipliers</th>
<th>Bang for the Buck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax Cuts</td>
<td></td>
</tr>
<tr>
<td>Refundable Lump-Sum Tax Rebate</td>
<td>1.22</td>
</tr>
<tr>
<td>Nonrefundable Lump-Sum Tax Rebate</td>
<td>1.01</td>
</tr>
<tr>
<td>Temporary Tax Cuts</td>
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</tr>
<tr>
<td>Child Tax Credit, ARRA parameters</td>
<td>1.38</td>
</tr>
<tr>
<td>Payroll Tax Holiday for Employees</td>
<td>1.27</td>
</tr>
<tr>
<td>Earned Income Tax Credit, ARRA parameters</td>
<td>1.24</td>
</tr>
<tr>
<td>Job Tax Credit</td>
<td>1.20</td>
</tr>
<tr>
<td>Making Work Pay</td>
<td>1.19</td>
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<tr>
<td>Payroll Tax Holiday for Employers</td>
<td>1.05</td>
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<tr>
<td>Across the Board Tax Cut</td>
<td>0.98</td>
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<tr>
<td>Housing Tax Credit</td>
<td>0.82</td>
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<tr>
<td>Accelerated Depreciation</td>
<td>0.39</td>
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<tr>
<td>Loss Carryback</td>
<td>0.25</td>
</tr>
<tr>
<td>Permanent Tax Cuts</td>
<td></td>
</tr>
<tr>
<td>Extend Alternative Minimum Tax Patch</td>
<td>0.53</td>
</tr>
<tr>
<td>Make Dividend and Capital Gains Tax Cuts Permanent</td>
<td>0.39</td>
</tr>
<tr>
<td>Make Bush Income Tax Cuts Permanent</td>
<td>0.35</td>
</tr>
<tr>
<td>Cut In Corporate Tax Rate</td>
<td>0.32</td>
</tr>
</tbody>
</table>

**Spending Increases**

- Temporary Increase in Food Stamps: 1.71
- Temporary Federal Financing of Work-Share Programs: 1.64
- Extending Unemployment Insurance Benefits: 1.55
- Increase Defense Spending: 1.53
- Increase Infrastructure Spending: 1.44
- General Aid to State Governments: 1.34
- Low Income Home Energy Assistance Program (LIHEAP): 1.13

Note: The bang for the buck is estimated by the one-year $ change in GDP for a given $ reduction in federal tax revenue or increase in spending.

Source: Moody’s Analytics
Cities know the Risks are Beyond Climate Vulnerability
The C40 Cities Finance Facility (CFF) facilitates access to finance for climate change mitigation and resilience projects in C40 cities in developing countries and emerging economies.
City Resilience Strategies

New York City
New Orleans
San Francisco
Norfolk
Berkeley
Boulder
Urban Resilience to Extremes SRN

Linking scholars with city and community practitioners to produce resilient infrastructure data, models, images, maps, stories, and on-the-ground projects in 10 cities to accelerate innovative urban sustainability knowledge and application.

- Resilient in the face of future extreme events
- Provides ecosystem services
- Improves social well being
- And exploits new technologies
How Health, Climate Change, and Social Justice Intersect in Chicago

by 3p Contributor on Wednesday, Dec 14th, 2016  Sociology

I'm immersed in a fascinating variety of projects for the Rockefeller Foundation and Regional Plan Association and all include a similar question about how to finance urban resilience. That got me wondering: What well-known financing solutions could help us to finance more adaptation today?

Here are seven:

1. Climate Reinvestment Act: In the post-housing bust period, Community Reinvestment Act funds have shifted to financing schools and the risk from funding low-income housing. This has been a shift for banks that used to achieve their CRA goals within their general market share in low-value mortgages. So, what if banks modified the credit needs of the communities where they operate using CRA investments for resilience that improved communities, such as green infrastructure to absorb stormwater and prevent flooding? Or how about LaSalle Bank, which a decade ago paid for tree planting along the Chicago marshall route counter urban heat island and runner's heat stress?

2. General Obligation Bonds: Cities are reluctant to assume more debt, worried especially about damaging their bond ratings. Yet, deferred maintenance, presumably triggered partly by insolvency bonds to pay for infrastructure improvements, means that much of the country’s infrastructure earns a dismal grade of D+ from the Society of Civil Engineers. Credit ratings, though, aren’t rational actors and more of them are mindful of reinsurance – which Standard & Poor’s recent reports on the impact of climate risk on sovereigns and corporations – and it’s a great time to borrow with interest rates low and low-risk securities diversified from stocks to a bull market.
Parking lot
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